BEFORE THE SECRETARY OF INTERIOR

CENTER FOR BIOLOGICAL DIVERSITY AND PACIFIC RIVERS COUNCIL Petitioners	)))))))	PETITION TO LIST THE SIERRA NEVADA MOUNTAIN YELLOW-LEGGED FROG (*RANA MUSCOSA*) AS AN ENDANGERED SPECIES UNDER THE ENDANGERED SPECIES ACT

February 8, 2000

EXECUTIVE SUMMARY

The Center for Biological Diversity and Pacific Rivers Council formally request that the United States Fish and Wildlife Service ("USFWS") list the Sierra Nevada population of the mountain yellow-legged frog (*Rana muscosa*) as endangered under the federal Endangered Species Act ("ESA"), 16 U.S.C. § 1531 - 1544. These organizations also request that mountain yellow-legged frog critical habitat be designated concurrent with its listing. The petitioners are conservation organizations with an interest in protecting the mountain yellow-legged frog and all of earth's remaining biodiversity.

The mountain yellow-legged frog in the Sierra Nevada is geographically, morphologically and genetically distinct from mountain yellow legged frogs in southern California. It is undisputedly a "species" under the ESA's listing criteria and warrants recognition as such.

The mountain yellow-legged frog was historically the most abundant frog in the Sierra Nevada. It was ubiquitously distributed in high elevation water bodies from southern Plumas County to southern Tulare County. It has since declined precipitously. Recent surveys have found that the species has disappeared from between 70 and 90 percent of its historic localities. What populations remain are widely scattered and consist of few breeding adults. Declines were first noticed in the 1950's, escalated in the 1970's and 1980's, and continue today. What was recently thought to be one of the largest remaining populations, containing over 2000 adult frogs in 1996, completely crashed in the past three years; only 2 frogs were found in the same area in 1999.

Numerous factors have contributed to the species' decline. Introduced fish, pesticides, ozone depletion, pathogens and cattle grazing have all been identified as factors impacting the species and its habitat.

This petition sets in motion a legal process in which the USFWS has 90 days to determine if the mountain yellow-legged frog may warrant listing under the ESA.

PETITIONERS

Center for Biological Diversity
P.O. Box 40090
Berkeley, CA 94704-4090
(510) 841-0812

Pacific Rivers Council
P. O. Box 6185
Albany, CA 94706-6185
(510) 548-3887

The above-listed petitioners formally request that the United States Fish and Wildlife Service (USFWS) list the Sierra Nevada population of the mountain yellow-legged frog (*Rana muscosa*) as endangered under the federal Endangered Species Act, 16 U.S.C. §1531 - 1544. This petition is filed under 5 U.S.C. § 553(e) and 50 C.F.R. part 424.14. Petitioners also request that mountain yellow-legged frog critical habitat be designated concurrent with its listing, pursuant to 50 C.F.R. part 414.12 and 5 U.S.C. § 553.

USFWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on USFWS.

The petitioners are conservation organizations with an interest in protecting the mountain yellow-legged frog.

The Center for Biological Diversity is a non-profit organization dedicated to preserving all native wild plants and animals, communities, and naturally functioning ecosystems in the Northern Hemisphere.

The Pacific Rivers Council is a non-profit conservation organization dedicated to protecting and restoring the nation's rivers, watersheds, and native aquatic species. The Pacific Rivers Council, as an organization and on behalf of its members, is greatly concerned with protecting and improving aquatic ecosystems in the Sierra Nevada and is committed to the conservation and restoration of native Sierran aquatic species such as the mountain yellow-legged frog. Members of the Pacific Rivers Council live, recreate, and work in the Sierra Nevada and extensively utilize public lands located within the region.

TABLE OF CONTENTS

I. NATURAL HISTORY AND STATUS OF THE SIERRA NEVADA MOUNTAIN YELLOW-LEGGED FROG

The Sierra Nevada population[1] of the mountain yellow-legged frog (*Rana muscosa*) is endangered throughout its range in California and Nevada. This petition summarizes the natural history of the mountain yellow-legged frog, the population information available on the mountain yellow-legged frog in the Sierra Nevada, and the threats to the species and its habitat. Petitioners are seeking listing of the Sierra Nevada population of the mountain yellow-legged frog as endangered under the federal Endangered Species Act ("ESA") and request quick action by the U.S. Fish and Wildlife Service to rescue this species from the brink of extinction.

A. NATURAL HISTORY

1. Description

The mountain yellow-legged frog is a moderate-sized, 40-80 mm (1.5-3.25 inch), highly variably colored frog. The species attains lengths of 67 mm in males, and 80 mm in females (Zweifel 1955, 1968), with average lengths of 56 mm for males and 59 mm for females (Wright and Wright 1949). Dorsal coloration and patterning is highly variable; individuals are usually a mix of brown and yellow, but often with gray, red or green-brown. Some individuals may be dark brown or gray with little pattern (Jennings and Hayes 1994). Dorsal patterns range from discrete dark spots that can be few and large, to smaller and more numerous spots with a mixture of size and shapes, irregular lichen-like patches (thus the name "muscosa"), or a poorly defined reticulum (Zweifel 1955). The posterior half of the upper lip is normally light colored. The throat is white or yellow, sometimes with mottling of dark pigment (Zweifel 1955). The ventral surface and under surfaces of the hind limbs are yellow, with ranges in hue from pale lemon yellow to an intense sun yellow (Wright and Wright 1949). The iris is gold with a horizontal black counter shading stripe (Jennings and Hayes 1994). Dorsolateral folds are present, but not usually prominent (Stebbins 1985). It has no vocal sacs, and the tympanum is smoother than in the foothill yellow-legged frog, *Rana boylii* (Slevin 1928; Wright and Wright 1949; Zweifel 1955, 1968). There is well-developed webbing on the hind feet (Wright and Wright 1949). The mountain yellow-legged frog produces an odoriferous secretion when disturbed (Zweifel 1968). Males average slightly smaller than females and have a swollen, darkened thumb (inner finger) base (Zweifel 1955).

2. Taxonomy

The mountain yellow-legged frog, *Rana muscosa*, is a true frog in the family Ranidae. *Rana muscosa* is a member of the *Rana boylii* group (Zweifel 1955). Mountain yellow-legged frogs were

---

[1] The term "population" is used here to refer to the distinct population segment ("DPS") encompassing all mountain yellow-legged frogs occurring within the Sierra Nevada. In the discussion of distribution and abundance in section I.B below, "population" is used to refer to individual groupings of frogs by drainage, lake, or locality.

originally described by Camp (1917) as a subspecies of *Rana boylii*. The Sierran populations were named *Rana boylii sierrae,* while those of southern California were named *Rana boylii muscosa*. Zweifel (1955) demonstrated that frogs from the high Sierra and the mountains of southern California were somewhat similar to each other yet were distinct from the rest of the *R. boylii* (=*boylei*) group. Since that time, most authors have followed Zweifel, treating the mountain yellow-legged frog as a full species, *Rana muscosa*.

The best current scientific evidence available indicates that Sierra Nevada populations of the mountain yellow-legged frog constitute a distinct taxonomic unit separate from frog populations inhabiting southern California mountain ranges. Current scientific evidence strongly indicates that Sierra Nevada populations of the mountain yellow-legged frog are a distinct species that warrants the FWS's consideration as a full species separate from the frog populations inhabiting southern California. This is the taxonomic arrangement as originally proposed by Camp (1917) and followed by Stejneger and Barbour (1923, 1933, 1939, 1943), Wright and Wright (1949), and Stebbins (1951, 1954), who named frog populations in the Sierra Nevada as *Rana sierrae* and frog populations in southern California as *R. muscosa*.

Both taxa are separated by a natural geographic land barrier, the Tehachapi mountain range. Based on electrophoretic studies of isozyme loci, the two taxa are significantly different from one another (Green 1986, 1995). Previously, morphological differences have been noted between mountain yellow-legged frogs collected from the Sierra Nevada and mountain yellow-legged frogs collected from southern California (Camp 1917; Zweifel 1955). However, Zweifel (1968) felt these differences were insufficient to indicate a meaningful taxonomic relationship. Since 1968, further scientific evidence indicates otherwise. In addition to significant biochemical differences (Vredenburg and Macey, in prep.), there is also a significant difference ($p < 0.0001$) in breeding vocalizations between the *R. muscosa* populations in southern California and those in the Sierra Nevada mountains (Zeismer 1997). In the Proposed Rule for listing the southern California Distinct Population Segment of the frog, the U. S. Fish and Wildlife Service determined that significant geographical, ecological, vocal, and genetic discontinuities exist between the two taxa (64 Fed. Reg. 71714, at 71717).

The apparent lack of gene flow between these taxa in the Sierra Nevada and southern California, as well as documented morphological differences, significantly distinct breeding vocalizations, and behavioral and geographical isolation, indicates that the southern California populations of the mountain yellow-legged frog warrant recognition as a separate and distinct species from mountain yellow-legged frogs in the Sierra Nevada.

Regardless of whether the Sierra Nevada and southern California populations are recognized as separate species or subspecies, they are undisputedly distinct, significant population segments that fall within the statutory and regulatory definitions of "species" under the ESA. This is described in greater detail in Section II.A, below.

3. Distribution

In the Sierra Nevada Mountains of California and Nevada the mountain yellow-legged frog ranges from southern Plumas County to southern Tulare County (Jennings and Hayes 1994), at elevations mostly above 1,820 meters (m) (6,000 feet (ft)). The known elevation range of *R. muscosa* in the Sierra Nevada extended from ca. 1370 m (San Antonio Creek, Calaveras County: Zweifel 1955) to over 3650 m (near Desolation Lake, Fresno County: Mullally and Cunningham 1956). A newly documented locality in 1997 from Pinkard Creek meadow, Butte County, extends the lower limit to 3,425 feet (USFS 2000a). With the exception of an isolated population in Butte County (now extirpated), its historic distribution was continuous in the Sierra Nevada. The frogs of the Sierra Nevada are isolated from the frogs of the mountains of southern California by the Tehachapi Mountains and a distance of about 225 kilometers (km) (140 miles (mi)). The southern California frogs now occupy portions of the San Gabriel, San Bernardino, and San Jacinto Mountains. Zweifel (1955) noted the presence of an isolated southern population on Mt. Palomar in northern San Diego County, but this population appears to be extinct (Jennings and Hayes 1994). In southern California, the elevation range reported by Stebbins (1985) is 370 m (1200 ft) to 2,290 m (7,500 ft). The current and historic distribution of the Sierra Nevada population of the mountain yellow-legged frog is described in detail in Section I.B, below.

4. Habitat

The mountain yellow-legged frog in the Sierra Nevada is found in glaciated lakes, ponds, tarns, springs, and streams (Storer 1925; Slevin 1928; Wright and Wright 1949; Stebbins 1951; Mullally and Cunningham 1956; Zweifel 1968). The species is usually associated with montane riparian habitats in lodgepole pine, yellow pine, sugar pine, white fir, whitebark pine, and wet meadow vegetation types (Zweifel 1955; Zeiner et al. 1988). Alpine lakes used by mountain yellow-legged frogs usually have margins that are grassy or muddy (Zweifel 1955), but they are not limited to this habitat. Streams utilized vary from rocky, high gradient streams with numerous pools, rapids, and small waterfalls to those with marshy edges and sod banks (Zweifel 1955). However, the species seems to prefer streams of low gradient and slow or moderate flow, probably due to flood effects (Storer 1925; Stebbins 1951; Heller 1960). Reproduction is also not possible in high gradient streams, as tadpoles require slack water (R. Knapp, pers. comm., 2000). Very small, shallow streams are not frequently used (Mullally and Cunningham 1956), probably because they lack the water depth necessary for refuge and overwintering sites (Jennings and Hayes 1994); however, this habitat type will be used if there are large source populations nearby (V. Vredenburg, pers. comm., 2000). Aquatic substrates utilized are highly variable, from plunge pool habitats to fine sand, rubble, and boulder substrate.

Adults are typically found sitting on rocks along the shoreline, usually where there is little or no vegetation (Wright and Wright 1949). Most frogs are seen on a wet substrate within 1 m of the water's edge. Both adults and larvae are most frequently found in areas with shallow water, partly because these are the warmest areas (Bradford 1983), and also because these areas provide refuge from fish predation (Jennings and Hayes 1994). Mountain yellow-legged frogs are sometimes found sitting upon the edge of ice sheets, but this is only for a few days a year, in early springtime (V. Vredenburg, pers. comm., 2000). The frogs will move over ice to get to breeding sites (Vredenburg, unpublished data). Some of the highest densities of frogs have been found at both creek junctions with irregular banks and a variety of water depths, and at marshes on the edges of lakes (Mullally and Cunningham 1956).

Mountain yellow-legged frogs in the Sierra Nevada deposit their eggs underwater in clusters attached to rocks, gravel, vegetation, or under banks (Zweifel 1955). Since tadpoles must overwinter at least once before metamorphosis, breeding sites are generally located in or connected to lakes and ponds that do not dry in the summer, and that are sufficiently deep (>2 m) so as to not freeze through in winter (Bradford 1983). Successful breeding occasionally has been observed in ponds less than 2 m deep (Pope 1999). Since larvae are susceptible to fish predation, successful breeding sites do not overlap with fish presence (Vredenburg, unpublished data).

5. Behavior

a. Movement

The mountain yellow-legged frog is a diurnal species that emerges from overwintering sites immediately following snowmelt (Zweifel 1955; Heller 1960). Mountain yellow-legged frogs are almost always found within 2-3 feet from water (Stebbins 1951; Mullally and Cunningham 1956; Karlstrom 1962). They are observed to rest on the bank or in clumps of vegetation and jump into the water when disturbed. They usually find refuge under rocks or crouch on the lake or stream bottom (Grinnell and Storer 1924; Storer 1925; Mullally and Cunningham 1956; Heller 1960). Tadpoles resting in shallow water will swim to deeper areas when disturbed (Grinnell and Storer 1924). Mountain yellow-legged frogs have been found to modulate temperatures by basking in the sun, moving between water and land, and through micro-habitat selection. Bradford (1983) found at least 80% of *R. muscosa* basking in the sun on wet soil in the morning. In the afternoon, they moved to shallow water near the shore, and then into deeper water at night. Tadpoles maintain high body temperatures by selecting warm shallow areas (Bradford 1983).

Adult frogs in the San Bernardino Mountains have been observed on land during the winter months on sunny days (Mullally 1959), but most Sierran habitats for the frog are buried by snow during the winter. Frogs apparently must hibernate in water during the coldest winter months (Mullally 1959), probably because they can tolerate only limited dehydration (Hillman 1980). Tadpoles and adults generally overwinter under ice (Grinnell and Storer 1924; Mullally 1959). A recent survey suggests that some adults may overwinter near shore under ledges and in deep underwater crevasses (Matthews and Pope 1999).

Mountain yellow-legged frogs do not have a distinct breeding migration, as adults spend most of their time in the vicinity of suitable breeding habitat (Bradford 1983). In some areas there is a seasonal movement from deeper lakes more favorable to overwintering to nearby areas that are more favorable to breeding (Matthews and Pope 1999; Vredenburg, et al. in press). While movement of distances up to 1 km have been observed, mountain yellow-legged frogs typically move less than a few hundred meters (Vredenburg, et al. in press). Juvenile dispersal is largely unknown, although Bradford (1991) reported juveniles in small intermittent streams that might have been dispersing to permanent water.

b. Reproduction and Growth

Mountain yellow-legged frogs breed soon after ice melt, in June or July (Grinnell and Storer 1924; Storer 1925; Wright and Wright 1949; Zweifel 1955). Females lay up to 800 eggs per mass (Zweifel 1955). Livezey and Wright (1945) report an average of 233 eggs per egg mass. Vredenburg et al. (in press) reported egg masses with as few as 15 eggs. Oviposition may occur in shallow water (Wright and Wright 1949) or deep water (Karlstrom 1962). Egg masses have been found attached to the lower sides of undercut banks or to rocks on the bottoms of streams (Zweifel 1955). Wright and Wright (1949) noted egg masses attached to banks of small streams. In the Sierra Nevada, the majority of breeding occurs in lakes and ponds, with the eggs attached to vegetation, banks, or rocks (V. Vredenburg, pers. comm., 2000).

Zweifel (1955) recorded hatching times ranging from 18-21 days in laboratory conditions. The length of the larval stage is variable and seems related to elevation and temperature. In lower elevations where summers are longer, tadpoles are thought to be able to grow to metamorphosis in a single season (Storer 1925). However, Vredenburg et al. (in press) report that throughout the Sierra, populations are clearly composed of three size classes that likely correspond to year classes. Larvae at high elevations or those subject to severe winters may not metamorphose until the end of their fourth summer (Vredenburg, et al. in press).

Larvae may reach 72 mm total length, and usually transform during July or August (Wright and Wright 1949). Newly metamorphosed individuals are 20-27 mm (Wright and Wright 1949). The time required to reach reproductive maturity is unknown. Likewise, longevity is unknown.

c. Feeding

Large mountain yellow-legged frogs are thought to feed preferentially upon terrestrial insects and adult stages of aquatic insects while on the shore and in shallow water (Bradford 1983). Feeding studies on Sierran mountain yellow-legged frogs are limited. Remains found inside the stomachs of southern California frogs include beetles, flies, wasps, bees, ants, true bugs, and spiders (Long 1970). Sierran frogs are known to consume large quantities of Yosemite toad (*Bufo canorus*) and Pacific treefrog (*Hyla regilla*) tadpoles (Mullally 1953; Zeiner et al. 1988; Pope 1999a), and are cannibalistic (Heller 1960). Sierran mountain yellow-legged frog tadpoles have been seen cannibalizing thousands of conspecific eggs as well as feeding on the carcasses of dead metamorphosed conspecifics (Vredenburg, et al. in press). Tadpoles graze on algae and diatoms along rocky bottoms in streams, lakes, and ponds (Zeiner et al. 1988).

6. Natural Mortality

a. Predators

Reported native predators of mountain yellow-legged frogs include western terrestrial garter snakes (*Thamnophis elegans*), Brewer's blackbirds (*Euphagus cyanocephalus*), Clark's nutcrackers (*Nucifraga columbiana*), coyotes (*Canis latrans*), and black bears (*Ursus americanus*) (Camp 1917; Moore 1929; Zweifel 1955; Mullally and Cunningham 1956; Bradford 1991; Vredenburg, et al. in press). Additionally, cannibalism has been observed in the species (Heller 1960; Vredenburg, et al. in press).

Non-native predators include various introduced trout species; Rainbow trout (*Oncorhynchus mykiss*), golden trout (*Oncorhynchus aguabonita*), brook trout (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*) have all been observed preying on mountain yellow-legged frogs (Grinnell and Storer 1924, Needham and Vestal 1938). The impacts of non-native trout on the species are described in Section II.B.5.a below.

b. Disease

Bradford (1991) observed a large scale die-off of mountain yellow-legged frogs from red-legged disease caused by a bacterium (*Aeromonas hydrophila*). Recently, a chytrid fungus has been found infecting tadpoles and sub-adults (Vredenburg, et al. in press). The impacts of disease on the species are further described in Section II.B.3.a below.

c. Other Mortality

Life history characteristics such as overwintering under frozen lakes and multi-year larval development make the mountain yellow-legged frog susceptible to large scale die-offs. In lakes <4 m deep, overwintering frogs may die apparently due to oxygen depletion, while tadpoles are able to survive (Bradford 1983). In 1978, winterkill was responsible for the mortality of all but one adult in 21 of 26 lakes monitored, while tadpoles survived in all 26 lakes (Bradford 1983). Conversely, in dry years tadpoles are lost to desiccation in the late summer or fall (Mullally 1959).

B. DISTRIBUTION AND ABUNDANCE

1. Historic Distribution and Abundance

a. Sierra Nevada in General

Verified museum records indicate that *R. muscosa* was historically well distributed almost continuously throughout the Sierra Nevada in California at moderate to high elevations, from southern Plumas County to southern Tulare County (Jennings and Hayes 1994). The historic range extended into Nevada only in the vicinity of Lake Tahoe and northward on the slopes of Mount Rose (Linsdale 1940; Zweifel 1955). Disjunct population clusters occurred to the north and the south of the main body of this geographic range. The northernmost population cluster was separated from the main Sierra group by the Feather River Canyon, and ranged from the vicinity of Butts Creek in Plumas County (Jennings and Hayes 1994) to the upper reaches of the Butte Creek drainage in Butte County (Zweifel 1955). In the southern Sierra, a single individual collected in 1952 on Breckinridge Mountain in Kern County was tentatively identified as *R. muscosa* (Jennings and Hayes 1994). The known elevation range of *R. muscosa* in the Sierra Nevada extended from ca. 1370 m (San Antonio Creek, Calaveras County: Zweifel 1955) to over 3650 m (near Desolation Lake, Fresno County: Mullally and Cunningham 1956).

b. State of Nevada

R. muscosa historically occurred in Nevada in the vicinity of Lake Tahoe and northward on the slopes of Mount Rose (Linsdale 1940). Linsdale reported that records ranged from 6,300 feet to 9,300 feet, along small streams and in small shallow lakes in meadows. In the general vicinity of Incline Lake, mountain yellow-legged frogs were collected in the 1920's (Panik, 1995a). Specific collection sites mentioned by Linsdale were: 5.5 miles north of Incline at 9,300 feet, and Incline at the north end of Lake Tahoe; 3 miles south of Mount Rose at 8,500 feet; and at Lake Tahoe. Other specific historic collection sites have been recorded in Nevada: a single frog was collected ½ mile south of Mount Rose Summit at 8,500 feet, by J. M. Savage and C. F. Walker in 1955 (Panik 1995); and a single specimen was obtained at the Whittell Tract at Little Valley in the Carson Range (Ryser 1966, unpublished manuscript, as cited in Panik 1995). The most recent observations of *R. muscosa* in Nevada were by Fred Ryser, in the Tahoe Meadows area. Ryser stated that he saw “many” mountain yellow-legged frogs in Tahoe Meadows and in ponds near Galena Creek from about 1965 to 1984 (Ryser, pers. comm., as cited in Panik 1995).

Other than the “many” frogs observed by Ryser, there are no accounts of the historical abundance of the species in Nevada.

c. Lassen National Forest

R. muscosa was historically present in the southern portion of Lassen National Forest and surrounding areas. Collections were made from the Butte Creek watershed and tributaries to the West Branch Feather River system (Cal. State Univ. Chico; Zweifel 1955). These historical occurrences are part of the isolated populations of the mountain yellow-legged frog, separated from the main Sierra group by the Feather River Canyon (M. Jennings, pers. comm., as cited in McFarland 1999). In Butte County, a frog was collected from De Sabla in 1945; at Coon Hollow along the west branch of the Feather River, 17 specimens were collected in 1961; a single frog was collected from Philbrook Lake in 1961; and C. Dokos collected 7 specimens from Bull Hill Creek and Snag Lake in 1965 and 1966. In Nevada County, 3 specimens of *R. muscosa* were collected from Paradise Lake in 1961 (Cal. State Univ. Chico).

d. Lassen Volcanic National Park

There are no historic records of *R. muscosa* occurring in Lassen Volcanic National Park (NPS 1999).

e. Plumas National Forest

In Plumas County 8 specimens of *R. muscosa* were collected from near LaPorte in 1960; 2 frogs were collected from Butts Creek and 5 frogs from Big Grizzly Creek in 1961(Cal. State Univ. Chico; Vindum and Koo 1999). A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates that there were additional historic sightings and collections of the species within the Plumas National Forest.

f. Tahoe National Forest

R. muscosa was historically present throughout the Tahoe National Forest and the surrounding areas of Sierra, Nevada, and Placer Counties. In Sierra County C. Williams collected 2 specimens from Lincoln Creek in 1961 (Cal. State Univ. Chico). In Nevada County H. Houser collected 91 specimens from 10 locations during the 1960's and D. Torgerson collected 8 specimens from 3 locations in 1961 (Cal. State Univ. Chico); A. C. Ziegler collected an unknown number of frogs at 8 locations, and an additional 13 adult frogs and 12 larvae from Sagehen Creek in 1961; F. Mine collected 3 frogs at Upper Sagehen Creek in 1965; frogs were collected at Poorman Creek in 1966 and 1969; and S. M. Case collected 13 frogs from 4 locations, including 10 specimens from Poorman Creek in 1973 and 1974 (USFS 1999). At the western end of Donner Lake frogs were caught during 1964 and 1965 by Hal Michael (Panik, 1995a). In Placer County, P. De Benedictis collected 26 specimens of *R. muscosa* at 8 locations in 1960 (USFS 1999). A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates that the species was historically well distributed throughout the Tahoe National Forest. The number of specimens collected in the 1960's and 1970's indicates that the species was fairly abundant at that time (USFS 1999).

g. Lake Tahoe Basin Management Unit

There are numerous historical sightings of *R. muscosa* in the Lake Tahoe Basin Management Unit, and anecdotal accounts indicate that the species was once quite abundant in the Lake Tahoe area (Matt Slesinger, USFS, pers. comm., 2000). The Museum of Vertebrate Zoology at the University of California, Berkeley has a number of specimens collected from the basin (Matt Slesinger, USFS, pers. comm., 2000). The species was formerly abundant “everywhere” in Alpine Meadows, Squaw Valley, and at Granite Chief, and literally thousands of frogs were seen each year at Lake Estelle from 1968-1974 (M. Graf, pers. comm., 1999).

h. Eldorado National Forest

There is some record of mountain yellow-legged frogs in the Pacific Ranger District of the Eldorado National Forest in the 1970's. Three adult frogs were collected at Smith Lake and 4 adults at Grouse Lake around approximately 1974 (Cal. Dept. Fish and Game - Natural Diversity Database). The species historically was very abundant in Pyramid Peak Lake and an adjacent lake (Lake 863) formerly known as the "frog ponds" (USFS 1999a). A permittee for the grazing allotment encompassing this lake reported that frogs had been common in the ranch area before the drought of 1976-77, and that seeing 4 or 5 on a gravel bar was not unusual (Lonnell Wilson, pers. comm., as cited in USFS 1999a). The species was formerly abundant in Desolation Wilderness, in lakes from Lake Schmidell towards Wrights Lake (M. Graf, pers. comm., 1999).

Other than this information, the Eldorado National Forest produced no historic records of *R. muscosa* in response to a 1999 Freedom of Information Act ("FOIA") request from the Southwest Center for Biological Diversity ("SWCBD"). A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates historic sightings and collections of the species throughout the southern half of the Eldorado National Forest.

i. Stanislaus National Forest

The Stanislaus National Forest has no historic records of *R. muscosa* (Laura Conway, USFS, pers. comm. 1999). A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates historic sightings and collections of the species within the Stanislaus National Forest.

j. Toiyabe National Forest

In 1951, a California Department of Fish and Game ("CDFG") survey of Summit Meadow Lake in Alpine County found frogs and tadpoles "plentiful" (CDFG 2000). In the 1960's biologist Lawrence Cory found a "thriving population with an unusually dense larval population" of *R. muscosa* in a pond connected to Koenig Lake in the Levitt Lake basin east of Sonora Pass (Cory 1989). A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates historic collections of the species within the Toiyabe National Forest.

k. Yosemite National Park

From 1914-1920 biologists J. Grinnell and T. I. Storer led a biological survey along a transect across the Sierra Nevada. They documented *R. muscosa* (=*R. boylii sierrae* of Grinnell and Storer) at 14 sites throughout Yosemite National Park and noted that the yellow-legged frog was the most abundant amphibian along the Yosemite Section of their survey. Numerous frogs were found in lakes and streams throughout the high-elevation portion of the Yosemite transect, from Westfall Meadows and Porcupine Flat east to the head of Lyell Canyon and Tioga Pass (Grinnell and Storer 1924). "Hundreds of frogs" were found at Young Lake and frogs were "very numerous" at Westfall Meadow (Camp field notes 1915, as cited in Drost and Fellers 1994). Large numbers of specimens were collected, for example 25 were taken at Vogelsang Lake (Grinnell field notes 1915, as cited in Drost and Fellers 1994).

From 1933-1935 the species was collected from 5 locations in Tuolumne and Mariposa Counties within the park (Martin 1940).

In 1939 and 1940 *R. muscosa* was collected from over 25 locations throughout Yosemite National Park (NPS 1999a). Frogs were described as "especially numerous" at Upper McCabe Meadows and "thousands" were counted near Middle McCabe Lake. The species was "abundant" in lakes and streams in Virginia Canyon from 10,800 to 11,200 feet, and "very numerous" in Upper Virginia Canyon's lakes, ponds, and streams. Tadpoles were found "swarming" along the edge of a lake just north of Isberg Peak (NPS 1999a).

The frog was documented at 6 additional locations in the park from 1957 to 1960 (Heller 1960; NPS 1999a). Dr. David Wake, a herpetologist with the U. C. Berkeley Museum of Vertebrate Zoology, reported that while hiking in 1959 near Tioga Pass in Yosemite National Park, he saw so many mountain yellow-legged frogs that "it was difficult to walk without stepping on them" (Parker 1994). Mullally and Cunningham (1956) remarked that some of the "densest aggregations of frogs ever noted" were within lakes near Ostrander Lake south of Glacier Point, but that in 1950 no frogs were found in Ostrander Lake.[2] They also observed frogs in 1955 at Tuolumne Meadows, Gaylor Lakes, Johnson Lake, and "abundant" numbers at Elizabeth Lake[3] (Mullally and Cunningham 1956).

Dr. Lawrence Cory, a biologist with St. Mary's College, did extensive collecting of *R. muscosa* in the Sierra through the 1960's, including locations within Yosemite National Park (Cory et al. 1970). Cory noted dense populations of the species, in some cases from "several dozen to hundreds of adults and with swarms of tadpoles"(Cory 1989). Cory observed a population at Mono Pass of "certainly hundreds of adults and swarms of hundreds of tadpoles"; a "very abundant" population in a small lake north of Mt. Hoffman; a "moderate population (estimated at dozens)" east of Ostrander Lake; and a population west of the May Lake basin.

A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates historic sightings and collections of the species throughout Yosemite National Park.

---

[2] Mullally and Cunningham also noted that Ostrander Lake has many trout "possibly planted."

[3] As well as at Porcupine Flat and Tioga Pass.

l. Inyo National Forest

Notes from the Grinnell and Storer survey apparently indicate that there was a population of the species on the east side of the Sierra at Farrington Ranch before 1920 (Drost and Fellers 1994). *R. muscosa* was collected or observed at over 25 locations in and adjacent to Inyo National Forest between 1911 and 1968[4] (Parker 1994; CDFG 1998). There is no indication of numbers of frogs collected or the abundance of the populations for most of these records. In 1954 5-10 adult frogs were seen at Pine Creek Pass. Douglas Powell reported frogs in 1955 in Cottonwood Basin, White Mountains, southeast of White Mt. Peak (Giuliani 1996). Scattered sightings of 1-2 adults were reported from 6 locations in the National Forest from 1966-1968. Mountain yellow-legged frogs were "common" on the Kern River within the Inyo National Forest until the 1950's (Roland Knapp, pers. comm., as cited in Parker 1994).

Reports from local ranchers (Tom Noland, pers. comm., as cited in Parker 1994) and research by herpetologist Bob Hansen (Hansen 1980) indicate that *R. muscosa* was abundant in the Inyo National Forest in the 1970's. According to Hansen, it was once difficult to walk in Crooked Meadows without stepping on them (Bob Hansen pers. comm., as cited in Knapp 1993). During surveys of the east slope of the White Mountains in the 1970's "numerous" mountain yellow-legged frogs were found at Fish Lake (Giuliani 1994).

A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates historic sightings and collections of the species on the Sierra Nevada side of the Inyo National Forest.

m. Sierra National Forest

In 1955 Mullally and Cunningham (1956) reported encountering *Rana muscosa* along Piute Creek "very sparingly" at 7700 ft., with frogs becoming more abundant at higher elevation. The "densest populations" were found above 10,000 ft. in the Humphrey's Basin area and a "great many, including tadpoles" were noted at and near Pine Creek Pass, with frogs also seen at Golden Trout and Desolation Lakes (Mullally and Cunningham 1956). Biologist Lawrence Cory reported seeing a "thriving" population of *R. muscosa* in a pond one-half mile south of Corbett Lake in the Kaiser Wilderness area of Fresno County in the 1960's (Cory 1989).

The Sierra National Forest produced no historic records of *R. muscosa* in response to a 1999 FOIA request from the SWCBD. A distributional map of *R. muscosa* produced by Jennings and

---

[4] In Tulare County - Monache Meadow 1911, and in Big Whitney Meadow, Ramshaw Meadow, and Golden Trout Creek. In Inyo County - Matlock Lake 1912; Kenneth Lake 1953; and Little Lakes Valley 1967. In Mono County - Pine City 1921; Mammoth Lakes 1922; Tioga Lake 1932, 1953; Hot Creek 1933; Tioga Pass 1939, 1949, 1950, 1954, 1955, 1956; Saddlebag Lake 1948; northeast of Tioga Pass 1964; Bennetville Trail 1966; Clark Lakes 1966; and Greenstone Lake 1968. In Fresno County - Fish Creek 1941; Pine Creek Pass 1945, 1954; and Duck Lake, unknown date. In Madera County - Crater Creek Meadow 1946; Shadow Lake 1951; Ediza Lake 1951; Pumice Flat 1966; Nydiver Lakes 1968 (CDFG Database); and Donohue Pass 1946. Off Inyo National Forest - Moon Lake 1958; Desolation Lake 1956; and Humphrey's Basin 1956 (Inyo National Forest files).

Hayes (1994) indicates that there were historic sightings and collections of the species within the Sierra National Forest.

n. Sequoia and Kings Canyon National Parks

There are relatively few accurate records for *R. muscosa* prior to 1955 in these National Parks. The species was known historically from museums, literature, park records, and personal communication to occur in at least 21 sites between 1955 to 1979, scattered throughout Sequoia and Kings Canyon National Parks. The headwaters of 7 creek systems were surveyed for *R. muscosa* in the parks in 1978-1979, and frogs were found at 27 sites greater than 200 meters apart (Bradford et al. 1994). Bradford et al. (1994) gave no indication of historic abundance of the species. A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicates numerous historic sightings and collections of the species within both National Parks.

o. Sequoia National Forest

R. muscosa was collected from at least 8 locations[5] throughout the Kern Plateau in Sequoia National Forest between 1891-1966, and at least 7 other locations from 1970-1979 (Hansen 1980; USFS 1999b). 49 specimens were collected at one location on a single day in 1934, and Karlstrom collected 7 frogs from a single location in 1955 (USFS 1999b). A distributional map of *R. muscosa* produced by Hansen (1980) indicates historic collections of the species in the Kern River and South Fork Kern River drainages.

2. Current Distribution and Abundance

a. Sierra Nevada in General

R. muscosa has disappeared from a significant extent of its historic range in the Sierra Nevada. Although small populations of mountain yellow-legged frogs remain widely scattered throughout the Sierra Nevada, the overall population of the frog has declined dramatically. This is most notable in the northern-most 125 km of the range (north of Lake Tahoe) and the southern-most 50 km, where only a few populations have been found in recent years (Jennings and Hayes 1994; Fellers 1999). North of Sierra National Forest there appears to be very few or no known large populations, based on analysis of amphibian survey data, a recent report by Gary Fellers on Yosemite National Park (Fellers 1999), and collected positive sightings from the Plumas, Tahoe, Eldorado, and Stanislaus National Forests (C. Davidson, pers. comm. 2000). In the southern Sierra (Sierra and Inyo National Forests and Sequoia and Kings Canyon National Parks) there are multiple documented large populations (32 sites with over 100 adults, 82 sites with 25 or more adults, and 149 sites with 10 or

[5] Taylor Meadow; Manter Meadow; Jackass Meadow; Beach Meadow; French Joe Meadow; Dunlap Meadow; Quaking Aspen Meadow; and 2 miles north-northwest of Johnsondale.

more adults) (Davidson, pers. comm., 2000), but some of the largest known populations have recently collapsed (e.g. Dry Creek/Crooked Meadows population in the Inyo National Forest - see section I.B.2.l below). It does not appear that the difference in numbers of *Rana muscosa* sites in the northern and the southern Sierra is a result of gross differences in survey effort[6] (C. Davidson, pers. comm, 2000). A significant number of local populations have apparently become extinct in the Sierra Nevada since the 1960's (e.g. Bradford et al. 1991, 1994; L. Cory, R. Hansen, D. Martin, pers. comm., as cited in Jennings and Hayes 1994).

A large number of Sierran populations have disappeared, but the exact extent of decline is unclear due to a lack of systematic surveys (Jennings and Hayes 1994). An increase in survey efforts in recent years has resulted in new locations of the species being found, though mostly of individual frogs or small populations. The most useful information for assessing the extent of declines of the mountain yellow-legged frog comes from re-survey efforts of sites of known locations, where the frog was historically documented.

Jennings and Hayes (1994) sampled known frog locations across the Sierra and noted a 50% decline, but many of his samples were from Sequoia and Kings Canyon National Parks, where populations are larger and more abundant than in the rest of the Sierra (Knapp and Matthews 2000). Jennings and Hayes (1994) identified over 145 known historic locations for *R. muscosa* throughout the Sierra Nevada from verified museum records and sightings. They determined, based on interviews with herpetologists and field surveys from 1988-1991, that the species was extant in only 42 of those locations, a decline of at least 71%. The species was absent south of Sequoia and Kings Canyon National Parks and in the northern Sierra and Feather River Canyon area.

Between 1989-1993, Bradford et al. (1994) re-surveyed historic sites documented between 1959-1979. In western Sequoia National Park they re-surveyed 27 historic sites without finding any frogs, and elsewhere in Sequoia and Kings Canyon National Parks they re-surveyed 22 historic sites, and only 11 contained frogs (Bradford et al. 1994). North of Kings Canyon up into Yosemite National Park they re-surveyed 24 historic sites and found frogs at only 3 sites (Bradford et al. 1994). In another re-survey effort, Drost and Fellers (1996) compared historic mountain yellow-legged frog presence at 14 sites surveyed in 1915 by Grinnell and Storer (1924) to distributions in 1995. Drost and Fellers found frogs at only 2 of these sites (a single tadpole at one site, and an adult female at another), whereas Grinnell and Storer (1924) had noted that "the yellow-legged frog is the commonest amphibian in most parts of the Yosemite section" (Drost and Fellers 1996). Combining data from these two re-survey efforts (Bradford et al. 1994; Drost and Fellers 1996), of 86 historic sites (surveyed 1915-1959), only 16 contained frogs when they were re-visited between 1989-1995. This is an 82% decline in distribution. Abundance of frogs in re-surveyed areas was also very low. Herpetologist Vance Vredenburg (U. C. Museum of Vertebrate Zoology) estimates from conversations with herpetologists studying the species that an accurate estimate of the current declines throughout the Sierra is closer to 90% (Vredenburg, pers. comm. 2000).

---

[6] In the four northern National Forests (Plumas, Tahoe, Eldorado, and Stanislaus) there are 2,222 amphibian records compared to 3,544 records in the south (Sierra and Inyo National Forests, Sequoia and Kings Canyon National Parks), and this comparison does not include 1,659 site records (one or more species at a site) from Yosemite National Park

Historically, where found, the frog was often documented in great abundance (Grinnell and Storer 1925; Needham and Vestal 1938). In many areas of the Sierra Nevada where mountain yellow-legged frog populations persist, herpetologists have noted sharp declines in abundance from historic numbers. Only a few frogs have been observed in the extreme northern end of the range since the 1970's (unpublished data cited in Jennings and Hayes 1994). For example, *R. muscosa* was still abundant when Dr. Lawrence Cory (St. Mary's College, Moraga, California) sampled the length of the Sierra Nevada beginning in the late 1950's and the 1960's. Cory found the species present in "good numbers" in the 1970's. Cory returned to previous survey sites in 1988 and 1989 and found no frogs anywhere in the northern Sierra, a only a few in the southern Sierra. However, Cory's survey did not cover all known historic sites (Stebbins and Cohen 1995).

The current known distribution and abundance of the mountain yellow-legged frog is summarized below for each National Forest and National Park in the Sierra. Re-survey efforts which illustrate the extent of frog declines in each area are emphasized, as are large remaining populations of frogs. A population is considered large if it has more than 20 adults or has numerous frogs of multiple year classes. This is an arbitrary, although very conservative, judgement of what constitutes a viable frog population. Smaller populations of frogs are increasingly vulnerable to extinction, as discussed in section II.B.5.h below, although even large frog populations have crashed in recent years (e.g. the Dry Creek/Crooked Meadows populations in the Inyo National Forest: see below). Additionally, since predation is so high and survival rates of young frogs so low, finding large numbers of eggs, larvae, and tadpoles is not an indication that a population is secure. In the absence of large meta-populations to re-colonize suitable habitat after localized extinctions, even populations of 20 or more adults should be considered at risk. Surveys for the frog where the number of sites searched or some other measure of survey intensity is known are mentioned to illustrate the current abundance (or absence) of frogs for each area. A more thorough examination of recent survey data, including locations and abundance, can be found in Appendix 1.

b. State of Nevada

R. muscosa was not observed at any of 45 sites in the Carson Range of the Sierra Nevada surveyed by the Nevada Division of Wildlife in 1994-1995, and at least 7 of the sites surveyed were historical sites (Panik 1995). The species was not found at any survey sites in the vicinity of Incline Lake in 1994 or 1995. 1995 surveys of 10 creeks in the Carson Range, including electroshock surveys in 6 of these creeks failed to locate the species (Panik 1995). A few scattered sightings have recently been reported in Nevada (D. Bradford, pers. comm., 2000), but these apparently were all of individual or extremely small numbers of frogs (R. Panik, pers. comm, 2000). It appears that the species has declined to near extinction in Nevada.

c. Lassen National Forest

No *R. muscosa* were found during surveys of 140 sites from 1993-1997, including in drainages with historical occurrences (USFS 1993, Fellers 1998). It appears that the species has been extirpated from Lassen National Forest, or that if it is still present the population has declined to near extinction.

d. Lassen Volcanic National Park

The species does not occur in Lassen Volcanic National Park (NPS 1999).

e. Plumas National Forest

Jennings and Hayes (1994) noted that the species was extinct in a number of locations where it was historically extant, based on re-surveys. Surveys by the Plumas National Forest from 1990-1999 have recorded the species in only a handful of locations. Most observations have been of individual frogs and sites with even 2 or 3 specimens are rare (Twedt and Evans 1993; Fellers and Freel 1995; Fellers 1997a; Vindum and Koo 1999; USFS 1994, 2000a). Analysis of amphibian survey data and collected positive sightings from the Plumas National Forest indicates that there are currently 54 known sites with *Rana muscosa*, but for the most part data on the numbers seen is not available (C. Davidson, pers. comm., 2000). The species appears to have disappeared from a significant number of historic locations and the abundance of the species appears to be quite low. The isolation of these populations makes the viability of the frog in Plumas National Forest doubtful unless immediate action is taken.

f. Tahoe National Forest

Jennings and Hayes (1994) indicate that the species was extinct by 1992 in a number of locations, based on re-surveys of historic locations. The Tahoe National Forest conducted amphibian surveys from 1993-1998, but the extent and thoroughness of these surveys is not reported. Mountain yellow-legged frogs were found in only a handful of locations and most observations were of individual frogs (USFS 1999). The largest population was a sighting of 5 adults and “many” larvae at Soda Springs in 1998 (USFS 1999). Analysis of amphibian survey data and collected positive sightings from the Tahoe National Forest indicates that there are currently 40 known sites with *Rana muscosa*, with weak data on the numbers of adults, but no sites reported with greater than 10 adults (C. Davidson, pers. comm., 2000). The species appears to have disappeared from a significant number of historic locations within the Tahoe National Forest and is in very low abundance where it still persists.

g. Lake Tahoe Basin Management Unit

Michael Graf reports seeing numerous mountain yellow-legged frogs from 1968-1974 “everywhere” in Alpine Meadows, in Bear Creek, and in the 5-Lakes area of Granite Chief Wilderness. Graf observed a large population at Lake Estelle, which “typically had over 1000 frogs each summer.” The species was gone from the Squaw Valley/Alpine Meadows area south in the basin by the mid-1980's (M. Graf, pers. comm., 1999). Extensive surveys by the Forest Service of over 138 sites and two entire drainages from 1997-1999 have turned up only one known reproducing population of *R. muscosa*, in Hell Hole Meadow (M. Slesinger, USFS, pers. comm., 1999; J. Ryner, USFS, pers. comm. 1999), with no adult frogs seen at this site in 1999 (Slesinger, pers. comm., 1999). The species appears to be almost extinct in the Tahoe Basin.

h. Eldorado National Forest

Sharp declines of *R. muscosa* have been documented at several sites in the Pacific Ranger District. Several adult frogs were collected at both Smith and Grouse Lakes during the 1970's, but none were found there during a 1997 survey. As noted before, frogs were once very abundant in Pyramid Peak Lake and "Lake 863" downstream, in the Lyons Creek drainage. Pyramid Peak Lake was reported by Craig Thomas to contain a very dense population of *R. muscosa* up until 1988, which he reported had disappeared by 1990. Thomas found a density in 1988 of "a frog for every two feet of shoreline" and described the lake as "teeming with frogs." Several years later no frogs could be seen. Only 4 adult and 9 juvenile frogs were discovered during a 1994 survey, and only 2 adult frogs, 4 larvae, and 2 egg masses were found during a 1995 survey of Pyramid Peak Lake. Lonnell Wilson had reported that *R. muscosa* was common near Lake 863 before 1976-77, and that seeing 4 or 5 frogs on a gravel bar was not unusual. Wilson reported seeing a couple adult frogs there during 1994. In a 1995 survey only 2 adult frogs and one larvae were observed, and during a 1996 survey no frogs were seen in Lake 863 (USFS 1999c).

A 1992 survey of over 37,000 meters of streams, ponds, and meadows at 16 sites in the National Forest found no frogs (Martin 1992). Re-surveys by Jennings and Hayes (1994) indicate that *R. muscosa* is gone from a number of historic locations. The Eldorado National Forest and CDFG Region 2 surveyed for amphibians each year from 1991-1998, but the extent and thoroughness of these surveys is not reported. Mountain yellow-legged frogs were located at 8-29 sites each year (including some sites re-visited in successive years), but the majority of sightings were of single frogs or very small populations. Small reproducing populations of all age classes of frogs were found at only a handful of sites each year, and no large populations (over 20 adults) have been found (USFS 1998, 1999c). Analysis of amphibian survey data and collected positive sightings from the Eldorado National Forest indicates that there are currently 118 known sites with *Rana muscosa*, 81 with adults sighted, but only one site with greater than 10 adults (14 adults) (C. Davidson, pers. comm., 2000). The species appears to have disappeared from a significant number of historic locations within the Eldorado National Forest and is in very low abundance where it still persists.

i. Stanislaus National Forest

A 1992 survey (Martin 1992) of over 42,000 meter of streams, meadows, and lakes in Stanislaus National Forest found *R. muscosa* at only 2 of 16 locations studied. Only 3 adult frogs and 223 larvae were found at one location, and a single adult was found at the other location.

Jennings and Hayes (1994) indicate that the species was gone from a number of historic locations, based on re-surveys.

The Stanislaus National Forest has recorded amphibian surveys from 1994-1998, but the extent and thoroughness of these surveys is unknown (USFS 1999d). Mountain yellow-legged frogs were located at 10-20 sites each of these years (including some sites re-visited in successive years), but the majority of sightings were of scattered small populations. The only large populations found were in Coolidge Meadow in 1994 (20 adults, 43 sub-adults, and 475 larvae); at Pruitt Lake (18 adults) and Blackbird Lake (15 adults, 20 sub-adults, and 2500 larvae) in 1995; and at Stanislaus Meadow (15 adults, 3 sub-adults, and 85 larvae), Wilson Meadow Lake (21 adults, 130 sub-adults, and 109 larvae), and Moore Creek (25 adults, 5 larvae, and 3 egg masses with 75 eggs per mass) in 1996. In 1997 the Stanislaus Meadow population was found to be substantially reduced (4 adults, 1 sub-adult, and 19 larvae) and the Moore Creek population (4 adults and one sub-adult) was almost gone. No frogs were found at all during the 1998 surveys, but there is no indication of the intensity of the survey effort relative to other years (USFS 1999d).

Analysis of amphibian survey data and collected positive sightings from the Stanislaus National Forest indicates that there are currently 82 known sites with *Rana muscosa* (51 with adults), but only eight sites with greater than 10 adults, only two with 25 or more adults, and no sites with greater than 30 adults (C. Davidson, pers. comm., 2000). The mountain yellow-legged frog seems to be greatly reduced in distribution and in low abundance in the Stanislaus National Forest.

j. Toiyabe National Forest

A large population of frogs in the Levitt Lake basin east of Sonora Pass has been documented to have disappeared. In 1988 Lawrence Cory revisited a formerly “thriving population with an unusually dense larval population” of *R. muscosa* near Koenig Lake. Careful search of all parts of the pond showed “convincingly” that the species was no longer present (Cory 1989). A re-survey by Jamie Reaser (Stanford University) in 1996 of Koenig Lake and peripheral ponds found no frogs (USFS 2000). Vance Vredenburg also visited this location in 1996 and 1998 and could find no *R. muscosa* (Vredenburg, pers. comm., 2000). In 1999, the Bridgeport Ranger District surveyed 5 lakes, 3 springs, and a seasonal pond in this area and found no *Rana muscosa* (USFS 2000).

According to Jennings and Hayes (1994), the species was extinct by 1992 in a number of locations in Toiyabe National Forest, based on re-surveys of locations where it was historically extant. Toiyabe National Forest personnel have surveyed and searched informally for frogs from 1995-1999 (USFS 1998; Pat Shanley, USFS, pers. comm. 1999). Within the Carson/Iceberg Wilderness, White Cliff Lake in the Silver King Creek drainage was observed to have “thousands of frogs hopping around” in 1990, but only 3 tadpoles and one sub-adult were located when the lake was revisited in 1999 (Pat Shanley, USFS, pers. comm. 1999; Stafford Lear, CDFG, pers. comm. 1999).

Of 17 sites surveyed in 1996, and 14 areas (containing single or multiple sites, covering 760 aquatic acres) surveyed in 1999, only two areas were found to have mountain yellow-legged frogs; locations at Chango Lake and in the Rainbow Meadow area. "Numerous" frog tadpoles and 10-20 adults had been found in 1995 in each of three adjacent ponds in the Rainbow Canyon drainage, and an unknown number of adults and tadpoles were found in pools along the creek through Rainbow Canyon. Frogs were again seen in 1999 at seven sites in six lakes at Rainbow Meadow, but only 3 adults, over 800 sub-adults, and over 1,000 larvae were found. In 1996 frogs were found at two sites at Chango Lake (2 adults, 107 sub-adults, and 749 tadpoles). In the 1999 survey, about 200 adults and 300 larvae were seen at Chango Lake (USFS 2000). The mountain yellow-legged frog seems to be greatly reduced in distribution and in low abundance in the Toiyabe National Forest.

k. Yosemite National Park

Severe declines and extinctions of the mountain yellow-legged frog have been extensively documented in Yosemite National Park. As noted above, Dr. David Wake (U. C. Berkeley Museum of Vertebrate Zoology) had reported so many *R. muscosa* near Tioga Pass in 1959 that "it was difficult to walk without stepping on them." Twenty years later Wake revisited the same spot and still found frogs there, but they were fewer and harder to find. In the late 1980's Wake returned again and the frogs were gone. He explained that "not even determined hunting could turn any up, and this in a National Park, a protected area" (Phillips 1994).

In 1988 Lawrence Cory revisited locations in Yosemite National Park that had formerly supported dense frog populations which he had observed in the 1960's. Cory found that most of these formerly thriving populations were extinct in 1988. For example, a pond at Mono Pass, formerly a population of "certainly hundreds of adults and swarms of hundreds of tadpoles" had no tadpoles nor frogs visible. A small lake north of Mt. Hoffman and west of the May Lake basin, formerly a "very abundant" population, showed no frogs or tadpoles during a "very careful search." A pond ½ mile east of Ostrander Lake, formerly a "moderate population (estimated at dozens)" had no frogs present (Cory 1989).

In 1992 and 1993 Drost and Fellers (1996) revisited 38 of the original 40 sites surveyed by Grinnell and Storer from 1914-1920 and made intensive searches for the frog species known from the area. Drost and Fellers found that mountain yellow-legged frogs had essentially disappeared from the transect sites, and located them at only two of the 14 sites in Yosemite where they originally were documented by Grinnell and Storer. Only a single tadpole was found at Mono Meadow and a single adult at Evelyn Lake. They found small but apparently viable populations at Summit Meadow and Mount Hoffman, away from the original Grinnell and Storer Yosemite transect. Drost and Fellers concluded that the species had suffered serious losses in the heart of its geographic distribution, reporting heavy declines throughout Yosemite National Park.

A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicated that the species was extinct in a number of locations in Yosemite National Park by 1992, based on re-surveys of locations where it was historically extant. The disappearance of local populations of *R. muscosa* in the last 20-30 years at Medlicott Dome and Young Lakes (G. Fellers, unpublished data, as cited in Drost and Fellers 1996), and Westfall Meadows (Yoon 1977) also have been documented.

Researchers from Humboldt State University (Colwell 1995) surveyed 35 lakes within the Tuolumne and Merced river drainages of Yosemite National Park in 1992 and 1993. Only 3 lakes were found to have *R. muscosa*.

In 1997, 260 sites with suitable habitat were surveyed for aquatic amphibians within Yosemite National Park (Fellers 1997) and *R. muscosa* was found at only 43 locations. Most of these locations had small populations. A handful of large populations of the frog were found; at Big Island Lake (29 adults, 315 larvae), southeast of lower Twin Lake (20 adults), north of Haystack Peak (34 adults, 65 larvae), and west of Richardson Peak (24 adults, 449 larvae). Fellers revisited sites surveyed by Drost and Fellers (1996). The Summit Meadow population contained 38 adults and 12 larvae in September, but of 18 sites surveyed around Mt. Hoffman, Fellers found only 10 larvae at a single pond. The documented disappearance (Drost and Fellers 1996) of *R. muscosa* from Westfall Meadows was reconfirmed. At Mono Meadow, where Drost and Fellers found a single tadpole in 1992-1993, Fellers found no adult frogs and 7 larvae in 1997 (Fellers 1997).

Analysis of amphibian survey data and a recent report by Gary Fellers (Fellers 1999) indicates that there are currently 203 known sites with *Rana muscosa*, (of 1,659 sites surveyed), but only five sites with 25 or more adults (C. Davidson, pers. comm., 2000). Although scattered small populations remain, the mountain yellow-legged frog appears to have declined significantly in abundance throughout Yosemite National Park. There have been numerous local extinctions and there are only five large populations of the frog currently known.

l. Inyo National Forest

Recent re-surveys of historic sites have documented the disappearance of mountain yellow-legged frogs from many sites in the Inyo National Forest. *R. muscosa* had been collected from Monache Meadows in 1911 (Parker 1994), but no frogs were found there during a 1994 survey (Christopher 1994). On the east slope of the White Mountains, “numerous” frogs had been found at Fish Lake in the 1970's, but the lake was dry and without frogs in 1994 (Giuliani 1994), and Giuliani (1996) found that frogs were gone from two other historic locations (Cottonwood Basin southeast of White Peak, and Middle Creek below Boundary Peak).

In 1992 R. Knapp reported a large population of frogs at Upper Wonder Lakes (Parker 1994), which was also seen during surveys in 1993 (CDFG 1998). This population apparently either has gone extinct or been severely reduced, based on re-survey during 1995-1996 (Knapp, pers. comm., 2000). A population of 20 adults seen in Mildred Lake/Convict Canyon in 1994 (Parker 1994) was also extinct as of 1999 (Knapp, pers. comm., 2000). Knapp re-surveyed several localities in 1997 that were known to be occupied in the early 1990's based on his surveys or surveys by others. Sites near Edith Lake in the Convict Creek drainage, upper Chalfant Lake in the Pine Creek drainage, and Slim Lake in the Independence Creek drainage no longer contained mountain yellow-legged frogs (R. Knapp, pers. comm., 2000).

Many local populations of *R. muscosa* documented in the 1960's and 1970's had disappeared from Maul Lake in the Hall Research Natural Area by the early 1990's (R. Knapp, pers. comm., as cited in Drost and Fellers 1996). A small population was noted in 1992 (CDFG 1998), and Roland Knapp began a frog reintroduction project in the lake in 1993. When fingerling trout were air dropped into the lake in 1994 the project had to be abandoned (Parker 1994) and the Maul Lake population was extinct by 1997, as was another frog population in a small nearby pond in the Lee Vining Creek drainage (Knapp pers. comm, 2000).

Two of the largest recently documented populations of mountain yellow-legged frogs in the Sierra were found at sites right next to each other at Dexter Creek (Crooked Meadows) and Dry Creek, tributaries to Mono Lake. However, these populations have recently crashed, and may soon disappear altogether. D. Giuliani reported seeing "many" adult frogs at Crooked Meadows in 1988 (Parker 1994). In 1993 R. Knapp counted 25 adults, eggs, and tadpoles of 2 year classes at Crooked Meadows. Knapp reported that herpetologist Bob Hansen had previously found it difficult to walk in this meadow without stepping on *R. muscosa*, and that the abundance of frogs had apparently been substantially reduced (Knapp 1993a). In 1993 Knapp also reported a very large population (over 1000 adults counted, and tadpoles) at Dry Creek, above and below Highway 120 (Knapp 1993). The Dry Creek population was estimated by CDFG to consist of approximately 2300 adults, 1000 sub-adults, and 2500 larvae in 1995 (CDFG 1998). In 1996 the Dry Creek/Crooked Meadows area population contained upwards of 1000 adults and many hundreds of tadpoles and egg masses (R. Knapp, pers. comm., 2000). The population has since crashed, apparently due to a chytrid fungal infection, as many of the tadpoles have deformed mouthparts (R. Knapp, pers. comm., 2000). Gary Fellers counted only 10 adults at the Dry Creek location in 1997 (Fellers 1997). Vance Vredenburg and Roland Knapp observed only about 20 adults, 10 tadpoles, and 5 egg masses in 1998 (R. Knapp, pers. comm., 2000). In the summer of 1999, Ron Panik (Western Nevada Community College) could only find two adult frogs at both sites, and believes the population may soon go extinct (Panik, pers. comm. 2000).

Survey efforts from 1990-1996 have revealed few other frog locations throughout the Inyo National Forest, and most sightings have been of small populations. On the east side of the Sierra, D. Giuliani (1995) surveyed 1500 acres of the Hot Creek area in 1990 and found no frogs. Giuliani also surveyed 20 watersheds of the eastern White Mountains from 1994-1996, yet no frogs were found, including at 3 historic locations (Giuliani 1996). A review of the Inyo National Forest files for amphibian surveys from grazing allotments and timber sales in 1994 indicates that of over 150 locations incidentally surveyed, *R. muscosa* was reported at 9 sites, and no large populations were found (USFS 1999e).

In 1993 the Inyo National Forest began a comprehensive amphibian survey on the Kern Plateau, covering 13 drainages (some only partially), but found only one small population of *Rana muscosa* (Parker 1994). 1994 surveys of 12 drainages in the southern Kern Plateau located only 2 small populations (Christopher 1994). Over 115 locations were covered in these 1994 surveys by Inyo National Forest personnel, and frogs were found at only 4 sites (CDFG 1998). From 1995-1996, Knapp and Matthews extensively surveyed 669 lakes, ponds, and other water bodies in the

John Muir Wilderness within Sierra and Inyo National Forests. Mountain yellow-legged frog adults were found in only 4% of these water bodies, and frog larvae in only 3%. More than 20 frogs were found at only 1% of the sites (Knapp and Matthews, in press).

In addition to the populations at Crooked Meadows and Dry Creek, mountain yellow-legged frogs have been found to exist in large numbers in the Inyo National Forest at several sites in two other areas; the Baker Creek and Cow Creek drainages. In 1994, 54 adult frogs were found at Baker Creek (Parker 1994). Frogs were again located in the area in 1995; in an unnamed pond near Baker Lake (1 adult, 50 sub-adults, and 100 tadpoles), and in three reaches of Baker Creek (27 adults; 90 adults; and 54 adults, 5 sub-adults, and 20 larvae were found at the three sites). In 1996, frogs were present throughout Baker Canyon; large populations were found in ponds and marshes above Gable Lake #2, in a pond south of Sixth Lake on the North Fork of Big Pine Creek, and in marshes around Seventh Lake in the same drainage. Frogs were found at two locations on Cow Creek in 1995; 158 adults, 5 sub-adults, and 10 tadpoles in Cow Creek; and 75 adults, 5 sub-adults, and 140 larvae at Sanger Meadow on Cow Creek (USFS 1999e).

m. Sierra National Forest

In 1988 L. Cory revisited a pond one-half mile south of Corbett Lake in the Kaiser Wilderness area of Fresno County. Cory had found a "thriving" mountain yellow-legged frog population in the pond in the 1960's, but there were "no frogs to be seen" by 1988 (Cory 1989). Re-surveys by Jennings and Hayes (1994) indicated that *R. muscosa* was extinct by 1992 in a number of historical locations in the Sierra National Forest. In 1997 Roland Knapp re-surveyed a large pond in Humphreys Basin, in the Paiute Creek drainage, that was known to be occupied in the early 1990's and found that the site no longer contained mountain yellow-legged frogs (R. Knapp, pers. comm., 2000).

A 1992 survey of over 26,000 meters of potential habitat at 15 sites turned up only two adult frogs at two locations (Martin 1992). A handful of small frog populations were found in 1994, but the level of survey effort is unknown (USFS 1999f). During 1995 amphibian surveys (Buck 1995) of over 260 sites, no mountain yellow-legged frogs were found in the Mariposa, Minarets, or Pineridge Districts, and a single small population was found in the Kings River District (USFS 1999f). M. Vinsen (Montana State University, masters thesis) surveyed 56 additional lakes during 1995 and found small populations at 2 sites, and the only known large populations at 3 others (USFS 1999g). Incidental surveys of a grazing allotment within the National Forest in 1995 revealed small populations of mountain yellow-legged frogs in only 2 of the 40 meadows surveyed (USFS 1999g).

Knapp and Matthews extensively surveyed 669 lakes, ponds, and other water bodies in the John Muir Wilderness within Sierra and Inyo National Forests in 1995 and 1996. Mountain yellow-legged frog adults were found in only 4% of these water bodies, and frog larvae in only 3% (Knapp and Matthews, in press).

Only three large populations of the frog have been found in the Sierra National Forest; in

1995 *R. muscosa* were found in Upper Mills Creek Lakes (181 adults/juveniles and 300 tadpoles), Snow Lakes (1047 adult/juveniles, 1020 tadpoles, and 200 eggs), and Golden Lake (18 adult/juveniles, 25 tadpoles, and 1100 eggs). Numbers of adult and juvenile frogs in these populations were not distinguished (USFS 1999f). Except for these three populations, the mountain yellow-legged frog appears to be scattered in isolated small populations in the Sierra National Forest and is in danger of extinction.

n. Sequoia and Kings Canyon National Parks

A distributional map of *R. muscosa* produced by Jennings and Hayes (1994) indicated that the species was extinct by 1992 in a number of locations throughout Sequoia and Kings Canyon National Parks, based on re-surveys of locations where it was historically extant. The species was already noted to have disappeared from many areas of Sequoia and Kings Canyon Parks by the late 1980's based on resurvey efforts (Bradford et al. 1994). In 1997 Roland Knapp re-surveyed an unnamed lake in the Cartridge Creek drainage that was known to be occupied in the early 1990's and found that the site no longer contained mountain yellow-legged frogs (R. Knapp, pers. comm., 2000).

The headwaters of 7 creek systems were surveyed for *R. muscosa* in Sequoia and Kings Canyon National Parks in 1978-1979 and again in 1989 (Bradford et al. 1994). Frogs were found at 27 sites greater than 200 meters apart in 1978-1979, but at only one site in 1989, and the population at this site had disappeared by 1991. A comparison of 21 historical (1955-1979) and recent (1989-1990) records scattered throughout both parks revealed that *R. muscosa* persisted at only 11 of these localities in 1989-1990. Bradford et al. concluded that *R. muscosa* was eliminated from half its historical locales in Sequoia and Kings Canyon National Parks in three decades, and was completely extirpated from some drainages (Bradford et al. 1994).

Bradford et al. (1993) searched 312 lakes in 1989 and 1990 in 95 survey basins in both Kings Canyon and Sequoia National Parks. *R. muscosa* was found in 109 lakes, with tadpoles occurring in 66 of these. Bradford et al. (1998) surveyed 104 lakes in the South Fork Kings River and Woods Creek drainages of Kings Canyon in 1992. Adult frogs were found in 32% of the lakes and tadpoles in 21%.

Surveys by G. Fellers (1994) also found *R. muscosa* absent from entire drainage basins within Sequoia and Kings Canyon National Parks. Fellers's crew checked 651 sites in 1994 within the range of the species and found frogs at only 138 localities. No *R. muscosa* were found in the South, East, Middle, or Marble forks of the Kaweah River. Some of these drainages historically supported large populations of yellow-legged frogs, including study sites used by David Bradford for a doctoral dissertation on the species. Fellers and Bradford re-visited Bradford's main study site in the Tablelands area of the Marble Fork and were unable to find frogs at any of the historic sites or anywhere else within the drainage (Fellers 1994).

Knapp and Matthews extensively surveyed 1,059 lakes, ponds, and other water bodies in the northern portion of Kings Canyon in 1996 and 1997. Mountain yellow-legged frog adults were found in 31% of these water bodies, and frog larvae in 20% (Knapp and Matthews 2000). Some large populations were found: 10% of the sites had more than 20 adults, 6% had more than 50 adults, and 4% had more than 100 adult frogs (Knapp and Matthews 2000). Some significant frog populations remain in Sequoia and Kings Canyon National Parks but extensive declines have been described.

o. Sequoia National Forest

On the Kern Plateau *R. muscosa* was rather rare by 1980, even in streams with suitable habitat. Where frogs were present numbers were few, suggesting that populations had been “decimated in recent years,” according to Hansen (1980). Historically, mountain yellow-legged frogs were known from 12 locations on the Kern Plateau along the Kern River and the South Fork Kern River (Hansen 1980). Since the 1980's, frogs have been found at only a handful of locations in the northern end of the forest, particularly in the headwaters of the Little Kern River (Keeler-Wolf 1989; Keeler-Wolf 1991; USFS 1999h, 1999i). All of these sightings were of single frogs or very small populations. A survey of over 66,000 meters of streams, lakes, and meadows at 17 sites in Sequoia National Forest in 1992 found no frogs (Martin 1992). The species appears to be severely reduced in numbers and range, and is close to extirpation in the Sequoia National Forest.

II. CRITERIA FOR ENDANGERED SPECIES ACT LISTING

A. THE SIERRA NEVADA MOUNTAIN YELLOW-LEGGED FROG IS A “SPECIES” UNDER THE ESA

The Sierra Nevada population of the mountain yellow-legged frog is a geographically isolated and genetically differentiated population facing a serious threat of extinction. As such, it is a “species” under the ESA and qualifies for an endangered listing to afford it the protections of the Act.

The ESA provides for the listing of all species warranting the protections afforded by the Act. The term “species” is defined broadly under the act to include “any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.” 16 U.S.C. § 1532 (16).

The U. S. Fish and Wildlife Service has already found the southern California population of the species to be both “discrete” and “significant” on the basis of geographical, ecological, vocal, and genetic discontinuities (64 Fed. Reg. 71714).

1. DISTINCT POPULATION SEGMENT

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service (“NMFS”) have published a policy to define a "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the ESA. 61 Fed. Reg. 4722 (February 7, 1996). Under this policy, a population must be found to be both "discrete" and "significant" before it can be considered for listing under the Act**.**

a. Discreteness

Under the joint NMFS/FWS policy, a population segment of a vertebrate species is considered discrete if it satisfies either one of the following conditions:

1.) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors.

2.) It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4 of the ESA.

61 Fed. Reg. 4722.

i. The Sierra Nevada population of the mountain yellow-legged frog meets the first criteria for "discreteness."

The range of the mountain yellow-legged frog is divided by a natural geographic barrier, a gap from the Tehachapi Mountains to the Transverse Ranges, which isolates Sierran frogs from those in the mountains of southern California. The distance of the separation is about 225 km (140 mi), but the separation may not have been this great in the recent past. A frog collected in 1952 on Breckenridge Mountain in Kern County (almost midway between the southern end of the Sierran population and the San Gabriel Mountains) was recently tentatively identified by Jennings and Hayes (1994) as a mountain yellow-legged frog. The geographic separation of the Sierran and southern California frogs was recognized in the earliest description of the species by Camp (1917), who treated frogs from the two localities as separate subspecies within the *R. boylii* group. He designated the Sierran frogs *R. b. sierrae* and the southern California frogs *R. b. muscosa*, based on geography and subtle morphological differences. Zweifel (1955) reevaluated the morphological evidence and found it insufficient to warrant Camp's recognition of two subspecies, the chief difference between the two being hind-limb length.

More recently, Ziesmer (1997) analyzed the calls of Sierran (Alpine and Mariposa Counties) and southern California (San Jacinto Mountains and Riverside County) mountain yellow-legged frogs. He found that the calls of Sierran frogs differed from southern California frogs in pulse rate, harmonic structure, and dominant frequency. Ziesmer concluded that the results supported the hypothesis that mountain yellow-legged frogs from the Sierra Nevada and southern California are separate species.

Allozyme (a form of an enzyme produced by a gene) variation throughout the range of the mountain yellow-legged frog has been examined, but the results are open to interpretation (Jennings and Hayes 1994). David Green analyzed allozyme variation in central Sierran mountain yellow-legged frogs (four individuals, Tuolumne County) and southern California mountain yellow-legged frogs (two individuals, Riverside County). He found fixed differences at 6 of 28 loci (sites on a chromosome occupied by specific genes) (64 Fed. Reg. 71714). These data suggest that Sierran and southern California mountain yellow-legged frogs are different at a level that could support the recognition of full species. Similar work by Vredenburg (pers. comm. 1999) also strongly suggests that Sierran and southern California populations comprise separate taxonomic units.

Recent unpublished genetic analysis by Macey and Vredenburg (unpublished data) may conclusively demonstrate genetic differences between southern California and Sierra Nevada populations of the mountain yellow-legged frog on the species level. The data also delineates three distinct frog populations in the Sierra Nevada; a northern population, a central population, and a southern population, with over 2 million years of separate evolution between the northern and the southern populations, and at least 1.5 million years of divergence between all populations. The three Sierra populations are certainly distinct on a sub-species level and possibly on a species level. The phylogenetic relationships of the species were based on analysis of 2,050 base pairs of mtDNA (Vredenburg, pers. comm., 2000).

Even if genetic analysis may not yet be sufficient to support recognizing the Sierran and southern California populations as separate species, it does support the conclusion of significant geographic separation. This conclusion is also supported by earlier observations of morphological differences (Zweifel 1955) and differences in vocalizations (Ziesmer 1997). Considered together, the evidence supports an interpretation of isolation between the two populations of frogs over a very long period. The Sierra Nevada population of the mountain yellow-legged frog meets the criterion of "marked separation from other populations of the same taxon" and therefore qualifies as "discrete" according to FWS's policy on distinct population segments.

b. Significance

According to the listing policy, once a population is established as discrete, its biological and ecological significance should then be considered. This consideration may include, but is not limited to, the following:

1.) Persistence of the discrete population segment in an ecological setting unusual or unique to this taxon.

2.) Evidence that loss of the discrete population would result in a significant gap in the range of a taxon.

3.) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range.

4.) Evidence that the discrete population segment differs markedly from other populations.

61 Fed. Reg. 4722 .

The Sierra Nevada population of the mountain yellow-legged frog meets three of these criteria for “significance”: (1) it is a discrete population in a unique ecological setting; (2) loss of the Sierra Nevada population of the mountain yellow-legged frog would result in a significant gap in the range of the species; and (3) the Sierra Nevada population of the mountain yellow-legged frog differs markedly from other populations of the species.

i. The Sierra Nevada population of the mountain yellow-legged frog is a Discrete Population in a Unique Ecological Setting.

One of the purposes of the ESA is to “provide a means whereby the ecosystems upon which endangered species depend may be conserved.” 16 U. S. C. 1531(b). The Sierra Nevada population of the mountain yellow-legged frog occurs within a separate ecosystem as defined by FWS from that of the southern California population of the species. As such, the role of the Sierra Nevada population of the mountain yellow-legged frog as an important member of the Sierran ecosystem adds to its “significance” under the ESA.

Not only are the two populations of mountain yellow-legged frogs found in separate ecosystems, they are found in strikingly different habitats within those ecosystems. Zweifel (1955) observed that the frogs in southern California are typically found in steep gradient streams in the chaparral belt, even though they may range up into small meadow streams at higher elevations. In contrast, Sierran frogs are most abundant in high elevation lakes and slow-moving portions of streams. Bradford's (1989) southern Sierra Nevada study site, for example, was in Sequoia and Kings Canyon National Parks at high elevations (between 2,910-3,430 m (9,600-11,319 ft)). The rugged canyons of the arid mountain ranges of southern California bear little resemblance to the alpine lakes of the Sierra Nevada. On the basis of habitat alone, one might easily conclude that these are two very different frogs.

ii. Loss of The Sierra Nevada population of the mountain yellow-legged frog would result in a significant gap in the range of the species.

A loss of the Sierra Nevada population of the mountain yellow-legged frog would create a significant gap in the range of the taxon as it would eliminate a significant portion of the species range. As discussed above, it would eliminate the frogs from a distinct separate ecosystem in a distinct part of their range. The loss of this population would represent a significant gap in the range of the taxon, as it would eliminate the species from the majority of its range and likely result in the downfall of the whole species complex (V. Vredenburg, pers. comm., 2000). The possible delineation of three distinct sub-species or even species of mountain yellow-legged frogs in the Sierra Nevada (Macey and Vredenburg, unpublished data), as mentioned above, raises the issue that even regional disappearances of the frog could result in the loss of a distinct population. As noted above, the frog is rapidly disappearing in the northern and central Sierra. This issue also presents challenges for efforts to re-introduce the species to historic areas of its range where the frog has declined, since frogs in the northern Sierra may be found to have different evolutionary adaptations than those in the southern Sierra.

iii. The Sierra Nevada population of the mountain yellow-legged frog differs markedly from other populations of the species.

As described above, the Sierra Nevada population of the mountain yellow-legged frog differs markedly from the southern California population in geographical, ecological, vocal, and genetic characteristics. It likely will soon be formally described as a separate species or subspecies from its southern California cousins. In the meantime, it is clearly a "species" as defined under the ESA.

In sum, the Sierra Nevada population of the mountain yellow-legged frog is a distinct vertebrate population segment of the species. It is eligible for consideration for listing under the ESA as it is both "discrete" and "significant." Moreover, as the FWS has recently found the southern California population of the species to be both "discrete" and "significant" (64 Fed. Reg. 71714), it would be arbitrary and capricious for the agency to not find the Sierra Nevada population also to be a listable entity under the ESA. As described below, the current status of the Sierra Nevada population of the mountain yellow-legged frog mandates that it be listed as endangered under the Act forthwith.

B. THE SIERRA NEVADA MOUNTAIN YELLOW-LEGGED FROG IS ENDANGERED UNDER THE ESA

The FWS is required to determine, based solely on the best scientific and commercial data available, whether a species is endangered or threatened because of any of the following factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. 16 U.S.C. §§ 1533(a)(1) and 1533(b).

Petitioners believe that all of these factors except (2), overutilization of the species, have played a role in bringing the Sierra Nevada population of the mountain yellow-legged frog to its current perilous condition.

1. PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF ITS HABITAT OR RANGE

Most of the known habitat for the Sierra mountain yellow-legged frog is in high elevation lakes, ponds, tarns, streams, and meadow wetlands within National Forests, Wilderness Areas, and National Parks. Therefore, direct habitat alteration through wholesale conversion to other uses is not a major threat to the frog. However, human activities such as fish stocking, cattle grazing, and chemical pollution through airborne drift potentially adversely affect frog habitat. The impacts from these activities are discussed more fully in section II.B.5 below. Water diversions, logging, and road construction and improvements within the National Forests may also have negative impacts on frog habitat.

2. OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Numerous museum specimens taken from many localities (Jennings and Hayes 1994) and the historic collections referenced in the section on historical abundance and distribution above, attest to the fact that mountain yellow-legged frogs have been collected from the Sierra Nevada for scientific purposes for many decades. These collections probably did not have a significant effect, although local populations may have been impacted by extensive scientific collecting. Currently very little scientific collecting of *R. muscosa* occurs in the Sierra Nevada. Irresponsible or un-permitted scientific or amateur collecting could seriously jeopardize many of the smaller populations. Any local extinctions would further isolate the remaining populations and probably reduce the time to extinction for the entire Sierra Nevada population.

3. DISEASE AND PREDATION

a. Disease

Bradford (1991) documented the loss of a Sierran population of *R. muscosa* due to the combined effect of "red-leg" disease (caused by the ubiquitous freshwater bacterium *Aeromonas hydrophila*) and predation by Brewer's blackbirds. Red-leg disease has also been attributed as a cause of decline of populations of the Yosemite toad (*Bufo canorus*) in the Sierra and the boreal toad (*Bufo boreas boreas*) in the Rockies (Sherman and Morton 1993; Carey 1993).

Since 1993, new aquatic pathogens have been observed killing amphibian species in the Sierra and worldwide (Carey et al. 1999). Of specific concern among those who study amphibian declines is the chytrid fungus, which may be seriously affecting many amphibians globally. Chytrid fungus damages the mouthparts of tadpoles, then goes on to damage keratin in the skin of metamorphosed frogs, eventually killing them. Chytrid fungi are ubiquitous in soil, but the aquatic chytrid infecting frogs was new to science (Berger et al. 1998). Chytrids have recently been discovered on larval mountain yellow-legged frogs in the Sierra Nevada (Gary Fellers, pers. comm., 1999; 64 Fed. Reg. 71714). At least two specimens of Yosemite toad collected by Sherman and Morton during a die-off at Tioga Pass in the 1970's were infected with the chytrid fungus (Carey et al. 1999), and the fungus is present in declining populations of Wyoming toads (Taylor et al. 1999). K. Matthews (USDA Pacific Southwest Research Station) reported a population of *R. muscosa* in the Sierra Nevada (Emigrant Wilderness) which died from Chytrids in 1998-1999 (Vredenburg, pers. comm., 2000). Roland Knapp reports the recent crash of a formerly huge population of mountain yellow-legged frogs in the Dry Creek/Crooked Meadows area near Mono Lake, apparently due to chytrid fungal infection, as many of the tadpoles have deformed mouthparts (R. Knapp, pers. comm., 2000). Blaustein et al. (1994) documented egg mortality in a population of western toads (*Bufo boreas*) in Oregon, due to the pathogenic fungus *Saprolegnia ferax*, a water mold which commonly attacks fishes. Blaustein et al. suggest that since the fungus is globally distributed, it may be a major contributor to other amphibian population declines.

It has been hypothesized that introduced fish may act as a vector for new diseases to infect *R. muscosa*. A new study shows that a virus is capable of being transmitted from fish to amphibians under natural conditions (Mao et al. 1999), evidence that this pathway is possible, and perhaps even probable. The study is the first to isolate identical iridoviruses from wild sympatric fish (threespine stickleback, *Gasterostelus aculeatus*) and amphibians (the red-legged frog, *Rana aurora*). The Mao et al. (1999) study strengthens the suggestion that fish may serve as a reservoir for amphibian viruses. There is also the possibility that disease could be spread by humans from a sick population of frogs to healthy ones.

Significant questions remain regarding the taxonomy of aquatic Sierra pathogens, and their relationship to the ecology of montane amphibian species, including the mountain yellow-legged frog. If the pathogens are native to the Sierra Nevada (which is unknown for the chytrid fungus), it may be that they are taking advantage of environmental stressors which render amphibians more susceptible to disease. A number of environmental stressors could theoretically have such an effect, including UV-radiation, climate change, chemical pollution, extremely cold temperatures, or even excessive handling (Sherman and Morton 1993; Drost and Fellers 1996; Carey et al. 1999; Carey and Bryant 1995; Carey 1993; Jennings 1996; Taylor et al. 1999).

Because of the small and isolated nature of many of the remaining Sierran frog populations, disease could be a serious problem for the species. Any local extinctions caused by disease would further isolate the remaining populations and probably reduce the time to extinction for the entire Sierra Nevada population.

b. Predation

As mentioned in section I.A.6.a. above, numerous species prey on the mountain yellow-legged frog. Bradford (1991) documented the extirpation of a population in Kings Canyon due to the combined effect of red-leg disease and predation by Brewer's blackbirds (*Euphagus cyanocephalus*), in which all metamorphosing individuals were consumed by the blackbirds. Because of the low numbers of frogs in many of the Sierra Nevada populations, predation is potentially a significant impact upon the species, especially at the local level. Predation upon eggs, larvae, and tadpoles by introduced species of trout may have the most significant impact. As is described more in depth below in section II.B.5.a., predation by trout likely has resulted in extirpation of many populations, and is likely a factor preventing re-colonization of historic habitat.

4. INADEQUACY OF EXISTING REGULATORY MECHANISMS

Existing regulatory mechanisms have not stopped the decline of mountain yellow-legged frogs in the Sierra Nevada. Existing regulatory mechanisms that could potentially provide some protection for the mountain yellow-legged frog include: (1) consideration under the California Environmental Quality Act ("CEQA") and the National Environmental Policy Act ("NEPA"); (2) consideration under section 404 of the Clean Water Act ("CWA"); and (3) co-occurrence with other species protected by the Endangered Species Act ("ESA") of 1973. One future regulatory mechanism which could potentially provide some protection for the mountain yellow-legged frog is the draft regional management plan proposed by the U. S. Forest Service Region 5. This proposed plan will amend the Land and Resource Management Plans ("LRMPs") of all 11 national forests within the Sierra Nevada, but the framework does not deal with amphibians at all.

The State of California considers mountain yellow-legged frogs a species of special concern, but it is not a threatened or endangered species and receives no protection under the California Endangered Species Act. California Sport Fishing Regulations include the mountain yellow-legged frog as a protected species that may not be taken or possessed at any time except under special permit from the California Department of Fish and Game. This prohibition may help prevent threats from collecting, but this threat is not a significant cause of the decline, and the Sierra Nevada population is expected to continue declining toward extinction even in the absence of collecting.

Both NEPA and CEQA require a full public disclosure of the potential environmental impacts of proposed projects. The public agency with primary authority or jurisdiction over the project is designated as the lead agency and is responsible for conducting a review of the project and consulting with other agencies concerned with resources affected by the project. Section 15065 of the CEQA guidelines require a finding of significance if a project has the potential to "reduce the number or restrict the range of a rare or endangered plant or animal." Species that are eligible for listing as rare, threatened, or endangered but are not so listed are given the same protection as those species that are officially listed with the State. Once significant impacts are identified, the lead agency has the option to require mitigation for effects through changes in the project, or to decide that overriding considerations make mitigation infeasible. In the latter case, projects may be approved that cause significant environmental damage, such as destruction of endangered species. Protection of listed species through CEQA is, therefore, at the discretion of the lead agency involved. CEQA provides that, when overriding social and economic considerations can be demonstrated, project proposals may go forward, even in cases where the continued existence of the species may be threatened, or where adverse impacts are not mitigated to the point of insignificance. In addition, fish stocking is exempt from CEQA under guideline 15301(j). NEPA lacks even the minimal substantive provisions of CEQA.

Besides the ESA, the primary Federal law that potentially affords some protection for the mountain yellow-legged frog is section 404 of the CWA. The CWA may provide some general protections for the habitat of the species. However, the Sierra population of the mountain yellow-legged frog has declined precipitously in spite of the existence of the CWA.

The Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), a federally listed threatened species, is present in some east side drainages of the Sierra Nevada. The Little Kern Golden trout (*Oncorhynchus mykiss whitei*) is a federally listed threatened species present in the Little Kern River drainage of Tulare County. Both trout listings offer minimal benefit to the mountain yellow-legged frog because the trout species co-occupy very few drainages with mountain yellow-legged frogs, and the trout may actually predate upon the frog. The California red-legged frog (*Rana aurora draytonii*) is listed as a federally threatened species, but occupies different elevations and has different habitat requirements than the mountain yellow-legged frog.

Eleven National Forests manage many of the known locations of mountain yellow-legged frogs in the Sierra Nevada. Currently, the U. S. Forest Service Region 5 does not have a range-wide strategy for the protection and recovery of the mountain yellow-legged frog in the Sierra Nevada. Additionally, the eleven individual national forests that lie within the historic range of the mountain yellow-legged frog also lack recovery strategies for the frog. A review of existing Land and Resource Management Plans ("LRMPs") for many of these forests reveals no mention of protection strategies for amphibians in general nor the mountain yellow legged frog in particular. (See e.g., Land And Resource Management Plans for the Stanislaus and Eldorado National Forests.)

The U. S. Forest Service Region 5 is preparing a draft regional management plan that will amend the LRMPs of all 11 national forests within the Sierra Nevada. Pre-draft materials indicate a 5-point mountain yellow-legged frog conservation strategy will be proposed by the U. S. Forest Service and carried out in consultation with USFWS, CDFG, the U. S. Geological Survey, the National Park Service, and research scientists. The strategy consists of: (1) compiling existing information on the distribution of mountain yellow-legged frog populations; (2) identifying factors in the life history of mountain yellow-legged frogs; (3) setting priorities to protect frog populations from negative effects of human activities; (4) increasing public awareness; and (5) establishing a timeline for restoring mountain yellow-legged frog populations. (Source: USFS Sierra Nevada Framework Draft Environmental Impact Statement ("DEIS") draft standards and guidelines dated 9/29/1999.)

It is critical to note that the U. S. Forest Service has not yet begun systematically gathering and synthesizing data on the distribution and life histories of mountain yellow-legged frog populations found within national forest boundaries in the Sierra. Rather, the agency has *proposed* this action in a pre-draft document (the Sierra Nevada Framework DEIS) *which has yet to be issued*.

The U. S. Forest Service has delayed publication of the DEIS multiple times and it is now more than 6 months overdue. Once the DEIS is published, a 90 day public review and comment period will follow. The U. S. Forest Service will review comments and either issue a Final EIS or a Supplemental EIS, the latter of which would trigger a second public review and comment period. After the Final EIS is issued all 11 national forests will have to amend their LRMPs and devise site-specific strategies for implementing the direction of the regional plan. Even under the best scenario a mountain yellow-legged frog conservation strategy as outlined above cannot be adopted, let alone implemented, before the end of the calendar year. In the meantime, the Forest Service does not have a current management plan for the mountain yellow-legged frog or an adaptive management strategy that addresses the specific conservation and recovery needs of the species. Even if implemented, the conservation strategy cannot provide the substantive protections that the ESA affords the species. Moreover, it does not address threats to the species originating outside the jurisdiction of the National Forests, such as pesticide drift.

The U. S. Forest Service, Pacific Southwest Region, and CDFG currently are attempting to formulate a conservation strategy to protect the mountain-yellow-legged frog. However, a conservation agreement has yet to be implemented and the proposed conservation strategy has no binding guarantee that CDFG will not stock fish in water bodies known to be occupied by the mountain yellow-legged frog. The proposed actions in the draft agreement only address the impacts of fish stocking and are limited in geographic scope. The proposed conservation agreement likely will not be enough to protect or recover the species, as frogs are also disappearing from areas where fish presence is not that different from historic levels, and there are other factors which are likely contributing to frog population declines (see section II.B.5 below).

The perilous status of the mountain yellow-legged frog reflects the overall failure or inability of existing CEQA, NEPA, and other Federal, State, and local ordinances and statutes to protect and provide for the conservation of the Sierra Nevada population.

5. OTHER NATURAL OR ANTHROPOGENIC FACTORS

a. Introduced Fish

Fish did not occur in much of the high elevation habitat occupied by *R. muscosa* until the late nineteenth century (Jennings 1988; Moyle 1976; Moyle et al. 1996). Introduction of trout into high elevation lakes and streams has resulted in significant predation of frogs, is likely serving to prevent re-colonization of locally depleted or extirpated populations, and may have altered the food chain of aquatic ecosystems as well (Knapp 1996; Jennings 1996; Bradford 1989; Bradford et al. 1993).

Predation by introduced trout is one of the best documented causes of the decline of Sierran mountain yellow-legged frogs. Biologists have long recognized that introduced species of fish are responsible for limiting the distribution of *R. muscosa* in the Sierra Nevada (Grinnell and Storer 1924; Cory 1963; Bradford 1989) through predation on tadpoles (Hayes and Jennings 1988) and adults (Needham and Vestal 1938). Bradford (1989) documented that in 67 lakes in Sequoia and

Kings Canyon National Parks, *R. muscosa* tadpoles were not found to coexist with fish. A similar pattern was shown by Zardus et al. (1977) for an additional 133 lakes in the region. Where frogs and fish did co-occur, they appeared to be utilizing different micro habitats. In one such lake, tadpoles were found in a shallow rocky area inaccessible to fish (Bradford et al. 1994a). At other sites the frogs utilized small bodies of water lacking fish and then retreated to the lakes when these areas dried (Bradford et al. 1993). Cory (1963) found that adult *R. muscosa* show escape behavior not found in populations with trout. The long larval stage (one to two and one half years) of *R. muscosa* makes it extremely vulnerable to predation by introduced aquatic predators (Bradford 1989; Bradford et al. 1993). Careful study of the distributions of introduced trout and mountain yellow-legged frogs for several years has shown that introduced trout have had negative impacts on mountain yellow-legged frogs over much of the Sierra Nevada (Bradford 1989; Knapp 1986, 1996; Knapp and Matthews 2000).

Bradford (1989) and Bradford et al. (1993) concluded that introduced trout eliminate many populations of mountain yellow-legged frogs and that the presence of trout in intervening streams sufficiently isolates other frog populations so that re-colonization after stochastic (random, naturally occurring) local extirpations is essentially impossible. This mechanism is sufficient to explain the elimination of Sierran mountain yellow-legged frogs from many of the sites they once inhabited. Wherever the two species co-occur, trout are likely to eliminate mountain yellow-legged frogs or keep populations low and limit dispersal. The widespread occurrence of introduced trout in the mountains of the Sierra may make it very difficult to reverse the decline of the species.

Juvenile *R. muscosa* have been observed in small intermittent tributaries. If a population is extirpated, under normal conditions re-colonization may take place through juveniles following small streams which connect permanent water (Bradford 1991). However, fish introductions in streams as well as lakes have resulted in extremely fragmented frog populations. Isolated populations may be eliminated due to natural causes, and re-colonization may be impeded by increased distances to source populations and direct predation on dispersing individuals from fish in intervening waterways. In addition, smaller populations are more susceptible to extinction (Bradford et al. 1993).

Knapp and Matthews (2000) recently completed a comprehensive study of the influence of introduced trout on the mountain yellow-legged frog in the southern Sierra. Fish stocking continues on the National Forests but was stopped in the National Parks in 1977, and was always less intensive on National Park Service lands. As a result many water bodies within the National Parks lack fish relative to similar habitats in the National Forests. Knapp and Matthews (2000) compared 1,059 lakes on Park Service land (Kings Canyon) with 1205 lakes on immediately adjacent Forest Service land (John Muir Wilderness) that are heavily stocked with fish. In the National Forests, mountain yellow-legged frog adults were found in only 4% and frog larvae in only 3% of the surveyed water bodies. In the National Park adults were found in 31% and frog larvae were found in 20% of the surveyed water bodies.[7] Population abundance was correspondingly much lower within the National Forest.[8] Knapp and Matthews concluded that fish presence was an important, and perhaps the primary reason for the decline of mountain yellow-legged frogs in many areas of the Sierra (Knapp and Matthews 2000).

An attempted reintroduction of *R. muscosa* in the Inyo National Forest is illustrative of the problems with fish stocking in the Sierra. Roland Knapp began reintroducing mountain yellow-legged frogs to Maul Lake, in the Hall Research Natural Area in 1993. The lake had been cleared of fish, and the frogs successfully overwintered. More frogs were reintroduced in the summer of 1994, but approximately 1000-2000 fingerling trout were subsequently air dropped into the lake, and the project had to be abandoned (Parker 1994). This is a graphic example of the disastrous consequences of the non-native fish stocking procedure of CDFG. There is currently no CDFG policy to avoid stocking lakes where *R. muscosa* are present.

Although fish stocking has undisputedly played a major role in the decline of mountain yellow-legged frogs in the Sierra Nevada, there is ample documentation that the species has declined even in areas where there is an absence of introduced fish. For example, surveys for *R. muscosa* in fishless areas of Sequoia and Kings Canyon National Parks in 1989-1990 revealed that they had disappeared from approximately half of historic localities within the last three decades (Bradford et al. 1994). Drost and Fellers (1996) noted that frog populations have disappeared from sites that either never were planted with fish or that are too small or ephemeral to support fish, for example, complete disappearance of the species from Tuolumne Meadows and the Tioga Pass area in Yosemite National Park, where there are extensive meadow pools and marshes which are effectively isolated from fish.

The timing of some frog population declines does not indict fish stocking as the sole or primary cause. Large numbers of trout were planted in Yosemite National Park from 1932-1951, with over one million fish per year planted in the late 1930's and 1940's. The number of fish planted has steadily declined since 1951, but documented declines of *R. muscosa* in Yosemite national Park have occurred later than this`period (Drost and Fellers 1996). Mountain yellow-legged frogs remained the most numerous frog species in Westfall Meadows in Yosemite National Park as late as 1977, long after fish were introduced (Yoon 1977). It has since disappeared from the area. It is difficult to draw conclusions from these examples however, as the impacts of fish stocking may not be immediate, and trout may persist in water bodies long after fish stocking has ended. Clearly fish stocking alone does not adequately explain the overall decline of the species, and there are other factors or combinations of factors which contribute significantly to frog disappearances.

---

[7] While the Knapp and Mathews study primarily is about why mountain yellow-legged frogs have declined, the fact that the formerly ubiquitous frogs were absent from 96% of the USFS water bodies and 67% of the NPS water bodies is itself extremely compelling evidence of the current endangered status of the species.

[8] In Kings Canyon, populations of more than 20 adults frogs were found at 10% of lakes surveyed, and only at 1% of lakes in the John Muir Wilderness. Populations of more than 50 adult frogs were at 6% and more than 100 adults at 4%of Kings Canyon lakes, while only at 0.5% and 0.3%, respectively, of lakes in John Muir Wilderness.

b. Contaminants

Pesticides used in the Central Valley are transported on wind currents or as part of eastbound storm systems into the Sierra Nevada (Seiber et al. 1998; Aston and Seiber 1997; Cahill et al. 1996). Surveys of freshly fallen snow at 7,000 feet have revealed the presence of toxic organophosphates such as diazinon, malathion, and chlorpyrifos residues (Seiber et al. 1998; Aston and Seiber 1997). The use of these and other second generation pesticides has increased greatly since the 1970's, when declines of mountain yellow-legged frogs were first observed. Little currently is known about the fate of these chemicals in high elevation aquatic habitats historically occupied by the mountain yellow-legged frog (Boyer and Grue 1995).

Many studies have demonstrated that pesticide residues in water, sediment, and aquatic vegetation can harm amphibians in aquatic environments by delaying or altering larval development, or by reducing breeding or feeding activity (Berrill et al. 1998, 1995, 1994, 1993; Boyer and Grue 1995; Beaties and Tyler-Jones 1992; Corn and Vertucci 1992; Hall and Henry 1992). Many pesticide chemicals currently in use in the Central Valley potentially can disrupt endocrine systems, adversely affecting adult breeding and embryonic larval development (Hayes 1997; Colburn et al. 1996).

These sub-lethal effects of pesticide residues on adult frogs may be catastrophic to a population, given the limited active season in which frogs must emerge, successfully breed, and consume sufficient food to withstand up to 9 months of hibernation. Similarly, any delay in larval development or metamorphosis increases the chance of desiccation by drought (especially for larvae in ephemeral pools), given that mountain yellow-legged frog larvae require multiple summers to reach metamorphosis.

Of great concern is the possibility that pesticide pollutants act as environmental stressors, rendering mountain yellow-legged frogs more susceptible to aquatic pathogens such as red-leg disease or the chytrid fungus (Carey et al. 1999; Carey and Bryant 1995; Carey 1993; Jennings 1996; Drost and Fellers 1996). These aquatic pathogens historically have been considered opportunistic, infecting only injured or immuno-suppressed amphibians, but not healthy individuals (Carey et al. 1999; Carey and Bryant 1995; Carey 1993; Cahill 1990; Anver and Pond 1984). Recent research indicates that sub-lethal levels of organophosphate pesticides in combination with normal background levels of red-leg bacteria may result in fatal infections to amphibians[9] (Taylor et al. 1999b). Taylor et al. (1999b) linked exposure to malathion with increased disease susceptibility or suppressed immune responses in adult Woodhouse's toads (*Bufo woodhousi*). Malathion is readily taken up through the skin, respiratory system, or gastrointestinal tract (Gunther et al. 1968). It is unknown how much malathion currently is applied or drifts into the Sierra Nevada, but in the 1980's, malathion was applied annually to almost 5 million hecatres in the United States (Smith 1987).

---

[9] Taylor et al. (1999b) exposed Woodhouse's toads (*Bufo woodhousi*) to the "red-leg" bacterium *Aeromonas hydrophila*, and external high, low, or no doses of field grade malathion. Disease susceptibility and mortality were significantly increased in toads exposed to both high and low doses of malathion.

Since mountain yellow-legged frogs spend a high percentage of their life cycle in water, moving through the interface of water and air, and respire through their skin, they are at high risk from these chemicals. Pesticides, often insoluble in water, tend to concentrate on the surface, a place where mountain yellow-legged frogs move through often, heightening their risk (Cory et al. 1970).

Dr. Lawrence Cory (Cory et al. 1970) believes that airborne pesticides from the west side of the Sierra from Central Valley agriculture may be at least partially responsible for the decline of mountain yellow-legged frogs. Cory collected 600 frogs from the west side of Mt. Whitney in the 1960's, and found that not one frog was free of DDT. The general pattern of DDT distribution showed concentrations higher in the central and southern Sierra. DDT contamination was heavier on the west slope of Sierra than on the east face, a pattern ascribed to airborne drift. However, since the greatest declines in the species were observed after DDT was banned in the 1970's, and frogs are virtually gone from the east side while the largest remaining populations are on the west side, the linkage between pesticide drift and frog declines is not straightforward. The fact that many declines were observed during the 1970's-1980's may simply be a result of increased survey effort by biologists. The Grinnell and Storer observations in 1914-1920 suggest that dramatic declines have been occurring since the turn of the century. Cory also implicated chlorpyrifos (Durzban) and Rice Molinate, two currently used pesticides, as possibly playing a role in the species' decline.

More recent data from the Sierra Nevada strongly implicates pesticide drift as a factor for frog declines in general and also specifically for *R. muscosa* declines (C. Davidson, H. B. Shaffer, and M. R. Jennings, unpublished manuscripts). Davidson et al. (unpublished manuscript) mapped 237 historic locations for the California red-legged frog (*Rana aurora draytonii*) across its entire range in California, determined their current population status, and analyzed the spatial pattern of declines. Observed patterns of decline were compared to declines predicted by climate change, UV-B radiation, pesticides, and habitat alteration hypotheses for amphibian decline. Declines showed a strong positive association with elevation, percent upwind agricultural land use, and local urbanization. Declines were not consistent with the climate change hypothesis. The elevational gradient in declines was consistent with the UV-B hypothesis, although a predicted north to south gradient in declines was not observed. Davidson et al. (unpublished manuscript) conclude that wind-borne agrochemicals may be an important factor in *R. a. draytonii* declines, and the association of declines with the amount of upwind agricultural use was most pronounced within the Central Valley-Sierra region.

Davidson et al. (unpublished manuscript) made similar comparisons for seven other California amphibian species, including *R. muscosa*. Two hundred and fifty-five historic sites were examined for presence of *R. muscosa* and the spatial patterns of declines analyzed. Declines for mountain yellow-legged frogs had a strong positive association with the amount of upwind agricultural land use. Davidson et al. (unpublished manuscript) found two times as much agricultural land use upwind of sites where *R. muscosa* had disappeared as for sites where the species was still present.

Current research by Jeff Angermann at U.C. Davis is investigating the use of toxaphene and PCBs in the last 30 years, and correlating these chemicals with the disappearance of *R. muscosa*

(Tolson 1999). The species' unique overwintering behavior makes it particularly vulnerable to pollutants. Both adults and tadpoles overwinter on or in the sediments of lakes, ponds, and slow moving rivers. These sediments become repositories of concentrated organochlorides and other pollutants. Mountain yellow-legged frogs can be repeatedly exposed to these toxic sediments for up to 9 months each year. The effects of sustained exposure to such pollutants currently is being explored.

c. Livestock Grazing

The impacts of livestock grazing on high elevation wetland ecosystems is well documented (Jennings 1996; Knapp and Matthews 1996; and authorities cited within). Livestock can remove and trample riparian and wetland vegetation (Kauffman and Krueger 1984; Marlow and Pogacnik 1985) used for cover and egg laying by frogs. Cattle also markedly alter the physical characteristics of stream margins because they tend to concentrate there (Belsky et al. 1999) and stream banks are more susceptible to trampling because of high soil moisture (Marlow and Pogacnik 1985). Trampling often increases soil compaction and stream bank erosion, filling in pools, and making stream channels wider and shallower (Duff 1977; Bohn and Buckhouse 1985; Kauffman and Krueger 1984; Kauffman et al. 1983). Mountain yellow-legged frogs need deep pools to overwinter. Livestock grazing can increase erosion of connecting stream channels, lowering the water table, and eliminating ephemeral and even permanent water bodies (Armour et al. 1994; Meehan and Platts 1978) used by frogs for breeding. Overgrazing can also eliminate undercut banks (Duff 1977; Platts 1981) used by frogs for cover. Grazing may also pollute sensitive aquatic habitat through input of excessive nitrogen, which can lead to increased levels of aquatic bacteria (Stephenson and Street 1978).

Disturbance of current or historic mountain yellow-legged frog habitat due to livestock grazing has been documented in many of the National Forests. For example, in the Inyo National Forest grazing impacts to riparian and aquatic organisms, damage to springs and wet meadows, and changes in channel morphology and pool depth have occurred in many areas that currently are or previously were suitable frog habitat. As early as 1980, Hansen noted that occurrence of mountain yellow-legged frogs on the Kern Plateau in Sequoia National Forest "may be of considerably more limited occurrence than in the past due to habitat modifications, particularly cattle grazing in the meadows" (Hansen 1980). These impacts were reported at numerous localities on the Kern Plateau (Christopher 1994), in Cottonwood Basin and McAfee Meadow Research Natural Area on the east slope of the White Mountains (Giuliani 1996), in Crooked Meadows (Knapp 1993a), Dry Creek (Knapp 1993), and Cold Meadow (Knapp 1994).

In Crooked Meadows, Knapp noted a negative correlation between grazing impacts and numbers of frogs. Knapp found no frogs in the lower portion of the meadow, which had been incised due to grazing practices, and was wide and shallow with no undercut banks. The ungrazed portions of the meadow contained the best frog habitat (the stream was deep and narrow, and there were overhanging banks for cover from predators) and most of the frogs. The depth of the largest pond had been reduced by sediment deposition from grazing practices. Knapp felt that as a result of this habitat alteration, the overwinter survival of tadpoles may have been decreased, as they need a certain depth of unfrozen water to survive winter (Knapp 1993).

d. Acidification from Atmospheric Deposition

Since lakes and streams of the Sierra Nevada are very weakly buffered and acidic deposition has been documented throughout the Sierra Nevada, there has been suspicion that lowered pH and elevated levels of aluminum may be contributing to declines. However, water chemistry and pH in 46 potential breeding sites did not differ between sites with *R. muscosa* and those without (Bradford and Gordon 1993; Bradford et al. 1994a, 1994b). In addition, laboratory experiments with levels of pH and aluminum found to occur in the field did not result in a significant decrease in survival of embryos and newly hatched tadpoles (Bradford et al. 1992), but did result in reduced body size of tadpoles (Bradford and Gordon 1993). Embryonic stages of *R. muscosa* were found to be more sensitive to increased acidity than larvae (Freda 1990), and transitional processes such as metamorphosis and egg hatching appear to be easily disrupted by acid stress (Clark and LaZerte 1985). While lowered pH in and of itself does not seem to be a major factor in the species' decline, its impact on growth rates may increase mortality in the field and make individual frogs more susceptible to disease outbreaks.

e. Nitrate Deposition

Agricultural fertilizers have been linked to amphibian deaths, including in a new study showing that several frog, toad, and other amphibian species in Oregon can be highly susceptible to fairly low levels of nitrate and nitrite exposure, especially at more vulnerable larval stages (Marco et al. 1999; Marco and Blaustein 1999). Marco et al. found that moderate exposure to nitrates and nitrites resulted in reduced feeding activity, disequilibrium, physical abnormalities, paralysis, and even death among some tadpoles and young frogs. Levels of nitrite considered safe for human drinking water killed over half of Oregon spotted frog (*Rana pretiosa*) tadpoles after 15 days of exposure. Nitrates are of low toxicity but can cause health problems when reduced to nitrites. Nitrite levels can become high in specific areas such as shore sites with high contents of organic matter and can be concentrated due to waste from livestock. Nitrate can be reduced to nitrite in the gastrointestinal tract of amphibians, especially in younger animals (Marco et al. 1999; Marco and Blaustein 1999). Additionally, nitrate deposition from air pollution can greatly alter lake ecosystems, and may shift the normal ecological balance in a manner that increases the ability for disease to take hold in amphibians (V. Vredenburg, pers. comm., 2000).

f. Ultraviolet Radiation

There is no direct evidence at this time that the thinning of the ozone layer has had adverse impacts upon frog populations. However, studies have shown an increase in UV-B radiation in high montane environments such as those occupied by the mountain yellow-legged frog (Blumthaler and Ambach 1990; Cahill 1990). Increased UV radiation does have detrimental effects on animals (e.g. Bullock 1982, Urbach 1969) and amphibians are particularly at risk because of their relatively unprotective integument (Drost and Fellers 1994). Blaustein et al. (1994a) found a potential correlation between increased UV-B radiation exposure and embryonic failure of some amphibian species. Increased UV-B radiation may also act as an environmental stressor, increasing amphibian susceptibility to disease (Carey et al. 1999).

g. Drought

Most researchers believe that deeper, permanent pools of water historically provided refugia for aquatic amphibian populations during periods of prolonged drought, which could replenish peripheral populations through re-colonization (Bradford et al. 1993; Knapp 1996; Drost and Fellers 1996). California has undergone two major drought periods since the 1970's, after which *R. muscosa* declines were first observed. Either drought period could have limited the frog's ability to successfully breed in ephemeral pool habitat. The introduction of non-native trout may have eliminated permanent water refuge habitats, rendering frog populations more vulnerable to drought-related extinction events (Bradford et al. 1993; Knapp 1996; Drost and Fellers 1996).

h. Other Factors

In at least one case, groundwater pumping has been documented to de-water riparian habitat and possibly eliminate a frog population. Giuliani (1994) had found "numerous" *R. muscosa* at Fish Lake on the east slope of the White Mountains in the 1970's. Agricultural groundwater pumps were installed in the area in the late 1980's, and in 1994 Giuliani found Fish Lake dry, the "entire aquatic and riparian habitat now dry desert hardpan," and without frogs (Giuliani 1994).

Because many of the remaining populations of the Sierra mountain yellow-legged frog are small isolated remnants, they are vulnerable to random natural events that could quickly extirpate them. It is a widely recognized principle that, in general, small populations are more vulnerable to extinction than large ones (Pimm 1991; Noss and Cooperrider 1994). Noss and Cooperrider (1994) identified four major factors that predispose small populations to extinction: (1) Environmental variation and natural catastrophes like unusually harsh weather, fires, or other unpredictable environmental phenomena; (2) chance variation in age and sex ratios or other population parameters (demographic stochastisity); (3) genetic deterioration resulting in inbreeding depression and genetic drift (random changes in gene frequencies); and (4) disruption of metapopulation dynamics (i.e., some species are distributed as systems of local populations linked by occasional dispersal, which wards off demographic or genetic deterioration).

It is likely that some or a combination of these factors contribute to an increased probability of extinction of local populations and the entire Sierra Nevada population of the mountain yellow-legged frog. When effective population size is small, the negative consequences can be demographic (e.g., not enough individuals of a given sex) or genetic (e.g., inbreeding depression), and can predispose these populations to a higher risk of extinction. The population genetics and metapopulation dynamics of the Sierran mountain yellow-legged frog have not been thoroughly investigated, but the connectivity of smaller populations within the Sierra Nevada population of the mountain yellow-legged frog likely is substantially reduced compared to the recent past. Bradford et al. (1993) delineated networks of sites where *R. muscosa* was found in Sequoia and Kings Canyon National Parks which were connected to one another via fishless streams. They compared the present fishless networks to those expected for the same sites had fish not been introduced to the parks, and concluded that the present connectivity networks consist of a mean average of only 1.4 sites (connectivity average 0.43), whereas the former networks averaged 5.2 sites (connectivity average 4.15). Bradford et al. (1993) concluded that there had been a 10-fold decrease in the connectivity (the mean number of potential dispersal links per network) of frog populations in these drainages.

Because the Sierra Nevada population of the mountain yellow-legged frog consists of mostly small isolated populations, it is particularly vulnerable to some or all of the effects of chance listed above. Given the low probability of improving the status of the Sierra Nevada population of the mountain yellow-legged frog under the status quo, the probability of small population size playing a role in the extinction of one or more local populations within the next few years is high. Any local extirpations will further isolate the remaining populations and probably reduce the time to extinction for the entire Sierra Nevada population of the mountain yellow-legged frog.

III. CRITICAL HABITAT

Petitioners request the designation of critical habitat for the mountain yellow-legged frog concurrent with its listing. The mountain yellow-legged frog already has vanished from many areas in its historic range. Critical habitat should encompass all lakes, ponds, springs, tarns, streams and wet meadows within the historic range of the species, as well as a 500 m buffer around those features to allow for adult and juvenile dispersal.

IV. CONCLUSION

The Sierra Nevada population of the mountain yellow-legged frog is clearly imperiled and warrants endangered status under the Endangered Species Act. *R. muscosa* has declined and continues to decline in distribution and abundance throughout a significant portion of its range in the Sierra Nevada and is on a rapid slide toward extinction. The species has been documented to have disappeared from numerous historic locations throughout the Sierra. The frog has declined significantly in distribution, by some estimates up to 90% from its historic range. The most severe losses have occurred in the northern and central Sierra Nevada. There are few large populations of the frog remaining, and the majority of recent sightings have been of small numbers or individual frogs. Even the remaining large populations are not secure, as the recent crash of two of the largest documented populations near Mono Lake has shown.

Anthropogenic and natural factors such as fish stocking, pesticide use, livestock grazing, UV radiation, acid deposition, and drought have likely each played a role individually and in combination, in contributing to the alarming declines of the species. As early as 1994, Charles Drost and Gary Fellers, herpetologists with the U. S. Geological Service - Biological Resources Division, concluded that the mountain yellow-legged frog warranted endangered status. Drost and Fellers (1994) stated "There have been efforts to gain Federal Endangered Species status for some or all populations of three of the species discussed here: 1) the Yosemite Toad; 2) the California Red-legged Frog; and 3) the Mountain Yellow-legged Frog. Our results argue strongly for such listing for all three of these species." Today, as the information presented in this petition makes clear, the mountain yellow legged frog is in evan greater peril than in 1994 and deserves prompt action under the ESA to protect it and its threatened habitat.

V. SIGNATURE PAGE

Submitted this _____ day of February, 2000

____

Jeff Miller
Center for Biological Diversity
P.O. Box 40090
Berkeley, CA 94704-4090
(510) 841-0812

____

Deanna Spooner
Pacific Rivers Council
P. O. Box 6185
Albany, CA 94706-6185
(510) 548-3887

VI. APPENDIX 1 - SUPPLEMENTAL SUMMARY OF RECENT SURVEY DATA

This appendix contains supplemental data from recent surveys.

b. State of Nevada

Apparently one or two frog populations have been recently found in Nevada (D. Bradford, pers. comm., 2000), but any remaining locations are scattered and contain individual or small numbers of frogs (R. Panik, pers. comm., 2000)

c. Lassen National Forest

No *R. muscosa* were found during surveys of 140 sites from 1993-1997, including in drainages with historical occurrences (USFS 1993, Fellers 1998).

d. Lassen Volcanic National Park

The species does not occur in Lassen Volcanic National Park (NPS 1999).

e. Plumas National Forest

Jennings and Hayes (1994) noted two locations where they considered the species extant based on verified sightings. Over the past 5 years amphibian surveys have been conducted on the Plumas National Forest. Most surveys took place where biologists identified possible habitat. From 1990 to present some frog observations were incidental to surveys conducted for specific projects within the National Forest. The Plumas National Forest used the "Standard Anuran Survey Protocol" (Martin 1993) to a limited extent between 1993 and 1995. In 1993 mountain yellow-legged frogs were detected in Lower Bucks, Upper Bolder Creek (eastside), Elysian Valley Creek, and Rock Lake (Twedt and Evans 1993). In 1994, a few surveys were conducted for grazing allotments, and a single frog was located at Pinkard Creek, elevation 3,500 feet (USFS 1994). 1995 surveys conducted along the South Fork Feather River resulted in no frog sightings. Starting in 1996, the Plumas National Forest conducted amphibian surveys using "A Standardized Protocol for Surveying Aquatic Amphibians" (Fellers and Freel 1995). No frogs were detected during formal surveys in 1996 (Fellers 1997a). Formal surveys were conducted on a few scattered parcels for a land exchange in 1997, and there were several detections within the Lost Creek watershed, extending the low elevation record for the species; and a single frog was again located at Pinkard Creek, 3,500 feet. Formal surveys in 1998 (Vindum and Koo 1999) resulted in one sighting at Rock Creek (Bottle Springs) and another at Pine Grove Creek. In 1999, frogs were seen at Faggs Reservoir, Silver Lake, Rock Lake, and at a small pond in Pine Grove Cemetery (J. Vindum, pers. comm. 2000). Faggs Reservoir and Rock Lake had tadpoles, adults, and juveniles, and only Silver Lake had only juveniles

(J. Vindum, pers. comm. 2000). Most observations from 1993 to present appear to have been of individual frogs, with 2 or 3 specimens seen in only a few areas (PNF 2000).

f. Tahoe National Forest

The frog was not found during surveys in 1995 in Summit Creek (at the western end of Donner Lake) where frogs were caught during 1964 and 1965 (Panik 1995). The Tahoe National Forest conducted amphibian surveys from 1993-1998. The extent and thoroughness of these surveys is not reported. In 1993 only 4 adult frogs were found at 2 locations. In 1996 only 1 adult and 4 sub-adult frogs were found at 3 locations. In 1997 only 12 adults plus an unknown number of larvae and eggs were found at 4 locations. In 1998 only 6 adults, 3 sub-adults, and many larvae (at Soda Springs, where 5 of the adult frogs were) were found at 4 locations (USFS 1999).

g. Lake Tahoe Basin Management Unit

The Forest Service has done extensive surveys of the Lake Tahoe Basin Management Unit, and except for scattered records of individual frogs, there is only one known reproducing population of *R. muscosa* (Jeff Ryner, USFS, pers. comm. 1999). A population of all age classes (estimated at 50-200 individuals according to Ryner, pers. comm. 1999; 3 adults at most seen and hundreds of 1st year tadpoles according to Matt Slesinger, USFS, pers. comm., 1999) was discovered in Hell Hole meadow above Star Lake (near Job's Peak, south of Lake Tahoe) in 1997. In 1999 fewer than 10 juveniles and about 100 2nd to 3rd year tadpoles were seen (Slesinger, pers. comm.). Frogs have been found in only one locality in the meadow, though numerous nearby ponds have been searched and suitable habitat seems to exist.

The Forest Service sampled ponds and wet meadows at 88 sites in 1997, and found frogs in no other locations; in 1997 and 1998 Stafford Lear of CDFG surveyed 2 entire drainages within the Basin and found no frogs; and University of California, Davis researcher Karen Leyse surveyed about 50 ponds in the basin during the past few years searching for salamanders, and noticed no frogs (Slesinger, pers. comm. 1999).

h. Eldorado National Forest

In 1989 a single adult frog was seen at Anderson Canyon Creek.

In 1991 2 adult frogs were seen at a tributary to Cole Creek.

In 1992 frogs were seen at 12 locations, with 22 adults, approximately 210 juveniles, and about 150 larvae counted. At 9 of these locations either one or no adult frogs were seen[10], including

---

[10] Including a tributary to Deer Creek; headwaters of Lower Beebe Lake Inlet; Forni Creek; Bassi Fork Creek; Boomerang Lake; and Barrett Lake Outlet.

Corrie Lochlan Lake, which contained approximately 100 juvenile frogs and 20 larvae. Small populations were encountered at Shangri-La Lake (10 adults), Ladeux Meadow (3 adults, 67 juveniles, and 42 larvae), and in the tributary to Cole Creek (2 adults, 8 juveniles, and 25 larvae). A separate survey by Canorus Ltd. (Martin 1992) of over 37,000 meters of streams, ponds, and meadows in Eldorado National Forest found no mountain yellow-legged frogs at 16 sites examined.

In 1993 frogs were seen at 29 locations. Approximately 55-60 adults, over 215 juveniles, and over 770 larva were counted. At 23 of these locations either one or no adult frogs were seen[11], and at four locations 2-5 adults were counted.[12] Small populations were noted at an unnamed tributary to Silver Lake (7 adults), and at an unnamed pond 1 mile from Hwy. 88 in Amador County (over 5 adults and about 500 larvae counted in June; 12-15 adults, about 150 juveniles and over 100 larvae were seen in July).

In 1994 frogs were seen at 23 locations, with 34 adults, 123 juveniles, and approximately 450 larvae counted. At 17 of these locations either one or no adult frogs were seen[13], including a tributary to Deer Creek (about 20 larvae seen) and in unnamed springs 3 miles southeast of Silver Lake (about 40 larvae). At 6 locations, 2-4 adult frogs were seen,[14] including sites with other age classes at Ladeux Meadow (4 adults, 3 juveniles, and 112 larvae) and the tributary to Cole Creek (3 adults, 85 juveniles, and over 250 larvae). In Middle Creek 6 adults frogs and 14 larvae were seen.

In 1995 frogs were seen at 25 locations, with 39 adults, 18 sub-adults, approximately 230 larvae, and 17 egg masses counted. At 16 of these locations one or no adult frogs were seen, including sites with other age classes at Pyramid Lake (4 larvae and 2 egg masses), an unnamed lake in the Pyramid Creek drainage (4 larvae and 12 egg masses seen), an unnamed lake in the Rubicon drainage (21 larvae), and Zitella Lake in the Rubicon drainage (3 sub-adults and 62 larvae). At 6 locations, only 2- 3 adult frogs were seen. 6 adults and 5 sub-adults were seen at an unnamed lake in the Pyramid Creek drainage, but all the adults were dead. Deer Creek, Little Indian Valley had a small population (8 adults, 4 juveniles, and an estimated 90 larvae).

---

[11] Including unnamed pond 4 miles southeast of Silver Lake; Deer Creek tributary; Middle Creek; Little Bear River headwaters; unnamed Caples Creek tributary; Pyramid Creek just below Ropi Lake; Lois Lake; unnamed Silver Lake tributary; unmapped pond 1/4 mile southwest of Lake Doris; lower Lake Doris; Lake Doris outlet; Lake Zitella outlet; Lake Zitella; McConnell Lake main inlet stream; 3 unnamed ponds downstream of Highland Lake outlet; unmapped pond east of McConnell Lake; McConnell Lake north shoreline; Rubicon River below China Flat; Lake #9; and unnamed pond north of Lake #9.

[12] Alder Creek; Bark Shanty Canyon Creek; Deadwood Canyon Creek; and Ladeux Meadow.

[13] Including unnamed lake 1/3 mile east-northeast of Gertrude Lake; Deer Creek tributary ~3 miles southeast of Lower Blue Lake; Forni Lake; Camp Creek; 2 unnamed streams in South Branch Indian Valley south of Summit Lake; Ladeux Meadow Creek; Gefo Lake; unnamed pond in Gefo Lake outlet; unnamed pond in inlet from Waca Lake; Waca Lake; unmapped pond in Waca Lake outlet channel; 3 unnamed lakes east of American Lake; and in unnamed pond south-southeast of Toem Lake.

[14] Including 2 unnamed ponds south of Waca Lake; Pyramid Lake, and unnamed tributary to Deer Creek.

In 1996 frogs were seen at only 10 locations, with 14 adults, 56 juveniles, and over 225 larvae counted. At 8 of these locations one or no adults were seen, including sites with other age classes at 2 unnamed ponds (#117 & #118) west of Meadow Lake (18 juveniles and 6 larvae), Boomerang Lake (9 juveniles and over 30 larvae), and an unnamed Shangri-La Lake (#811) east of Upper Twin Lake (1 adult, 2 juveniles, and 13 larvae). Deadwood Canyon Creek had a small population (7 adults, 8 juveniles, and an estimated 75 larvae of 2 age classes), as did Deer Creek, Little Indian Valley (4 adults, 17 juveniles, and over 100 larvae).

In 1997 frogs were seen at 11 locations, with 28 adults, approximately 35 juveniles, and about 440 larvae counted. At 4 of these locations one or no adult frogs were seen. At 5 locations 2-3 adult frogs were seen, including sites with other age classes at Ladeux Meadow Stream (3 adults and 81 larvae; subsequently 4 adults, 7 juveniles, and 169 larvae of 2 year classes seen during re-survey a week later) and an unnamed lake (#678) 1 mile north of Highland Lake (3 adults, several juveniles, and over 30 larvae). Deer Creek, Little Indian Valley had a small population (9 adults, 26 juveniles, and over 60 larvae of 2 year classes).

In 1998 frogs were seen at 8 locations. Approximately 15 adults, 107 juveniles, and 47 larvae were counted. At 6 of these locations one or no adult frogs were seen. At 2 locations along Tragedy Creek, 2 adult frogs, 102 juveniles and 44 larvae were seen. Four adult frogs were seen on 3 successive visits to a tributary of Cole Creek 3 miles east of Lower Bear River Reservoir.

i. Stanislaus National Forest

In 1994 frogs were seen at 20 locations. At 12 of these locations fewer than 5 adult frogs were seen.[15] At 4 locations in the Emigrant Wilderness, 39 adults, 17 sub-adults, and 238 larvae were counted. Small populations were found at Chewing Gum Lake (7 adults), in 2 locations at Y-Meadow Dam (6 adults and 1 sub-adult), and in Coolidge Meadow (20 adults, 43 sub-adults, and 475 larvae).

In 1995 frogs were seen at 12 locations. At 7 of these locations fewer than 4 adult frogs were seen.[16] Small populations were found at Pruitt Lake (18 adults) and Stanislaus Meadow (3 adults, 35 larvae, and one egg mass with about 100 eggs). Larger populations were noted at Blackbird Lake (15 adults, 20 sub-adults, and 2500 larvae), Shallow Lake (7 adults, 15 sub-adults, and 652 larvae), and Letora Lake (6 adults, 4 sub-adults, and 1500 larvae).

In 1996 frogs were seen at 18 locations. At 3 of these locations only a single adult frog was seen. At 9 locations in the Emigrant Wilderness, 41 adult frogs, 128 sub-adults, and over 1600 larvae were counted. Small populations were found at Sardella Lake (40 larvae), Coyote Lake (5

---

15 Maxine Lake; Buck Lake; Wood Lake; Coyote Lake; Long Lake and outlet; Deer Lake; Spring Meadow; Cow Meadow Lake; Star Jordan Lake; Lower and Middle Wire Lake; and Leopold Lake.

16 Summit Meadow; Emigrant Lake; Fraser Lake; Frog Lake; Letora Pond; Wheeler Lake; and Mosquito Lake.

adults), Stanislaus Meadow (15 adults, 3 sub-adults, and 85 larvae), Wilson Meadow Lake (21 adults, 130 sub-adults, and 109 larvae), and Moore Creek (25 adults, 5 larvae, and 3 egg masses with 75 eggs per mass).

In 1997 frogs were found in only 10 locations. At 6 of these locations one or no adults were seen, including sites with frogs of other age classes at Snow Lake (125 larvae found) and Cherry Creek (407 larvae found). Very small populations were found at Y Meadow Dam (2 adults and 4 larvae), Willow Creek (2 adults, 1 larvae, and one egg mass with 100 eggs), Moore Creek (4 adults and one sub-adult), and Stanislaus Meadow (4 adults, 1 sub-adult, and 19 larvae).

In 1998 no mountain yellow-legged frogs were found in Stanislaus National Forest, but the intensity of survey effort relative to other years is unknown.

j. Toiyabe National Forest

There are no known surveys for *R. muscosa* in the Hoover or Mokelumne Wildernesses within Toiyabe National Forest (USFS 1998), although Toiyabe NF personnel have searched informally for frogs (Pat Shanley, USFS, pers. comm. 1999). In Upper Fish Valley in the Silver King Creek drainage within the Carson/Iceberg Wilderness, 3 adults and 2 sub-adults were found in 1999. Of 17 sites surveyed in 1996, 2 had frogs, both at Chango Lake. Fourteen areas containing single or multiple sites, covering 760 aquatic acres, were surveyed in 1999, and only Chango Lake and Rainbow Meadow had frogs (USFS 2000).

k. Yosemite National Park

R. muscosa was found in 1992 and 1993 by Drost and Fellers (1996) at a few sites along the Yosemite transect away from the Grinnell and Storer (1924) sites. A single adult was found at the "G7" meadow, a small population (16-18 adults and 30 tadpoles) was located at Summit Meadow along Glacier Point Road, and 113 tadpoles were counted at Mount Hoffmann.

Fellers (1997) found *R. muscosa* at 43 locations. At 10 of these locations one or no adult frogs were found. At 17 locations fewer than 10 adult frogs and few frogs of other year classes were found. 11 sites appeared to have small to medium populations.[17] The Summit Meadow population visited by Drost and Fellers in 1992-1993 was revisited by Fellers in 1997; in July 11 adult frogs

[17] Dry Creek (10 adults); unnamed wetland ½ km southeast of lower Twin Lake (20 adults); unnamed pond ½ km south of lower Twin Lakes (10 adults, 37 larvae); unnamed lake and meadow 1 km north of Haystack Peak (34 adults, 65 larvae); Upper Peninsula Lake (9 adults, 28 larvae); Peninsula Lake (10 adults, 10 larvae); Bear Lake (10 adults, 13 larvae); unnamed ponds 0.4 km southeast of Big Island Lake (14 adults, 420 larvae); Big Island Lake (29 adults, 315 larvae); unnamed pond 0.2 km west of Big Island Lake (10 adults, 38 larvae); and unnamed lake 1.1 km west of Richardson Peak (24 adults, 449 larvae).

and 37 larvae were found; 38 adults and 12 larvae were found in September. Fellers surveyed 18 sites around Mt. Hoffman, and only 10 larvae were found at a single pond.

l. Inyo National Forest

D. Giuliani saw a single adult frog at Gable Lakes in 1990 (Parker 1994).

In 1992 *R. muscosa* was seen at 11 locations, including at Hall RNA (reintroduction study area) and Saddlebag Lake in Mono County; at Chalfant Tarns (above Pine Creek) and 3 locations in the upper drainage of Baker Creek in Inyo County; and at Upper Mills Lake (off the National Forest) in Fresno County (CDFG 1998). D. Giuliani saw small populations of frogs at Cow Creek (Sanger Meadow) and Dry Creek/Big Sand Flat, and reported adults and larvae at Baker Creek (Parker 1994). Roland Knapp reported a large population of frogs at Upper Wonder Lakes, and tadpoles only in tarns northeast of Matlock Lake (Parker 1994).

In 1993 the Inyo National Forest began a comprehensive amphibian survey on the Kern Plateau, covering 13 drainages[18] (some only partially). *R. muscosa* was found only at Casa Vieja Meadow during this survey, where 4-5 adults and no tadpoles were counted (Parker 1994).

R. muscosa was seen at 5 locations in 1993, including Casa Vieja Meadow, and the large population noted at Upper Wonder Lakes in 1992 (CDFG 1998). Roland Knapp reported a very large population (over 1000 adults counted, and tadpoles) at Dry Creek, above and below Highway 120 (Knapp 1993). 7 adults and 110 tadpoles were counted at Maul Lake.

R. muscosa was seen at 10 locations[19] in 1994 (Parker 1994; CDFG 1998).

According to Parker (1994), the Inyo National Forest surveyed 14 grazing allotments and 8 other sites in 1994, and *R. muscosa* was found at only 3 sites; Baker Creek (54 adults on June 27), Sanger Meadow/Cow Creek (5 sub-adults and 140 tadpoles), and the Birch Creek water diversion (3 adults). However, a review of the Inyo National Forest files for amphibian surveys from grazing allotments and timber sales in 1994 indicates that of over 150 locations surveyed, *R. muscosa* was reported at 9 sites (USFS 1999e). Several significant populations were found by S. Riley and J. Lovtang in June, including at Cow Creek (158 adults, 5 sub-adults, and 10 tadpoles), Cow Creek at Sanger Meadow (75 adults, 5 sub-adults, and 140 larvae), an unnamed pond near Baker Lake (1 adult, 50 sub-adults, 100 tads), Baker Creek (27 adults), Baker Creek Reach 2 (90 adults), and Baker Creek Reach 3 (54 adults, 5 sub-adults, and 20 larvae).

---

[18] Golden Trout Creek (Groundhog Meadow); Big Whitney Meadow; Barigan Stringer; Strawberry Creek; 2 reaches of the South Fork Kern River; Snake Creek; Round Mountain Stringer; Soda Creek; Monache Creek; Kingfisher Stringer (dry); Cow Canyon Creek; and Casa Vieja.

[19] In Inyo County - at Upper Wonder Lakes; Baker Creek; Cow Creek (Sanger Meadow); Wonder Lakes; and at tarn 200 m south of Sixth Lake (Big Pine Lake). In Mono County - at Birch Creek above Swall Meadows; Saddlebag Lake; Convict Canyon near Mildred Lake; and Mildred Lake. In Tulare County - at Cold Meadow on the Kern Plateau.

In 1994 the Inyo National Forest also surveyed 12 drainages in the southern Kern Plateau[20] and rechecked populations already located at Casa Vieja Meadow (Christopher 1994). The survey found frogs only at Casa Vieja (2 adults and no tadpoles) and Cold Meadow (juveniles only), the two largest wet meadows in The upper Ninemile Creek and Cold Creek drainages. Roland Knapp reportedly saw a few adults and tadpoles of different year classes in Cold Meadow (R. Knapp, pers. comm., as cited in Christopher 1994).

Tadpoles were seen at the Wonder Lakes population in August. Roland Knapp discovered a new population at Cold Meadow in 1994 (2 adults, 50 sub-adults, and 10 tadpoles) (Knapp 1994). The Christopher survey also saw frogs at Cold Meadow.

R. muscosa were seen by Forest Service personnel at 4 other sites in 1994; Mildred Lake/Convict Canyon (20 adults), tarns near Saddlebag Lake (150 2nd year tadpoles), Big Pine Lake/Sixth Lake, (100 sub-adults), and Pine Creek (5 adults) (Parker 1994).

As of 1994, 15 *R. muscosa* populations were known on the Inyo National Forest.[21] Some of these populations were very small, with fewer than a dozen adults seen (Parker 1994).

CDFG files indicate that *R. muscosa* was seen at 4 locations in the general vicinity of Crooked Meadows in 1995[22] (CDFG 1998). Over 115 locations were surveyed by Inyo National Forest, and frogs were found at 4 sites.

A population of *R. muscosa* (4 adults and more than 200 tadpoles) was discovered along the shore of Banner Lake in 1995.

In 1996 frogs were present throughout Baker Canyon; large populations were found in ponds and marshes above Gable Lake #2, in a pond south of Sixth Lake on the North Fork of Big Pine Creek, and in marshes around Seventh Lake in the same drainage. Additionally, a small population (3 adults, 2 larvae, and thousands of eggs) was found in the West Fork of Coyote Creek (USFS 1999e).

m. Sierra National Forest

---

[20] Beer Keg Meadow; north tributary of Casa Vieja; tributary to Ninemile Creek south of Casa Vieja Meadow; Ninemile Creek (canyon below Casa Vieja Meadow); Kingfisher Stringer; Long Canyon Creek; Long Stringer; Lost Trout Creek; Monache Creek; River Spring; Snake Creek; and Soda Creek.

[21] Near Maul Lake; Saddlebag Lake; Crooked Meadows; Dry Creek (Hwy 120); McGee Canyon; Convict Canyon; Swall Meadow (Birch Creek); Chalfant Tarns (above Pine Creek); Baker Creek (west of Big Pine); Cow Creek (west of Big Pine); Sixth Lake (Big Pine Lake); Upper Wonder Lake (west of Bishop); tarns northeast of Matlock Lake (northwest of Lone Pine); Cold Meadow (Golden Trout Wilderness Area); and Casa Vieja (Golden Trout Wilderness Area).

[22] At 2 locations in Crooked Meadows; springs east of Crooked Meadows: and Wild Horse Canyon.

In 1992 Martin (1992) found 2 adult frogs, one at Desolation Lake and the other at Lakecamp Creek.

In 1994 Sierra National Forest found small populations in the John Muir Wilderness. Unknown numbers of *R. muscosa* were found in Snow Corral Meadow and Trouble Meadow Creeks, Upper Mills Creek Lake (Second Recess), Snow Lakes, in ponds above Fourth Recess Lake, and in the East Fork of Big Creek (USFS 1999f).

In 1995 Buck (1995) found 13 adults and 99 tadpoles at Snow Corral/Trouble Meadow in the Kings River District. Surveys by Knapp and Matthews in 1995 also located frogs in Snow Corral Meadow (7 adults, 4 juveniles, and 89 tadpoles) and Trouble Meadow (2 adults and 10 tadpoles), and at Golden Lake, Alsace Lake, and Pioneer Lake #1A (USFS 1999f). Meg Vinsen found *R. muscosa* in lower Blue Jay Lake #3 (2 adult/ juveniles and 14 tadpoles), Upper Hopkins Lake #2 (5 adults/juveniles), Upper Mills Creek Lakes (181 adults/juveniles and 300 tadpoles), Snow Lakes (1047 adult/juveniles, 1020 tadpoles, and 200 eggs), and Golden Lake (18 adult/juveniles, 25 tadpoles, and 1100 eggs). A 1995 survey of the Blasingame Grazing Allotment (USFS 1999g) revealed mountain yellow-legged frogs in Meadow #221 northeast of Rodeo Meadow (1 adult, 8 sub-adults, and 25 larvae) and Meadow #311 west of Ershim Meadow (1 adult was heard splashing and 20-30 larvae were seen).

In 1996 frogs were found at 8 sites (USFS 1999f). Unknown numbers of frogs were seen at Big Bear Lake, Black Bear Lake, Lower Mills Creek Lake, Upper Mills Creek Lake, Blue Jay Lake #3, Jawbone Lake, Negit Lake, and Tether Lake. *R. muscosa* were again seen at Snow Corral Meadow in 1996 (a single adult and 50 tadpoles) and in 1997 (4 adults and 1 sub-adult) (USFS 1999f).

n. Sequoia and Kings Canyon National Parks

No supplemental information.

o. Sequoia National Forest

In 1989 a single frog was seen in the North Fork of the Middle Fork of the Tule River at Moses Mountain (Keeler-Wolf 1989).

In 1991 *R. muscosa* was reported as occasional along Mountaineer Creek, up to its source at about 8600 feet (Keeler-Wolf 1991).

In 1995 and 1996 frogs were found in the headwaters of Little Kern River, just south of Farewell Gap. G. Fellers found adults in the river in 1995, and sub-adults in a nearby pond. In 1996 Fellers located 5 adults, 12 sub-adults, and tadpoles in the river; a number of tadpoles in pools off the main channel, and a frog in Silver Lake (USFS 1999i). *R. muscosa* was documented by Steve

Anderson in Taylor Meadow in 1996 (USFS 1999h). In an unconfirmed sighting in 1998, T. Tharalson heard possible mountain yellow-legged frogs in an unnamed pond 2 miles southeast of Taylor Meadow (USFS 1999h).

VII. BIBLIOGRAPHY OF LITERATURE CITED

Anver, M. R. and C. L. Pond 1984. Biology and diseases of amphibians. In: Laboratory animal medicine, J. G. Fox et al. (Editors), pp. 427-447. Academic Press, Inc., Orlando, Florida.

Armour, C., D. Duff, and W. Elmore 1994. The effects of livestock grazing on Western riparian and stream ecosystems. Fisheries 19(9): 9-12.

Aston, L. and J. Seiber 1997. Fate of summertime airborne organophosphate pesticide residues in the Sierra Nevada mountains. Journal of Environmental Quality 26: 1483-1492.

Beaties, R. and R. Tyler-Jones 1992. The effects of low pH and aluminum on breeding success in the frog *Rana temporia*. Journal of Herpetology 26(4): 353-360.

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(1): 419-431.

Berger, L. et al. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. Proceeding of the National Academy of Sciences, USA 95: 9031-9036.

Berrill, M., S. Bertram, A. Wilson, S. Louis, D. Brigham, and C. Stromberg 1993. Lethal and sub-lethal impacts of Pyrethroid insecticides on amphibian embryos and tadpoles. Environmental Toxicology and Chemistry 12: 525-539.

Berrill, M., S. Bertram, L. M. McGillivray, M. Kolohon, and B. Pauli 1994. Effects of low concentrations of forest-use pesticides on frog embryos and tadpoles. Environmental Toxicology and Chemistry 13(4): 657-664.

Berrill, M., S. Bertram, B. Pauli, and D. Coulson 1995. Comparative sensitivity of amphibian tadpoles to single and pulsed exposures of the forest-use insecticide Fenitrothon. Environmental Toxicology and Chemistry 14(6): 1101-1018.

Berrill, M., D. Coulson, L. McGillivray, and B. Pauli 1998. Toxicity of Endosulfan to aquatic stages of anuran amphibians. Environmental Toxicology and Chemistry 17(9): 1738-1744.

Blaustein, A.R., D. G. Hokit, R. K. Ohara, and R.A. Holt 1994. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. Biological Conservation 67: 251-254.

Blaustein, A., P. Hoffman, D. Hokit, J. Kiesacker, S. Walls, and J. Hays 1994a. UV repair and resistance to solar UV-B in amphibian eggs: A link to population declines? Proc. Natl. Acad. Sci. 91; Ecology: 1791-1795.

Blumthaler, M. and W. Ambach 1990. Indication of increasing solar ultraviolet radiation flux in alpine regions. Science 24: 206-208.

Bohn, C. C. and J. C. Buckhouse 1985. Some responses of riparian soils to grazing management in northeastern Oregon. Journal of Range Management 38:378-381.

Boyer, R. and C. Grue 1995. The need for water quality criteria for frogs. 103 Env. Health Persp. No. 4 (April 1995).

Bradford, D. F. 1983. Winterkill, oxygen relations, and energy metabolism of a submerged dormant amphibian, *Rana muscosa*. Ecology 64(5): 1171-83.

Bradford, D. F. 1989. Allotropic distribution of native frogs and introduced fishes in the high Sierra Nevada lakes of California: Implication of the negative effects of fish introductions. Copeia 1989 (3): 775-778.

Bradford, D. F. 1991. Mass mortality and extinction in a high-elevation population of *Rana muscosa*. Journal of Herpetology 25(2): 174-177.

Bradford, D. F., C. Swanson, and M. S. Gordon 1992. Effects of low pH and aluminum on two declining species of amphibians in the Sierra Nevada, California. Journal of Herpetology 26: 369-377.

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

Bradford, D. F. and M. S. Gordon 1993. Aquatic amphibians in the Sierra Nevada: Current status and potential effects of acidic deposition on populations. California Air Resources Board, Sacramento, California.

Bradford, D. F., D. M. Graber, and F. Tabatabai 1994. Population declines of the native frog, *Rana muscosa*, in Sequoia and Kings Canyon National Parks, California. The Southwestern Naturalist 39(4): 323-327.

Bradford, D. F., S. D. Cooper, and A. D. Brown 1994a. Distribution of aquatic animals relative to naturally acidic waters in the Sierra Nevada. Final Report. California Air Resources Board, Research Division, Sacramento, California. Contract No. A132-173. 164 pp.

Bradford, D. F., M. S. Gordon, D. F. Johnson, R. D. Andrews, and W. B. Jennings 1994b. Acidic deposition as an unlikely cause for amphibian population declines in the Sierra Nevada, California. Biological Conservation 69: 155-161.

Bradford, D. F., S. D. Cooper, T. M. Jenkins, Jr., K. Kratz, O. Sarnelle, and A. D. Brown 1998. Influences of natural acidity and introduced fish on faunal assemblages in California alpine lakes. Canadian Journal of Fisheries and Aquatic Sciences 55: 2478-2491.

Buck, M. K. 1995. Sierra National Forest Amphibian Surveys - 1995. USFS.

Cahill, M. M. 1990. A review: Virulence factors in motile Areomonas species. Journal of Applied Bacteriology 69: 1-16.

Cahill, T., J. Carroll, D. Campbell, and T. Gill 1996. Air quality. In: Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II. Assessments and scientific basis for management options. Centers for Water and Wildland Resources, Davis, California.

California Department of Fish and Game and USDA Forest Service, Pacific Southwest Region. Undated. A joint approach to address mountain yellow-legged frog (MYLF) and fish stocking issues in the Sierra Nevada. Draft agreement. 2 pp.

California Department of Fish and Game 1998. Database of high mountain lake amphibian surveys, in John Kleinfelter letter to Inyo National Forest dated February 23, 1998.

California Department of Fish and Game 2000. Lake Survey Forms, 1951-1952. Sent by Stafford Lehr, Associate Fishery Biologist, Mother Lode District.

California Department of Fish and Game - Natural Diversity Database. Specimens in U. C. Berkeley Museum of Vertebrate Zoology.

California State University, Chico. Compilation of Chico State amphibian records (specimens from Tehema, Butte, Plumas, and Lassen Counties) prepared by B. Clark (former Wildlife Biologist, Eagle Lake Ranger District, LNF). Review, verification, and correction of records made by M. Jennings, letter (with enclosure) to M. McFarland dated March 27, 1994.

Camp, C. L. 1917. Notes on the systematic status of the toads and frogs of California. University of California Publications in Zoology 17(9): 115-125.

Carey, C. 1993. Hypothesis concerning the causes of the disappearance of boreal toads from the mountains of Colorado. Conservation Biology 7: 355-361.

Carey, C. and C. Bryant 1995. Possible interactions among environmental toxicants, amphibian development, and decline of amphibian populations. 103 Env. Health. Persp., Supp. 4, pp. 13-16 (May 1995).

Carey, C., N. Cohen, and L. Rollins-Smith 1999. Amphibian declines; an immunological perspective. Developmental and Comparative Immunology, pp. 1-14.

Christopher, S. V. 1994. Occurrence and habitat use of stream-dwelling amphibians and reptiles at regions in southern Kern Plateau, Inyo National Forest, California. University of California, Santa Barbara, California. Report submitted to Kern Plateau Cooperative Research Group and USDA Forest Service, Inyo National Forest, Lone Pine, California.

Clark, K. L. and B. D. LaZerte 1985. A laboratory study of the effects of aluminum and pH on amphibian eggs and tadpoles. Can. J. Fish. Aquat. Sci. 42: 1544-1551.

Colburn, T., D. Dumanoski, and J. P. Myers 1996. Our stolen future. Plume/Penguin Books, Middlesex, England.

Colwell, M. A. 1995. Bird communities and frogs at Yosemite's high lakes. Final Report. Submitted to Yosemite Association. Wildlife Department, Humboldt State University, Arcata, California.

Corn, P. and F. Vertucci 1992. Descriptive risk assessment of the effects of acidic deposition on Rocky Mountain amphibians. Journal of Herpetology 26(4): 361-369.

Cory, B. L. 1963. Effects of introduced trout on the evolution of native frogs in the high Sierra Nevada Mountains. Page 172. Proc. XVI, International Congress on Zoology, Washington, DC.

Cory, L., P. Fjeld, and W. Serat 1970. Distribution patterns of DDT residues in the Sierra Nevada mountains. Pesticides Monitoring Journal 3(4): 204-211.

Cory, L. R. 1989. Memorandum to National Park Service dated February 28, 1989.

Drost, C. A. and G. M. Fellers 1994. Decline of frog species in the Yosemite section of the Sierra Nevada. National Park Service Technical Report No. NPS/WRUC/NRTR 94-02.

Drost, C. A. and G. M. Fellers 1996. Collapse of a regional frog fauna in the Yosemite area of the California Sierra Nevada, USA. Conservation Biology 10(2): 414-425.

Duff, D. A. 1977. Livestock grazing impacts on aquatic habitat in Big Creek, Utah. In: Proceedings of the workshop on wildlife-fisheries relationships in the Great Basin. University of California Agricultural Station, Sci. Spec. Publ. 3301: Berkeley, CA.

Fellers, G. M. 1994. An assessment of the status of amphibians in the vicinity of California National Parks. National Biological Survey, Point Reyes, California.

Fellers, G. M. 1997. 1997 aquatic amphibian surveys: Yosemite National Park. Biological Resources Division, USGS, Point Reyes, California.

Fellers, G. M. 1997a. 1996 aquatic amphibian surveys, Plumas National Forest. Unpublished report prepared for the Plumas National Forest. Biological Resources Division, USGS. Point Reyes National Seashore, Point Reyes, California. 24 pp. + maps.

Fellers, G. M. 1998. 1996-97 aquatic amphibian surveys, Lassen National Forest. Unpublished report prepared for the Lassen National Forest. Biological Resources Division, USGS. Point Reyes, California.

Fellers, G. M. and Freel 1995. Standardized protocol for surveying aquatic amphibians. National Biological Service. Point Reyes National Seashore, Point Reyes, California.

Fellers, G. M. 1999. Declining amphibians in Yosemite National Park: final report. Biological Resources Division, USGS, Point Reyes National Seashore, Point Reyes, California.

Freda, J. 1990. Effects of acidification on amphibians. In: Biological effects of changes in surface water acid-base chemistry, Baker, J. P. et al. (editors), pp. 114-129. Technology Report 13, National Acid Precipitation Program, Washington, D.C.

Giuliani, D. 1994. Survey for amphibians in Inyo National Forest; East slope White Mountains. U. S. Forest Service, Lone Pine, California.

Giuliani, D. 1995. Survey for amphibians in Inyo National Forest; East slope White Mountains Part II. U. S. Forest Service, Lone Pine, California.

Giuliani, D. 1996. Survey for amphibians in Inyo National Forest; East slope White Mountains Part III. U. S. Forest Service, Lone Pine, California.

Green, D. M. 1986. Systematics and evolution of western North American frogs allied to *Rana aurora* and *Rana boylii*: Electrophoretic evidence. Systematic Zoology 35(3): 283-296.

Green, D. M. 1995. Unpublished data: letter of June 16, 1993 to Gerry Jackson, U. S. Fish and Wildlife Service.

Grinnell, J. and T. I. Storer 1924. Animal life in the Yosemite. University of California Press, Berkeley, California. 752 pp.

Gunther, F. A., W. E. Westlake, and P. S. Jaglan 1968. Reported solubilities of 738 pesticide chemicals in water. Residue Reviews 20: 1-148.

Hall, R. and P. F. Henry 1992. Assessing effects of pesticides on amphibians and reptiles: Status and needs. Herp. Jr. vol. 2: 65-71.

Hansen, R. W. 1980. The Kern Plateau herpetofauna: A preliminary survey. U. S. D. A., Forest Service, Sequoia National Forest, Porterville, California.

Hayes, M. P. and M. R. Jennings 1988. Habitat correlates of the distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylii*): Implications for management. Pages 144-158 in Management of amphibians, reptiles, and small mammals of

North America, Proceedings of the Symposium, July 19-21, 1988 - Flagstaff, Arizona. U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-166:1-458.

Hayes, T. 1997. Steroids as potential modulators of thyroid hormone activity in anuran metamorphosis. Amer. Zool. 37: 185-194.

Heller, C. L. 1960. The Sierra yellow legged frog. Yosemite Nature Notes: 39(5), pp. 126-128.

Hillman, S. S. 1980. Physiological correlates of differential dehydration tolerance in anuran amphibians. Copeia 1980(1): 125-129.

Jennings, M. R. 1988. Natural history and decline of native Ranids in California. In: Proc. Conference on California Herpetology, Southwestern Herpetologists Society, pp. 61-72.

Jennings, M. R. and M. P. Hayes 1994. Amphibian and reptile species of special concern in California. California Department of Fish and Game, Rancho Cordova, California. pp. 74-78.

Jennings, M. R. 1996. Status of amphibians. In: Sierra Nevada ecosystem project: Final report to Congress, Vol. II. University of California, Davis, Centers for Water and Wildlife Resources: Davis, California.

Jennings, Mark R. 1998. Angeles and San Bernardino National Forest Mountain yellow-legged frog (Rana muscosa) surveys, 1997. Unpublished report on file with U.S. Geological Survey, Biological Resources Division, Western Ecological Research Center, Piedras Blancas Field Station, San Simeon, CA 9342-0070.

Karlstrom, E. L. 1962. The toad genus *Bufo* in the Sierra Nevada of California. University of California Publications in Zoology 62(1): 1-104.

Kauffman, J. B. et al. 1983. Impacts of cattle on streambanks in northeastern Oregon. Journal of Range Management 36: 683-685.

Kauffman, J. B. and W. C. Krueger 1984. Livestock impacts on riparian ecosystems and streamside management implications...a review. Journal of Range Management 36: 685-691.

Keeler-Wolf, T. 1989. An ecological survey of the Moses Mountain Candidate Research Natural Area, Sequoia National Forest, Tulare County, California.

Keeler-Wolf, T. 1991. Ecological survey of Mountaineer Creek RNA.

Kleinfelter, John 1998. Letter to Inyo National Forest dated February 23, 1998.

Knapp, R. A. 1986. The high cost of high Sierra trout. Wilderness Record, 19(2). Davis, California.

Knapp, R. 1993. Letter to Bonnie Pritchard, Mono Lake Ranger District, Inyo National Forest dated October 22, 1993.

Knapp, R. A. 1993a. Letter to Bonnie Pritchard, Mono Lake Ranger District, Inyo National Forest dated June 15, 1993.

Knapp, R. A. 1994. Letter to Ron Keil, Inyo National Forest dated September 28, 1994.

Knapp, R. A. 1996. Non-native trout in the Sierra Nevada: An analysis of their current distribution and impacts on native aquatic biota. Unpublished literature review on file with USFWS (Prepared as part of the Sierra Nevada Ecosystem Project).

Knapp, R. A. and K. R. Matthews 1996. Livestock grazing, golden trout, and streams in the Golden Trout Wilderness, California: Impacts and management implications. North American Journal of Fisheries Management 16: 805-820.

Knapp, R. A. and K. R. Matthews 2000. Non-native fish introductions and the decline of the mountain yellow-legged frog (*Rana muscosa*) from within protected areas. Conservation Biology 14: 1-12.

Lind, Amy. April 2, 1998. Region 5 USFS Sensitive Animal Species Evaluation and Documentation Form.

Linsdale, J. M. 1940. Amphibians and reptiles in Nevada. Proceeding of the American Academy of Arts and Sciences 73(8):197-257.

Livezey, R. L. and A. H. Wright 1945. Descriptions of four salientian eggs. The American Midland Naturalist 34(2): 701-706.

Long, M. L. 1970. Food habits of *Rana muscosa* (Anura: Ranidae). Herpeton, Journal of the Southwestern Herpetologists Society 5(1): 1-8.

Mao, J., D. E. Green, G. Fellers, and V. G. Chinchar 1999. Molecular characterization of iridoviruses isolated from sympatric amphibians and fish. Virus Research 63(1999): 45-52.

Marco, A., C. Qilchano, and A. R. Blaustein 1999. Sensitivity to nitrate and nitrite in pond-breeding amphibians from the Pacific northwest, USA. Environmental Toxicology and Chemistry 18: 2836-2839.

Marco, A. and A. R. Blaustein 1999. The effects of nitrite on behavior and metamorphosis in Cascades frogs (*Rana cascadae*). Environmental Toxicology and Chemistry 18: 946-949.

Marlow, C. B. and T. M. Pogacnik 1985. Time of grazing and cattle-induced damage to stream-banks. In: R. R. Johnson et al. (tech. coords.), Riparian ecosystems and their management: reconciling conflicting uses. USDA Forest Service Gen. Tech. Rep. RM-120.

Martin, C. 1940. A new snake and two frogs for Yosemite National Park. Yosemite Nature Notes, Vol. XIX, No. 11 (November 1940), p. 83-85.

Martin, D. L. 1992. Sierra Nevada anuran survey: An investigation of amphibian population abundance in the National Forests of the Sierra Nevada of California. United States Forest Service.

Matthews, K. R., and R.A. Knapp. High mountain lake project summary: impacts of fish stocking in high elevation lakes in the Sierra Nevada. Unpublished summary on file with US Forest Service Pacific Southwest Research Station.

Matthews, K. R. and K. L. Pope 1999. A telemetric study of the movement patterns and habitat use of *Rana muscosa*, the mountain yellow-legged frog, in a high-elevation basin in Kings Canyon National Park, California. Journal of Herpetology, 33(4): 615-624.

McFarland, M. 1999. Lassen National Forest February 19, 1999 memo to Plumas National Forest.

Meehan, W. R. and W. S. Platts 1978. Livestock grazing and the aquatic environment. Journal of Soil and Water Conservation 33: 274-278.

Moore, R. D. 1929. *Canis latrans lestes* Merriam feeding on tadpoles and frogs. Journal of Mammology 10(3): 255.

Moyle, P.B. 1973. Effects of introduced bullfrogs, Rana catesbeiana, on the native frogs of the San Joaquin Valley, California. Copeia 1973:18-22.

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley, California.

Moyle, P. B., R. M. Yoshiyama, and R. A. Knapp 1996. Status of fish and fisheries. Sierra Nevada Ecosystem Project: final report to Congress. Vol. II. Assessments and scientific basis for management options. University of California, Centers for Water and Wildland Resources, Davis. pp. 953-973.

Mullally, D. P. 1953. Observations on the ecology of the toad *Bufo canorus*. Copeia 1953(3): 182-183.

Mullally, D. P. and J. D. Cunningham 1956. Ecological relations of *Rana muscosa* at high elevations in the Sierra Nevada. Herpetologica 12(3):189-198.

Mullally, D. P. 1959. Notes on the natural history of *Rana muscosa* Camp in the San Bernardino Mountains. Herpetologica 15(2): 78-80.

National Park Service 1999. June 4, 1999 letter from Marilyn Parris (Lassen Volcanic National Park) to Southwest Center for Biological Diversity in response to Freedom of Information Act request.

National Park Service 1999a. Yosemite Park Wildlife Office Mountain Yellow-legged frog database.

Needham, P. R. and E. H. Vestal 1938. Notes on growth of golden trout (*Salmo aguabonita*) in two high Sierra lakes. California Fish and Game 24: 273-279.

Noss, R. F. and A. Y. Cooperrider 1994. Saving nature's legacy: Protecting and restoring biodiversity. Island Press, Washington, D. C.

Panik, H. R. 1995a. Progress report: An ecological survey of the Mountain Yellow-legged frog in Nevada. Unpublished report of file with the Nevada Division of Wildlife. Nevada Division of Wildlife, Carson City, Nevada.

Panik, H. R. 1995. An ecological survey of the Mountain Yellow-legged frog (*Rana muscosa*) in Nevada. Unpublished report of file with the Nevada Division of Wildlife. Nevada Division of Wildlife, Carson City, Nevada.

Parker, D. 1994. Inyo National Forest amphibian status report. U. S. Forest Service, Bishop, California Office.

Phillips, K. 1994. Tracking the vanishing frogs. St. Martin's Press.

Pickwell, G. 1947. Amphibians and reptiles of the Pacific states. Stanford University Press, Stanford University, California. Xiv + 236 pp.

Pimm, S. L. 1991. The balance of nature?: Ecological issues in the conservation of species and communities. University of Chicago Press, Chicago, Illinois.

Platts, W. S. 1981. Sheep and streams. Rangelands 3: 158-160

Pope, K. L. 1999. Mountain yellow-legged frog habitat use and movement patterns in a high elevation basin in Kings Canyon National Park. Master's thesis, Cal Poly San Luis Obispo, California. 64 pp.

Pope, K. L. 1999a. *Rana muscosa* diet. Herpetological Review 30(3): 163-164.

Seiber, J., S. Datta, L. Hansen, L. McConnell, and J. LeNoir 1998. Wet deposition of current-use pesticides in the Sierra Nevada mountain range, California, USA. 17 Environ. Toxicology and Chemistry No. 10: 1908-1916.

Sherman, C. K. and M. L. Morton 1993. Population declines of Yosemite toads in the Eastern Sierra Nevada of California. Journal of Herpetology 27(2): 186-198.

Slevin, J. R. 1928. The amphibians of western North America. Occasional Papers of the California Academy of Sciences 16: 1-152.

Smith, G. J. 1987. Pesticide use and toxicology in relation to wildlife: Organophosphorus and carbarnate compounds. Resource Publication 170, United States Department of the Interior, Fish and Wildlife Service, Washington, D. C. 171 pp.

Stebbins, R. C. 1951. Amphibians of western North America. University of California Press, Berkeley, California.

Stebbins, R. C. 1954. Amphibians and reptiles of western North America. McGraw-Hill Book Company, New York, New York.

Stebbins, R. C. 1985. A field guide to western reptiles and amphibians. Second edition, revised. Houghton Mifflin Company, Boston Massachusetts.

Stebbins, R. C. and N. W. Cohen 1995. A natural history of amphibians. Princeton University Press, Princeton, New Jersey. Pages 225-228.

Stejneger, L. and T. Barbour 1923. A check list of North American amphibians and reptiles. Second edition. Harvard University Press, Cambridge, Massachusetts. x + 171 pp.

Stejneger, L. and T. Barbour 1933. A check list of North American amphibians and reptiles. Third edition. Harvard University Press, Cambridge, Massachusetts. xiv + 185 pp.

Stejneger, L. and T. Barbour 1939. A check list of North American amphibians and reptiles. Fourth edition. Harvard University Press, Cambridge, Massachusetts. xiv + 207 pp.

Stejneger, L. and T. Barbour 1943. A check list of North American amphibians and reptiles. Fifth edition. Bull. Mus. Comp. Zool. 93(1): xix + 260 pp.

Stephenson, G. R. and L. V. Street 1978. Bacterial variations in streams from a southwest Idaho rangeland watershed. Journal of Environmental Quality 7: 150-157.

Storer, T. I. 1925. A synopsis of the amphibia of California. University of California Publications in Zoology 27: 1-342.

Taylor, S. K., E. Williams, E. T. Thorne, K. Mills, D. Withers, and A. C. Pier 1999. Causes of mortality of the Wyoming toad. Journal of Wildlife Diseases 35(1): 49-57.

Taylor, S. K., E. S. Williams, and K. W. Mills 1999b. Effects of malathion on disease susceptibility in Woodhouse's toads. Journal of Wildlife Diseases 35(3): 536-541.

Tolson, M. P.. 1999. Amphibian decline: Air pollutants. Web site document. At: http://tsrtp.ucdavis.edu/tsrtp/newsletters/12/1/angerman.html

Twedt, J. and J. Evans 1993. Plumas National Forest anuran survey report 1993. Unpublished report.

U. S. Forest Service 1993. Lassen National Forest amphibian surveys. Unpublished report. 5 pp. + map.

U. S. Forest Service 1994. Plumas National Forest amphibian surveys. Unpublished report + maps.

U. S. Forest Service 1998. Table of extent of Mountain Yellow-legged frog surveys conducted in National Forests and Parks of the Sierra Nevada, in a fax from Kathleen Matthews, Pacific Southwest Research Station, dated June 19, 1998.

U. S. Forest Service 1999. Tahoe National Forest amphibian and aquatic reptile sighting, updated March 1999.

U. S. Forest Service 1999a. Eldorado National Forest files, notes of meeting with Lonnell Wilson.

U. S. Forest Service 1999b. Database believed to be maintained by Dr. David Wake, U. C. Berkeley Museum of Vertebrate Zoology.

U. S. Forest Service 1999c. Eldorado National Forest amphibian record files.

U. S. Forest Service 1999d. Stanislaus National Forest data table 1993-1998.

U. S. Forest Service 1999e. Inyo National Forest amphibian reports and aquatic survey data sheets.

U.S. Forest Service 1999f. Sierra National Forest - high mountain lake amphibian surveys summary. Information provided by Roland Knapp.

U. S. Forest Service 1999g. Environmental Assessment, Blasingame Grazing Allotment. Sierra National Forest.

U. S. Forest Service 1999h. Sequoia National Forest files.

U. S. Forest Service 1999i. Notes from Christie McGuire, CDFG. In Sequoia National Forest files.

U. S. Forest Service 2000. Humboldt- Toiyabe National Forest amphibian surveys. Information provided by Michael Vermeys, Wildlife Technician.

U. S. Forest Service 2000a. Letter from Sheri Smith, Plumas National Forest District Ranger to SWCBD dated January 4, 2000. Forest mountain yellow-legged frog database attached.

Vindum, J. V. and M. S. Koo 1999. 1998 amphibian and reptile surveys in the Plumas and Tahoe National Forests. Reference No. CCSA-05-98-17-123. Department of Herpetology, California Academy of Sciences, Golden Gate Park, San Francisco, California.

Vredenburg, V. T., G. Fellers, and C. Davidson. In press. The mountain yellow-legged frog (*Rana muscosa*). In: Status and conservation of amphibians of the United States. M. Lannoo. Editor. Smithsonian Press, Washington D. C.

Vredenburg, V. T. and J. R. Macey in prep. Molecular phylogeny and historical biogeography of the mountain yellow-legged frog (*Rana muscosa*).

Wright, A. H. and A. A. Wright 1933. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Associates, Cornell University Press, Ithaca, New York.

Wright, A. H. and A. A. Wright 1949. Handbook of frogs and toads of the United States and Canada. Third edition. Comstock Publishing Company, Ithaca, New York.

Yoon, D. 1977. The effect of introduced fish on the amphibian life in Westfall Meadow. Yosemite Nature Notes 46: 69-70.

Zardus, M., T. Blank, and D. Schulz 1977. Status of fishes in 137 lakes in Sequoia and Kings Canyon National Parks, California. U. S. Department of the Interior, National Park Service, Sequoia and Kings Canyon National Parks, Three Rivers, California.

Zeiner, D. C., W. F. Laudenslayer, Jr., and K. E. Mayer (compiling editors) 1988. California's wildlife. Volume I. Amphibians and reptiles. California Statewide Wildlife Habitat Relationships System, California Department of Fish and Game, Sacramento, California.

Ziesmer, T. C. 1997. Vocal behavior of foothill and mountain yellow-legged frogs (*Rana boylii* and *Rana muscosa*). Masters thesis submitted to Sonoma State University, December 8, 1997.

Zweifel, R. G. 1955. Ecology, distribution, and systematics of frogs of the *Rana boylei* group. University of California Publications in Zoology 54(4): 207-292.

Zweifel, R. G. 1968. *Rana muscosa*. Catalog of American amphibians and reptiles, 65:1-2.

<u>Personal Communications</u>

David F. Bradford, Ph.D., Ecologist, U. S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, Nevada

Laura Conway, U. S. Forest Service, Stanislaus National Forest

Carlos Davidson, University of California, Section of Evolution and Ecology, Davis, California

Gary M. Fellers, Biological Resources Division, USGS, Point Reyes National Seashore, Point Reyes, California

Michael Graf. Esq., Natural Resources Defense Council

Roland Knapp, Ph.D., Research Biologist, University of California Sierra Nevada Aquatic Research Laboratory, Mammoth Lakes, California

Stafford Lehr, Associate Fishery Biologist, California Department of Fish and Game, Mother Lode District, Rancho Cordova, California

Ron Panik, Ph.D., Western Nevada Community College

Jeff Ryner, U. S. Forest Service, Lake Tahoe Basin Management Unit

Pat Shanley, U. S. Forest Service, Carson Ranger District

Matt Slesinger, U. S. Forest Service, Lake Tahoe Basin Management Unit

Jens Vindum, Department of Herpetology, California Academy of Sciences, Golden Gate Park, San Francisco, California

Vance Vredenburg, University of California Museum of Vertebrate Zoology, Department of Integrative Biology, Berkeley, California