Recovery Plan for the California Red-legged Frog *(Rana aurora draytonii)*

Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

Approved: ______________________________
Manager, California/Nevada Operations Office
Region 1, U.S. Fish & Wildlife Service

MAY 28 2002

Date: ______________________________

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Literature Citation Should Read As Follows:

U.S. Fish and Wildlife Service. 2002. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, Oregon. viii + 173 pp.

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Acknowledgements

Primary Authors

Ina Pisani of the Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service, Sacramento, California acted as the Recovery Team Manager and prepared this recovery plan. Recovery plan preparation was supervised and edited by Karen Miller, Diane Elam, and Carmen Thomas, Sacramento Fish and Wildlife Office.

Acknowledgements

Grace McLaughlin of the Ventura Fish and Wildlife Office provided technical input on many aspects of this recovery plan. In particular, Ms. McLaughlin provided assistance in the delineation of recovery units and core areas and compiled Appendix B which addresses the potential effects of contaminants on the California red-legged frog.

Each member of the California red-legged frog recovery team contributed valuable information and assistance. In particular, we gratefully acknowledge the efforts of Norman Scott and Galen Rathbun of the U.S. Geological Survey, Biological Resources Division, Western Ecological Research Center, Piedras Blancas Field Station and Mark Jennings for preparing the appendices that address pond management and reestablishment of California red-legged frogs, and for being generous with their technical assistance and time throughout the development of this recovery plan. We thank them also for their thorough editorial review. In addition, we wish to thank William Cunningham of the Natural Resources Conservation Service and Amy Lind of the U.S. Forest Service for preparing the appendix that lists existing incentive programs.

The following individuals contributed significant information/assistance during recovery plan preparation (California red-legged frog recovery team members are italicized):

Paul Barrett
Steven Bobzien
Maria Boroja
Patricia Bratcher
Sara Lee Chubb
David Cook
William W. Cunningham
Joseph Didonato
Gary Fellers
Darren Fong
Catherine Hibbard
Joshua Hoffman
Steve Holzman
Michael Jani
Mark Jennings
Douglas Krofta
Sheila Larsen
Amy Lind
Laurie Litman
Ivette Loredo
Ed Lorentzen
Sheila Massey
Curt McCasland
Tony McKinney
Grace McLaughlin
Meri Moore
Steven Morey
Dave Pereksta
Galen Rathbun
Mark Rentz
Lisa Roberts
Tamara Sasaki
Norman Scott
William Shook
John Steuber
Terry Strange
Kate Symonds
Brad Valentine
Phil Zentner

Illustrations are courtesy of the California Department of Fish and Game.

Executive Summary

Current Species Status: The California red-legged frog (*Rana aurora draytonii*) is federally listed as threatened. This subspecies of red-legged frog occurs from sea level to elevations of about 1,500 meters (5,200 feet). It has been extirpated from 70 percent of its former range and now is found primarily in coastal drainages of central California, from Marin County, California, south to northern Baja California, Mexico. Potential threats to the species include elimination or degradation of habitat from land development and land use activities and habitat invasion by non-native aquatic species.

Habitat Requirements: The California red-legged frog requires a variety of habitat elements with aquatic breeding areas embedded within a matrix of riparian and upland dispersal habitats. Breeding sites of the California red-legged frog are in aquatic habitats including pools and backwaters within streams and creeks, ponds, marshes, springs, sag ponds, dune ponds and lagoons. Additionally, California red-legged frogs frequently breed in artificial impoundments such as stock ponds.

Recovery Objective: The objective of this plan is to reduce threats and improve the population status of the California red-legged frog sufficiently to warrant delisting.

Recovery Priority Number: 6C, per criteria published by Federal Register Notice (48 FR 43098; September 21, 1983). This number indicates a subspecies with high threats and low recovery potential, in conflict with development projects.

Recovery Criteria: This subspecies will be considered for delisting when:

1) Suitable habitats within all core areas (described in Section II of this recovery plan) are protected and/or managed for California red-legged frogs in perpetuity, and the ecological integrity of these areas is not threatened by adverse anthropogenic habitat modification (including indirect effects of upstream/downstream land uses);

2) Existing populations, throughout the range, are stable (i.e., reproductive rates allow for long term viability without human intervention). Population status will be documented through establishment and implementation of a scientifically acceptable population monitoring program for at least a 15-year period, which is approximately 4 to 5 generations of the California red-legged frog. This 15-year period will preferably include an average precipitation cycle. An average precipitation cycle is a period when annual rainfall includes average to 35 percent above-average through greater than 35 percent below-average and back to average or greater. The direction of change is unimportant in this criterion.

3) Populations are geographically distributed in a manner that allows for the continued existence of viable metapopulations despite fluctuations in the status of individual populations (i.e. when populations are stable or increasing at each core area);

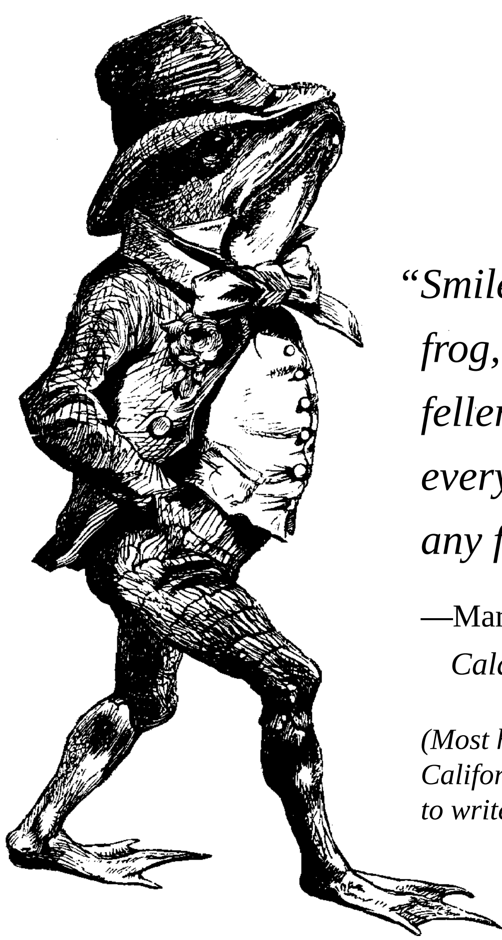
4) The subspecies is successfully reestablished in portions of its historic range such that at least one reestablished population is stable/increasing at each core area where frogs are currently absent; and

5) The amount of additional habitat needed for population connectivity, recolonization, and dispersal has been determined, protected, and managed for California red-legged frogs.

Actions Needed:
1. Protect known populations and reestablish populations.
2. Protect suitable habitat, corridors, and core areas.
3. Develop and implement management plans for preserved habitat, occupied watersheds, and core areas.
4. Develop land use guidelines.
5. Gather biological and ecological data necessary for conservation of the species.
6. Monitor existing populations and conduct surveys for new populations.
7. Establish an outreach program.

Estimated Cost of Recovery: $10,031,500 plus costs that are not yet determined**.**

Date of Recovery: Delisting could occur by 2025 if recovery criteria have been met.



"Smiley was monstrous proud of his frog, and well he might be, for fellers that had traveled and been everywheres all said he laid over any frog that they ever see."

—Mark Twain, *Celebrated Jumping Frog of Calaveras County*

(Most historians and scientists believe that the California red-legged frog inspired Mark Twain to write his short story.)

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I. Introduction

A. BRIEF OVERVIEW

The California red-legged frog (*Rana aurora draytonii*) is endemic to California and Baja California, Mexico, and its known elevational range extends from near sea level to elevations of about 1,500 meters (5,200 feet). Nearly all sightings have occurred below 1,050 meters (3,500 feet) (Natural Diversity Database 2001). The species has been extirpated from 70 percent of its former range and now is found primarily in coastal drainages of central California, from Marin County, California, south to northern Baja California, Mexico, and in isolated drainages in the Sierra Nevada, northern Coast, and northern Transverse Ranges (U.S. Fish and Wildlife Service 1996a). Populations remain in approximately 256 streams or drainages in 28 counties (Table 1).

The California red-legged frog is threatened within its remaining range, by a wide variety of human impacts to its habitat, including urban encroachment, construction of reservoirs and water diversions, contaminants, agriculture, and livestock grazing. These activities can destroy, degrade, and fragment habitat. The introduction of non-native predators and competitors also continues to threaten the viability of many California red-legged frog populations.

The California red-legged frog was included as a Category 1 candidate species in our (U.S. Fish and Wildlife Service) November 21, 1991, Animal Notice of Review (U.S. Fish and Wildlife Service 1991). On January 29, 1992, we received a petition from Dr. Mark R. Jennings, Dr. Marc P. Hayes, and Mr. Dan Holland to list the California red-legged frog. On October 5, 1992, we published a 90-day petition finding (U.S. Fish and Wildlife Service 1992) with substantial information indicating the requested action may be warranted. On July 19, 1993, we published a 12-month finding on the petitioned action (U.S. Fish and Wildlife Service 1993) indicating that listing of the California red-legged frog was warranted and that a proposed rule would be published promptly. On February 2, 1994, we published a proposal to list the California red-legged frog as an endangered species (U.S. Fish and Wildlife Service 1994a). Based on information received during the comment period on the proposed rule, we determined the California red-legged frog to be a threatened species; the listing was effective on June 24, 1996 (U.S. Fish and Wildlife Service 1996a). The recovery priority number of the California red-legged frog is 6C, indicating a subspecies with a high degree of threat and low recovery potential. Recovery

NOTE: In this document the term "frog" refers to the California red-legged frog unless otherwise indicated.

Table 1. Number of streams per county (north to south) where California red-legged frogs are present, post-1985 (Natural Diversity Database 2001, M. Jennings *in litt.* 1993).

County	*Number of Streams*	*County*	*Number of Streams*
El Dorado	2	San Mateo	22
Plumas	1	Santa Clara	21
Butte	1	Santa Cruz	17
Yuba	1	Stanislaus	2
Placer	1	Fresno	1
Tehama	1	Merced	5
Napa	5	San Benito	5
Sonoma	3	Monterey	32
Solano	6	Kern	1
Marin	19	San Luis Obispo	30
Contra Costa	21	Santa Barbara	35
San Joaquin	2	Ventura	6
Alameda	12	Los Angeles	2
San Francisco	1	Riverside	1

priority numbers are based on criteria published by Federal Register Notice (48 FR 43098; September 21, 1983).

B. SPECIES DESCRIPTION

Class - Amphibia
 Order - Anura
  Family - Ranidae
   Genus - *Rana*
    Species - *Rana aurora*
     Subspecies - *Rana aurora draytonii*

The California red-legged frog (*Rana aurora draytonii*) is one of two subspecies of the red-legged frog (*Rana aurora*). The other subspecies is the northern red-legged frog *(R. a. aurora*). The northern red-legged frog ranges from Vancouver Island, British Columbia, Canada, south along the Pacific coast, west of the Cascade ranges to northern California. Some red-legged frogs found in the intervening areas (southern Del Norte to northern Marin County along the Coast Range), exhibit intergrade characteristics of both subspecies (Hayes and Krempels 1986). The two subspecies, and intergrades of the subspecies, may occur together in some areas such as the vicinity of Point Reyes National Seashore in Marin County, and portions of Sonoma County.

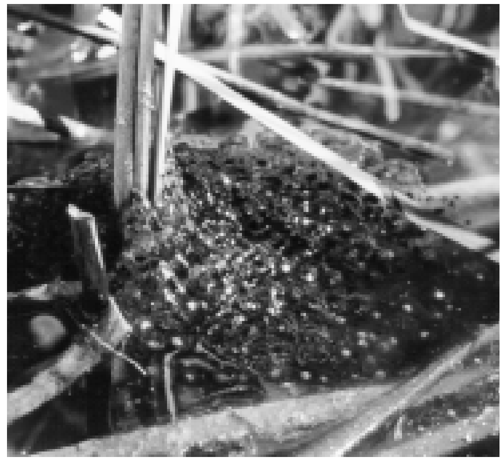
Figure 1. Adult California red-legged frog.
Photo © Steven Bobzien

The California red-legged frog is the largest native frog in the western United States (Wright and Wright 1949). Adult females attain a significantly longer body length than males (138 millimeters [5.4 inches] versus 116 millimeters [4.5 inches] snout-urostyle length) (Hayes and Miyamoto 1984). The posterior abdomen and hind legs of adults are often red or salmon pink; the back is characterized by small black flecks and larger irregular dark blotches with indistinct outlines on a brown, gray, olive, or reddish-brown background color. Dorsal spots usually have light centers (Stebbins 1985). Dorsolateral folds (the ridges of skin along the back) are prominent (Figure 1). Larvae (tadpoles) range from 14 to 80 millimeters (0.6 to 3.1 inches) in length, and the background color of the body is dark brown or olive with darker spots (Figure 2) (Storer 1925). A line of very small, indistinct gold-colored spots becomes the dorsolateral fold (G. Rathbun *in litt.* 1998).

Several morphological and behavioral characteristics differentiate the two subspecies of red-legged frogs. Adult California red-legged frogs are larger than northern red-legged frogs by 35 to 40 millimeters (1.4 to 1.6 inches) (Hayes and Miyamoto 1984). Dorsal spots of northern red-legged frogs usually lack the light centers that are common to California red-legged frogs (Stebbins 1985). The southern subspecies (California red-legged frog) has paired vocal sacs and calls in air, whereas the northern subspecies (northern red-legged frog) lacks vocal sacs and calls under water (Hayes and Krempels 1986, Licht 1969). Female California red-legged frogs deposit egg masses (Figure 2) on emergent vegetation so that the masses float on the surface of the water (Hayes and Miyamoto 1984) although biologists from the East Bay Regional Park District have seen submerged egg masses throughout the egg development stage on numerous occasions (J. DiDonato *in litt.* 2000). Northern red-legged frogs also attach their eggs to emergent vegetation, but the mass is submerged (Licht 1969). California red-legged frogs breed from November through early April (Storer 1925) and northern red-legged frogs breed from January through March (Nussbaum *et al*. 1983).

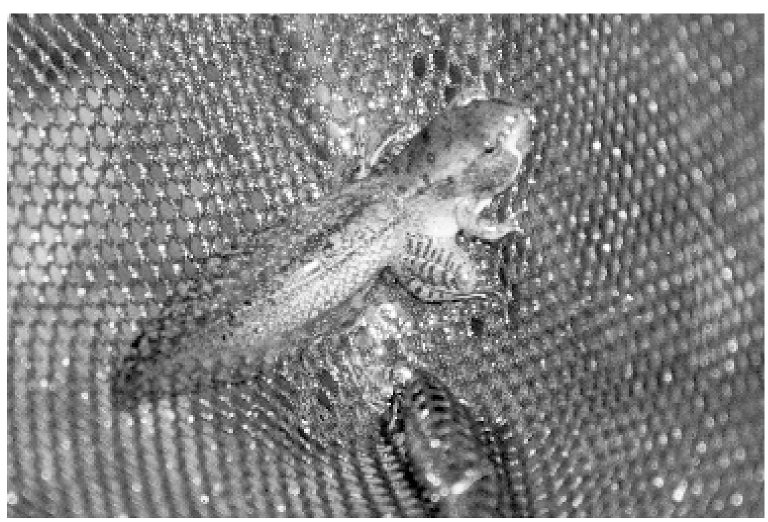
C. HISTORIC AND CURRENT DISTRIBUTION

It is believed that before the arrival of Europeans on the west coast of North America, the California red-legged frog was common in coastal habitats from the vicinity of Point Reyes National Seashore, Marin County, California, and inland from the vicinity of Redding, Shasta County, California, southward to northwestern Baja California, Mexico (Jennings and Hayes 1985, Hayes and Krempels 1986). Historically, the California red-legged frog was known from 46 counties (Figure 3) but the taxon is now extirpated from 24 of these (U.S. Fish and Wildlife Service 1996a).



The California red-legged frog is now known only from isolated localities in the Sierra Nevada, northern Coast, and northern Transverse Ranges. It is believed to be nearly extirpated from the southern Transverse and Peninsular ranges. This species is still common in the San Francisco Bay area (including Marin County) and along the central coast (Figure 4) (Natural Diversity Data Base 2001, Jennings *in litt.* 1998a). It is still present in Baja California, Mexico, but this recovery plan does not address populations in Mexico.

Figure 2. California red-legged frog egg mass (top)
Photo © David Cook
Tadpole (center)
Photo © Steven Bobzien
New metamorph (bottom)
Photo © Robert Snow



The following paragraphs discuss, in general, the status of the California red-legged frog in each of the recovery units (north to south). Briefly, there are eight recovery units (Figure 5). These include the following regions: Sierra Nevada Foothills and Central Valley; North Coast Range Foothills and Western Sacramento River Valley; North Coast and North San Francisco Bay; South and East San Francisco Bay; Central Coast; Diablo Range and Salinas Valley; Northern Transverse Ranges and Tehachapi Mountains; and Southern Transverse and Peninsular Ranges. Recovery units are identified and described in more detail below and in the Recovery chapter (Section II.C). Detailed locality information is available through the California Department of Fish and Game's Natural Diversity Database (Natural Diversity Database 2001).

Under the discussion of each recovery unit, watersheds occupied by the California red-legged frog are listed; a watershed is considered occupied when the presence of the species is confirmed. Watersheds are used here because California red-legged frogs can be found in a range of habitats within a watershed (e.g., stock ponds, creeks) and because they may be known from a single location or numerous locations within a watershed. Thus, an occupied watershed refers to an assumed network of habitat areas, populations, and site-specific localities. Occupied drainages or watersheds include all of the bodies of water that support frogs (i.e., streams, creeks, tributaries, associated natural and artificial ponds, and adjacent drainages), and habitats through which frogs can move (i.e., riparian vegetation, uplands). Where frogs are known from a particular location within a drainage, the more specific term "locality" is used (e.g., the Pescadero Marsh locality or the Spivey Pond locality versus the broader Scott Creek drainage).

Because populations of frogs may be extirpated with some frequency, occurrence data may not adequately describe the status of the species in a region. This limitation may be the result of a lack of long term survey data, a lack of complete survey data (due to restricted access to private lands), and fluctuations in population numbers. The numbers at a site or series of sites can vary widely from year to year. When conditions are favorable, California red-legged frogs can experience extremely high rates of reproduction and produce large numbers of dispersing young and a concomitant increase in number of occupied sites. Conversely, frogs may temporarily disappear from a normally occupied area. At sites where frogs seem absent, long-term monitoring is necessary to determine if these sites are recolonized or "rescued" by dispersers from nearby subpopulations. Therefore, the information on distribution and status should be understood within the context of the larger metapopulation scale (Scott and Rathbun *in litt.* 1998). In this plan, metapopulations are considered collections of populations that are

Figure 3. Historic range of the California red-legged frog in the United States by county.

linked by migrants (i.e., dispersers), allowing for recolonization of unoccupied habitat patches after local extinction events.

Sierra Nevada Foothills and Central Valley. The California red-legged frog was probably extirpated from the floor of the Central Valley before 1960 (U.S. Fish and Wildlife Service 1996a). The last verifiable record of this species on the valley floor was a sighting in Lodi (San Joaquin County) in 1957, and the last record of a reproducing population on the valley floor is from the vicinity of Gray Lodge Wildlife Area (Butte County) around 1947, although this record is unverified (Jennings *et al. in litt.* 1992). Elimination of the frog from the floor of the valley was particularly significant in that it isolated Sierra-Nevada foothill populations that may have depended on immigrants from the valley floor (Jennings *et al. in litt.* 1992). However, California red-legged frogs may never have been widespread on the valley floor as specimen-based records are scarce north of the Kern River drainage.

California red-legged frogs historically occupied portions of the western slope of the Sierra Nevada from Shasta County south to Tulare County, but these populations have been fragmented and nearly eliminated. In 1960, isolated populations were known from at least 30 Sierra Nevada foothill drainages bordering the Central Valley. Records show that the lower elevations of some National Forests and Yosemite National Park were once occupied by California red-legged frogs (M. Jennings *et al. in litt.* 1992). Adjacent to and in the vicinity of the Plumas National Forest (Butte, Yuba, and Plumas Counties), many sightings of California red-legged frogs were reported in the early 1960s near Lake Oroville. Specifically, frogs were verified from the North Fork Feather River and the

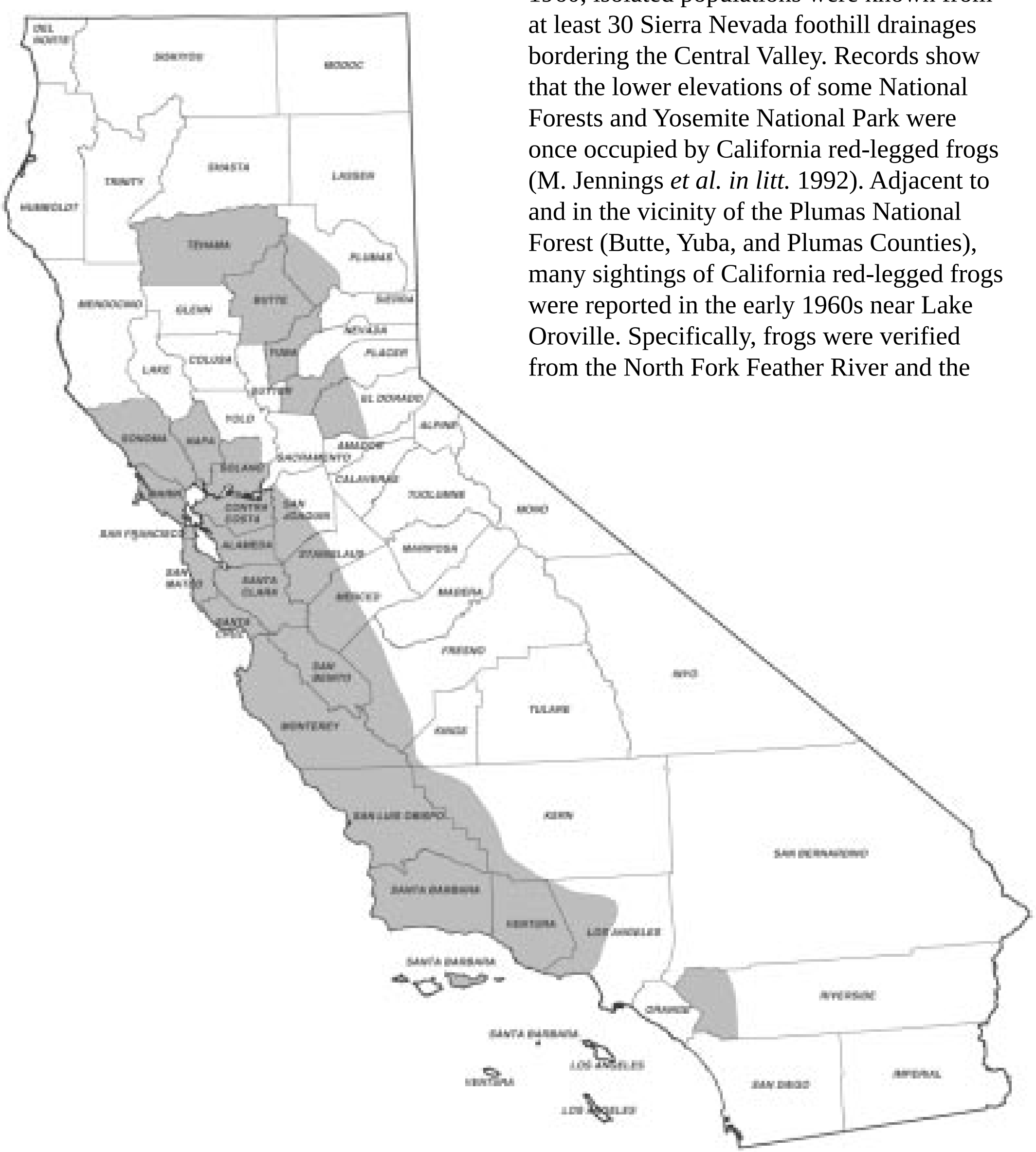


Figure 4. Current range of the California red-legged frog in the United States by county.

Figure 5. California red-legged frog recovery units.

South Fork Feather River in 1961. In El Dorado County, records exist for Rock Creek in 1974 and Traverse Creek in 1975. Within the vicinity of the Stanislaus National Forest, California red-legged frogs were seen in San Antonio Creek (Calaveras County) in 1975, in Jordon Creek in 1967, and in Piney Creek from 1972 to 1984 (Mariposa County). Within the vicinity of the Tuolumne River, many historic sites exist. For example, a collection from the Mather vicinity was taken in 1922, and again in 1945. Within Yosemite National Park, collections were made from Gravel Pit Lake (about 1,500 meters [5,000 feet]) in 1940, Swamp Lake (1,500 meters [5,000 feet]) from 1938 to 1941, and Miguel Meadows (1,600 meters [5,200 feet]) in 1939 (M. Jennings *et al. in litt.* 1992). These collections represent the highest elevation records for the California red-legged frog in the Sierra Nevada. No confirmed sightings have been observed or collected in the Tuolumne River drainage for several decades. In the southernmost Sierran foothills, frogs were historically located within Kern County, particularly in streams and irrigation ditches near Bakersfield (Natural Diversity Data Base 2001, Jennings *in litt.* 1998a).

Currently, only a few drainages in the foothills of the Sierra Nevada are known to support California red-legged frogs, compared to over 60 known historic localities and 18 historic sites where specimens were collected (Jennings and Hayes 1992, Barry 1999). In 1991, California red-legged frogs were observed at Pinkard Creek in Butte County (1,200 meters [3,500 feet]) (Hayes 1991). However, intensive surveys in subsequent years have failed to reveal additional observations of this species. In recent surveys a population of mountain yellow-legged frogs (*Rana muscosa*) was observed, suggesting that the original observation may have been a mountain yellow-legged frog misidentified as a California red-legged frog. Additional locations in Butte County include French and Indian Creeks. The French Creek population, also referred to as the Swayne Hill/Chino Creek population, was discovered in 1997; at least a few hundred adults plus tadpoles and juveniles have been observed and reproduction appears to be highly successful at this site (S. Barry *in litt.* 2000). California red-legged frogs have been observed on Indian Creek, near the town of Woodleaf from 1973 to 1983 (Jennings *et al. in litt.* 1992). Each of these Butte County populations is located on private lands, adjacent to the Plumas National Forest. An additional site in Butte County was located in 2000, on the Feather River Ranger District of the Plumas National Forest on a tributary to the North Fork Yuba River west of New Bullards Bar Reservoir (C. Roberts pers. comm. 2000, Barry 2000). In El Dorado County near Placerville, a confirmed population of California red-legged frog was discovered in an impoundment (Spivey Pond) in the North Fork of Weber Creek. In 2 years of surveys at this site (1997 and 1998), adults, egg masses, and tadpoles have been observed. In 2001, a California red-legged frog was documented near the confluence of Rubicon River and the Middle Fork of the American River in Placer County (G. Fellers *in litt.* 2001). This locality is on U.S. Forest Service land. Much of the Sierra Nevada range is unsurveyed, particularly on private lands, and therefore the true status in this region is largely unknown.

North Coast Range Foothills and Western Sacramento River Valley. Historically, the California red-legged frog was found in several counties in this region. In the 1960s, frogs were found in Glenn County east of Elk Creek and in many drainages in Colusa County. In 1986 and 1987, California red-legged frogs were reported in Sunflower Gulch and Cottonwood Creek, west of Red Bluff (Tehama County), but subsequent surveys documented only bullfrogs (*Rana catesbeiana*) (M. Jennings pers. comm. 1998). Within the vicinity of Clear Lake (Lake County), records exist from 1961 near the town of Hobergs, on Cold Creek. Barry (*in litt.* 2000) observed California red-legged frogs along Pope Creek and several tributaries near Pope Valley in the Putah Creek drainage throughout the 1970s and 1980s, and the habitat in this area remains unaltered. There are three confirmed sightings of this species in upper Napa County: from 1983, along Highway 128 between Highway

121 and Wragg Canyon Road, and from 1992 and 1997, along nearby Steele Creek which is a tributary to Lake Berryessa (S. Barry *in litt.* 2000). Recently, unverified sightings have been reported in the vicinity of the Stebbins Cold Canyon Ecological Reserve, Cache Creek, and tributaries to Clear Lake (Lake County) (M. Jennings pers. comm. 1998). California red-legged frogs were also documented in 1998 in a tributary to American Canyon Creek in lower Napa County (Natural Diversity Database 2001).

North Coast and North San Francisco Bay. Significant numbers of California red-legged frogs occur in small coastal drainages, ponds, and man-made stockponds in the vicinity of Point Reyes, including Point Reyes National Seashore and Golden Gate National Recreation Area (Marin County). For example, large numbers of frogs occur in Olema Marsh and the general vicinity of Drakes Estero (Point Reyes National Seashore). Many areas within the vicinity of Mount Tamalpais and the Tiburon peninsula (Marin County) also support California red-legged frogs, including Tennessee Valley (Natural Diversity Database 2001, D. Fong *in litt*. 1998).

A large breeding population is located at Ledson Marsh in Annadel State Park (Sonoma County). Also in Sonoma County, two sightings of California red-legged frogs have been verified near Sears Point at the junction of Highway 37 and Lakeville Road and the junction of Highway 37 and Highway 121 (Natural Diversity Database 2001).

In Solano County, there are three known occurrences of California red-legged frogs near Suisun Marsh (e.g., Sulphur Springs Creek). Several localities are recorded near the cities of Fairfield, Cordelia, American Canyon, and Vallejo (Natural Diversity Database 2001). Most remaining known occurrences in the vicinity of southern Solano County are threatened by proposed development (C. McCasland *in litt.* 1998a).

South and East San Francisco Bay. In the late 1800s and early 1900s, California red-legged frogs were reported in various areas of San Francisco County including Lake Merced, Golden Gate Park, and the Presidio. The most recent sighting was in 1993, near Strybing Arboretum in Golden Gate Park. These populations may have been introduced for commercial harvesting or may be relics of a larger metapopulation. Currently, it is likely that these populations face such severe barriers that dispersal between populations may be precluded. Canals within the West of Bayshore parcel, near the San Francisco International Airport in San Mateo County, currently support California red-legged frogs. This population experienced a decline over the past several years due to site management activities and tidal influences (U.S. Fish and Wildlife Service 1996b). However, data collected at the site since 1996 indicate that the localized population contained more individuals than previously thought. Numerous individuals of all size classes have been observed and few bullfrogs are present. Breeding has been confirmed in some seasonal impoundments and within the canal system. The population, however, is isolated by residential development (M. Allaback *in litt.* 2000).

Contra Costa and Alameda Counties contain the majority of known California red-legged frog localities within the San Francisco Bay area, although they seem to have been nearly eliminated from the western lowland portions of these counties (west of Highway 80 and Highway 580), particularly near urbanization. California red-legged frogs still occur in small isolated populations in the East Bay foothills (between Highway 580 and Highway 680), and are thriving in several areas in the eastern portions of Alameda and Contra Costa Counties. Numerous ponds and creeks in Simas Valley (Contra Costa County) support California red-legged frogs (Dunne 1995). This area, owned and managed in part by East Bay Municipal Utility District, includes Rodeo and Pinole Creeks, and is connected with Briones and Wildcat Canyon Regional Parks (East Bay Regional Park District). On East Bay Regional Park lands, sizeable breeding populations are found at Pine Creek (Diablo Foothills Regional Park/ Castle Rock Regional Recreation Area), Sand Creek (Black Diamond Mines Regional

Park), and Round Valley Creek (Round Valley Regional Preserve) (S. Bobzien *in litt.* 1998). Recently, frogs have been sighted in small ponds and seeps in the foothills of Mount Diablo (M. Westphal pers. comm. 1998). California red-legged frogs are present in Kellogg Creek watershed and its tributaries upstream of Los Vaqueros Reservoir and downstream to Vasco Road in eastern Contra Costa County. Here, 87 of 91 stockponds and mitigation wetlands have reproducing populations. Recent surveys (September 2000) recorded nearly 3,000 individuals. Conservative estimates for the total population range from 7,000 to as high as 10,000 post-metamorph frogs (J. Alvarez *in litt.* 2000). Many localities occur in Corral Hollow Creek, in San Joaquin County, and near the San Joaquin/Alameda County border. In the Corral Hollow watershed, frogs are found in the California Department of Fish and Game's Corral Hollow State Ecological Reserve, although this Reserve is currently threatened by siltation possibly caused and/or exacerbated by an off-road vehicle park, livestock grazing, and urban development up- and downstream (M. Jennings *in litt.* 1993, Jennings and Hayes 1994). Adult frogs have been observed in Upper Alameda Creek (Sunol Regional Wilderness) and also in many of the creeks from this area, south to Henry W. Coe State Park (e.g., Arroyo Hondo and Sulphur, Smith, Isabel, and San Felipe Creeks) (Santa Clara County). California red-legged frogs currently occupy many ponds and creeks within Henry W. Coe State Park in Santa Clara County (M. Jennings *et al. in litt.* 1992, K. Freel *in litt.* 1998) and are abundant in many ponds in the Palassou Ridge area south of Henry W. Coe State Park (L. Serpa *in litt.* 2000).

Central Coast. The central coast from San Francisco to Santa Barbara County supports the greatest number of currently occupied drainages. South of San Francisco, many California red-legged frogs occur in tributaries to Crystal Springs Reservoir and adjacent lands (San Mateo County) (Natural Diversity Database 2001). Most coastal streams and ponds (natural and artificial) from Pacifica south to Half Moon Bay (San Mateo County) support this species (S. Larson pers. comm. 1998). Pescadero Marsh and Año Nuevo State Reserve (San Mateo County) support large numbers of California red-legged frogs; Pescadero Marsh is considered one of the few places, throughout the range, to support more than 350 adult frogs. Almost all coastal drainages from the Santa Cruz/San Mateo County line south to the city of Santa Cruz are occupied by California red-legged frogs. Wilder Ranch State Park (Santa Cruz County) also supports this species. The frogs occur in the Carmel River watershed and most of its tributaries (Natural Diversity Database 2001, EIP Associates 1993); Rancho San Carlos, a private ranch on the upper portion of the Carmel River Valley is another locality where more than 350 adults have been observed (M. Jennings *et al. in litt.* 1992).

This species is widespread in Monterey County; nearly all coastal drainages from Garrapata Creek south to Salmon Creek, including the Little and Big Sur drainages and the vicinity of Pfeiffer Beach, support frogs. In San Luis Obispo County, California red-legged frogs are found in many streams, stock ponds, dune ponds, and springs on the coastal plain and western slopes of the Santa Lucia Range from San Carpoforo Creek in the north to the Santa Maria River in the south. Sites include Pico, Little Pico, and Toro Creeks; Pico Pond; and San Simeon, Santa Rosa, Chorro, and Arroyo Grande Creeks. On Camp San Luis Obispo of the California National Guard, frogs occur in Whiskey Spring, tributaries to Chorro Creek and Chorro Reservoir, and other sites (Jennings *et al. in litt.* 1992, U.S. Fish and Wildlife Service 1996a).

Diablo Range and Salinas Valley. California red-legged frogs were once widespread and abundant in the inner Coast ranges between the Salinas River system and the San Joaquin Valley. Currently, no more than 10 percent of the historic localities within the Salinas River hydrographic basin and inner Coast ranges (between the Salinas basin and the San Joaquin River south of Pacheco Creek drainage) still support this species (Jennings and Hayes 1994).

On the eastern side of the Diablo Range, there are several occurrences of red-legged frogs including Mine Creek in Fresno and Merced Counties; and Piedra Azul Creek and North Los Banos Creek in Merced County. Large populations have been recently reported on Romero Ranch, and potential habitat exists on the Simon Newman Ranch. These ranches are located between Henry W. Coe State Park and San Luis Reservoir. The Nature Conservancy purchased these sites; it has since sold the Romero Ranch and soon will sell Simon Newman Ranch with rare species protection assured through conservation easements. South of Henry W. Coe State Park and San Luis Reservoir, California red-legged frogs are found in Quien Sabe and Tres Pinos creeks, the Pajaro and San Benito rivers, and the general vicinity of Hollister (San Benito County) such as Santa Ana Creek, Tequisquita Slough, and the Hollister Hills State Vehicular Recreation Area. Numerous populations exist in Pinnacles National Monument, particularly in Chalome and Bear Gulch Creeks. (Natural Diversity Data Base 2001, M. Jennings *in litt.* 1998a).

The Elkhorn Slough watershed (Monterey County) currently supports this species. Within this area, adult California red-legged frogs were observed at McClusky Slough in 1996; this is a site where restoration efforts for the endangered Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*) are ongoing. Several adult California red-legged frogs have been observed in the Salinas River drainage (M. Jennings *in litt.* 1998). On Fort Hunter Liggett Military Reserve, no current or historic records of California red-legged frogs exist, but surveys are being conducted in this area which includes the Nacimiento and San Antonio Rivers (G. McLaughlin pers. comm. 1998).

Northern Transverse Ranges and Tehachapi Mountains. On the Santa Maria River, California red-legged frogs occur up- and downstream of Twitchell Reservoir (Natural Diversity Database 2001). To the south, the lower drainage basin of San Antonio Creek, the adjacent San Antonio Terrace, and San Antonio Lagoon are considered to be among the most productive areas for red-legged frogs in Santa Barbara County (Christopher 1996). Most of this area occurs on Vandenberg Air Force Base. In this area, California red-legged frogs are found in dune swale ponds; this habitat type has remained essentially undisturbed, and the conditions seem to be less suitable for introduced fishes, crayfish, and bullfrogs because they dry completely in drought years. Jalama Lagoon also supports a relatively large population of the California red-legged frog (Christopher 1996).

The largest known populations in the northern Transverse Range are on upper Alamo Creek (a tributary to Cuyama River), a northern tributary to the Sisquoc River, and La Brea Creek and its southern tributary Manzana Creek (S. Sweet *in litt.* 2000).

Populations of California red-legged frogs in the lower Santa Ynez River Basin (Santa Barbara County) are smaller and patchily distributed. In this basin, deep pools with dense marginal vegetation are rare and introduced aquatic predators are abundant and diverse (Christopher 1996). California red-legged frogs are also found in fairly high numbers in the upper Santa Ynez River basin, up to Lake Cachuma and its tributaries (S. Christopher pers. comm. 1998); tributaries to the Santa Ynez River (e.g., Salispuedes Creek) also support California red-legged frogs. The small coastal drainages between Gaviota and Goleta also support California red-legged frogs (M. Jennings *et al. in litt.* 1992, S. Christopher pers. comm. 1998, D. Pereksta pers. comm. 1998) as do areas west to Point Conception (P. Bloom *in litt.* 2000).

Drainages on the southern portion of the Los Padres National Forest such as Upper Santa Ynez, (in and above Jameson Reservoir), Agua Caliente, Juncal, Indian, and Mono Creeks still support California red-legged frogs. They were depleted significantly from the mainstem of Sespe Creek following a 1979-1981 bullfrog invasion. However, they have persisted in low numbers in several of the tributaries. The species is also in decline in Piru Creek due to changes in flow regimes since the construction of Pyramid Dam in

1973 and the introduction of many predatory fish via the California aqueduct (P. Bloom *in litt.* 2000). In the Santa Clara River watershed, California red-legged frogs may be found in the headwaters and tributaries of the Santa Clara River (Jennings *et al. in litt.*1992). To the east, in the Tehachapi Mountains, historic records (mid-1800s) of California red-legged frogs exist in Kern County in El Paso Creek and near Fort Tejon. In the 1980s, this species was observed in Cedar Creek near Glennville and near the Kern and San Luis Obispo County line (M. Jennings *et al. in litt.* 1992).

Sweet and Leviton (1983 as cited in Jennings 1988a) reported the natural occurrence of the California red-legged frog on Santa Cruz Island (Santa Barbara County). According to Jennings (1988a), it is likely that they were introduced by Basque or French workers for consumption. Based on recent reports, the frogs still exist on Santa Cruz Island (M. Jennings *in litt.* 1998b).

Southern Transverse Range and Peninsular Ranges. The California red-legged frog was a common native frog in parts of Los Angeles, San Bernardino, Orange, Riverside, and San Diego Counties (Jennings *et al. in litt*. 1992). Numerous records of California red-legged frogs exist from the 1930s, along the Mojave River near Victorville (San Bernardino County), as well as along the San Luis Rey River in San Diego County. The frog historically occurred in the San Gabriel Wilderness Area of the Angeles National Forest (Los Angeles County); until 1999, there were no post-1970 observations in this area or nearby parts of Angeles National Forest (Jennings 1993). In 1999, a population of California red-legged frogs was located on the Angeles National Forest in the San Francisquito drainage. Current population estimates suggest that there are between 15 and 25 adults (R. Fischer pers. comm 2001). However, this population is threatened by non-native predators (bullfrogs, crayfish, and non-native fish species), disease, and parasites.

Until a recent sighting, California red-legged frogs were considered to be extirpated from the Santa Monica mountains (Los Angeles County); the last record was from 1976 (M. Jennings *in litt.* 1998a). A recent discovery of California red-legged frogs was made in East Las Virgenes Creek (Ventura County) in the Simi Hills, adjacent to the Santa Monica Mountains National Recreation Area. No frogs were found in nearby streams (Las Virgenes Creek, Palo Comado, Cheeseboro, and Liberty canyons) (Sapphos Environmental 1999). Current survey information suggests that this breeding population contains 20 to 25 adults, 10 to 15 juveniles, and several hundred tadpoles (R. Smith *in litt.* 2001).

> Rangewide, and even within local populations, there is much variation in how frogs use their environment; in some cases, they may complete their entire life cycle in a particular habitat....and in other cases, they may seek multiple habitat types.

Today, in southern California, south of the Tehachapi Mountains, California red-legged frogs are currently known from only a few locations, compared to over 80 historic records from this region. Former populations in the Whitewater River canyon (Riverside County), the eastern San Bernadino mountains, and Sentenac Canyon in the San Felipe Creek system of the Southern Peninsular Ranges (San Diego County) have not been observed since the 1960s (Jennings and Hayes 1994). The existing locations include Amargosa Creek near Palmdale (Los Angeles County) and Cole Creek on The Nature Conservancy's Santa Rosa Plateau Ecological Reserve (Riverside County). Current survey data suggest that the effective population size has been severely reduced primarily due to predation by bullfrogs. While this population contained greater than 10 breeding adults in the late 1980s to early 1990s, recent survey data suggests that only 2 males remain. This area is the focus of augmentation and reestablishment project being pioneered by the U.S. Fish and Wildlife Service, the Los Angeles Zoo, The Nature Conservancy, and the Mexican government.

D. HABITAT

General Habitat. While nearly all of the known California red-legged frog populations have been documented below 1,050 meters (3,500 feet), some historical sightings were noted at elevations up to 1,500 meters (5,200 feet). Suitable habitat above 1,050 meters (3,500 feet) may be more specific and may include such requirements as: quiet water refugia within 0.5 kilometers (0.25 miles) during high water flows, emergent vegetation present on a minimum of 25 percent of a pool or pond margin, and standing water that is retained into late July (S. Chubb *in litt.* 1999). Expanded surveys will provide information necessary to determine the elevational range limits of the California red-legged frog.

Overall, populations are most likely to persist where multiple breeding areas are embedded within a matrix of habitats used for dispersal.

California red-legged frogs live in a Mediterranean climate, which is characterized by temporal and spatial changes in habitat quality. In addition to climatic fluctuations, the habitats used by this species typically change in extent and suitability in response to the dynamic nature of floodplain and fluvial processes (i.e., natural water flow and sedimentation regimes that, in flux, create, modify, and eliminate deep pools, backwater areas, ponds, marshes, and other aquatic habitats) (N. Scott and G. Rathbun *in litt.* 1998). Therefore, the frog uses a variety of areas, including various aquatic, riparian, and upland habitats (Figures 6, 7, 8, 9).

Rangewide, and even within local populations, there is much variation in how frogs use their environment; in some cases, they may complete their entire life cycle in a particular habitat (i.e., a pond is suitable for all life stages), and in other cases, they may seek multiple habitat types. Overall, populations are most likely to persist where multiple breeding areas are embedded within a matrix of habitats used for dispersal (N. Scott and G. Rathbun *in litt.* 1998). The following descriptions describe the range of habitat types used by the frog.

Breeding Habitat. Breeding sites of the California red-legged frog are in a variety of aquatic habitats; larvae, tadpoles, and metamorphs have been collected from streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds, dune ponds, and lagoons. Breeding adults are often associated with deep (greater than 0.7 meter [2 feet]) still or slow moving water and dense, shrubby riparian or emergent vegetation (Hayes and Jennings 1988), but frogs have been observed in shallow sections of streams that are not cloaked in riparian vegetation. Reis (1999) found the greatest number of tadpoles occurring in study plots with water depths of 0.26 to 0.5 meters (10 to 20 inches). While frogs successfully breed in streams, high flows and cold temperatures in streams during the spring often make these sites risky environments for eggs and tadpoles. California red-legged frogs also frequently breed in artificial impoundments such as stock ponds. It is assumed, however, that these ponds must have proper management of hydroperiod, pond structure, vegetative cover, and control of non-native predators, although some stock ponds support frogs despite a lack of emergent vegetation cover and the presence of non-native predators (N. Scott and G. Rathbun *in litt.* 1998). Additional research on the habitat requirements of the California red-legged frog in artificial ponds may clarify this issue.

Dispersal and Use of Uplands and Riparian Areas. During periods of wet weather, starting with the first rains of fall, some individuals may make overland excursions through upland habitats. Most of these overland movements occur at night. Evidence from marked and radio-tagged frogs on the San Luis Obispo County coast suggests that frog movements, via upland habitats, of about 1.6 kilometers (1 mile) are possible over the course of a wet season. Frogs have been observed to make long-distance movements that are straight-line, point to point migrations rather than using corridors for moving in

Figure 6.
Aerial view of breeding areas surrounded by upland dispersal habitat.
Photo © Curt McCasland, USFWS.

between habitats (N. Scott and G. Rathbun *in litt.* 1998). Dispersing frogs in northern Santa Cruz County traveled distances from 0.40 kilometer (0.25 mile) to more than 3 kilometers (2 miles) without apparent regard to topography, vegetation type, or riparian corridors (Bulger *in litt.*1998).

During dry periods, the California red-legged frog is rarely encountered far from water (Jennings *et al. in litt.* 1992). However, California red-legged frogs will sometimes disperse in response to receding water which often occurs during the driest time of the year. For example, between September 20 and October 20 in 1999, 7 adults were observed moving through nearby uplands on the University of Santa Cruz campus as the breeding pond dried (M. Allaback *in litt.* 2000).

The manner in which California red-legged frogs use upland habitats is not well understood; studies are currently examining the amount of time California red-legged frogs spend in upland habitats, patterns of use, and whether there is differential use of uplands by juveniles, subadults, and adults. Dispersal distances are considered to be dependent on habitat availability and environmental conditions (N. Scott and G. Rathbun *in litt.* 1998).

Frogs spend considerable time resting and feeding in riparian vegetation when it is present. It is believed that the moisture and cover of the riparian plant community provide good foraging habitat and may facilitate dispersal in addition to providing pools and backwater aquatic areas for breeding. California

Frogs have been observed to make long-distance movements that are straight-line, point to point migrations rather than using corridors for moving in between habitats.

Breeding sites of the CLRF are in a variety of aquatic habitats:

- Stream
- Deep pools
- Backwater areas
- Ponds
- Marshes
- Sag ponds
- Dune ponds
- Lagoons

red-legged frogs can be encountered living within streams at distances exceeding 3 kilometers (2 miles) from the breeding site, and have been found up to 30 meters (100 feet) from water in adjacent dense riparian vegetation, for up to 77 days (Rathbun *et al.* 1993).

Summer Habitat. California red-legged frogs often disperse from their breeding habitat to forage and seek summer habitat if water is not available. This summer habitat could include spaces under boulders or rocks and organic debris, such as downed trees or logs; industrial debris; and agricultural features, such as drains, watering troughs, abandoned sheds, or hay-ricks.

Figure 8. Breeding pool and streamside vegetation in Round Valley Creek, Contra Costa County.
Photo © Steven Bobzien

Figure 7. Breeding habitat in Ledson Marsh, Sonoma County.
Photo © David Cook

California red-legged frogs use small mammal burrows and moist leaf litter (Jennings and Hayes 1994); incised stream channels with portions narrower and deeper than 46 centimeters (18 inches) may also provide habitat (U.S. Fish and Wildlife Service 1996a). This depth may no longer be an accurate estimate of preferred depth for this species as individuals have been found using channels and pools of various depths. Most observations are associated with depths greater than 25 cm (10 inches). For example, M. Allaback (*in litt.* 2000) has observed numerous red-legged frogs inhabiting stream channels with pools that are less than 46 centimeters (18 inches) deep, particularly in north coastal Santa Cruz County and generally from late spring to the fall. Some of the observations have been along tributaries where there are no pools that are 46 centi-meters (18 inches deep) for several thousand feet. At one site, along a tributary to Liddell

Creek (Santa Cruz County), the same individuals were seen at the same streamside locations for several weeks in late summer during a monitoring project. Pool depth averaged approximately 30 centimeters (12 inches). In 2000, an adult red-legged frog was observed in shallow, 5 centimeter (2 inch) deep riffle habitat in a disturbed drainage in lower Little Bull Valley (Contra Costa County). Here, no pool or pond habitat was present within approximately 300 meters (1,000 feet).

California red-legged frogs use large cracks in the bottom of dried ponds as refugia. Approximately 25 red-legged frogs were observed using open cracks in the bottom of three separate dried ponds. At least one pond was dry for more than 2 months when adult frogs were found deep in the cracks of the pond bottom. Many cracks within which frogs were found were damp at a depth of 46 centimeters (18 inches). These cracks may have provided moisture for frogs that were also avoiding predation and solar exposure (J. Alvarez *in litt.* 2000). Dispersal and habitat use, however, is not observed in all studied red-legged frogs and is most likely dependent upon climatic conditions, habitat suitability, and varying requisites of each life stage.

Water Quality. California red-legged frogs are sensitive to high salinity, which often occurs in coastal lagoon habitats. When eggs are exposed to salinity levels greater than 4.5 parts per thousand, 100 percent mortality occurs (Jennings and Hayes 1990). Larvae die when exposed to salinity levels greater than 7.0 parts per thousand (M. Jennings *in litt.* 1993). Reis (1999) found that the proportion of study plots without tadpoles was greatest among plots with salinity levels greater than 6.6 parts per thousand.

Early embryos of northern red-legged frogs are tolerant of temperatures only between 9 and 21 degrees Celsius (48 and 70 degrees Fahrenheit) (Nussbaum *et al*. 1983). Study plots at Pescadero Marsh (San Mateo County) with the greatest number of California red-legged frog tadpoles had mean water temperatures between 15.0 and 24.9 degrees Celsius (60 to 75 degrees Fahrenheit). Observations by S. Bobzien (pers.comm. 1998) indicated that California red-legged frogs were absent when temperatures exceed 22 degrees Celsius (70 degrees Fahrenheit), particularly when the temperature throughout a pool was this high and there are no cool, deep portions.

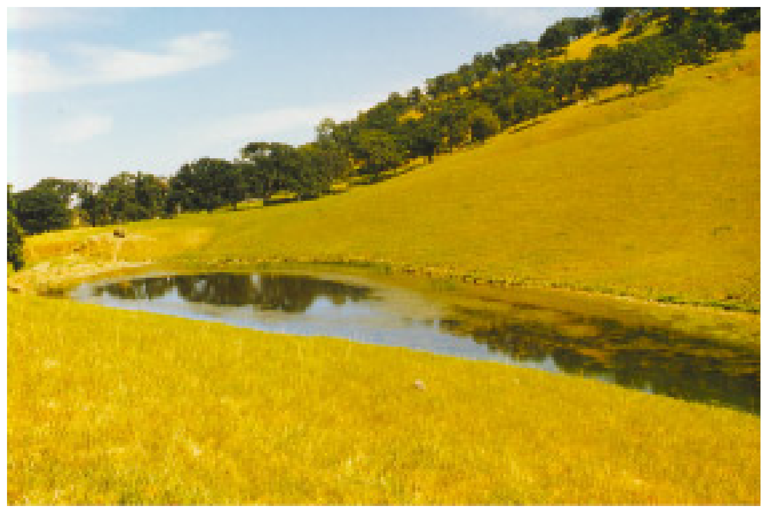


Figure 9. Dune swale breeding pond on Vandenberg Air Force Base, Santa Barbara County (top).
Photo © Ina Pisani

Breeding habitat in a stockpond on Ohlone Regional Wilderness, Alameda County (bottom).
Photo © Steven Bobzien

E. LIFE HISTORY AND ECOLOGY

Reproduction. California red-legged frogs breed from November through April (Storer 1925). Males appear at breeding sites from 2 to 4 weeks before females (Storer 1925). At these sites, males frequently call in small groups of two to seven individuals, although in some instances they may call individually (Jennings *et al. in litt.* 1992). Females are attracted to the calling males. A pair in amplexus (breeding position) moves to an oviposition site (the location where eggs are laid) and the eggs are fertilized while being attached to a brace. Braces include emergent vegetation such as bulrushes (*Scirpus* spp.) and cattails (*Typha* spp.) or roots and twigs; the egg masses float on the surface of the water (Hayes and Miyamoto 1984). Each mass contains about 2,000 to 5,000 eggs that are each about 2.0 to 2.8 millimeter (0.08 to 0.11 inches) in diameter (Figure 8). The eggs are dark reddish brown (Storer 1925).

Growth and Development. Eggs hatch in 6 to 14 days depending on water temperatures (Jennings 1988b). Egg predation is infrequent and most mortality probably occurs during the tadpole stage (Licht 1974), although eggs are susceptible to being washed away by high stream flows. Schmeider and Nauman (1994) report that California red-legged frog eggs have a defense against predation which is possibly related to the physical nature of the egg mass jelly, although Rathbun (1998) has documented newt predation on eggs and suggested that this predation may be an important factor in the population dynamics of the California red-legged frog.

Typically, most adult frogs lay their eggs in March. Eggs require approximately 20-22 days to develop into tadpoles, and tadpoles require 11 to 20 weeks to develop into terrestrial frogs. (Bobzien et. al. 2000, Storer 1925, Wright and Wright 1949). Several researchers, however, have observed overwintering tadpoles (i.e., tadpoles that did not metamorphose within their first breeding season) in recent surveys. In Round Valley Creek (Contra Costa County) on East Bay Regional Park District land, overwintering tadpoles were documented in 1997, 1998, 1999, and 2000. In these cases, metamorphs were observed in March and April from previous breeding seasons. These frogs were relatively small in size and still had posterior scar tissue where their tails were located. Further, numerous tadpoles were seen in late fall (October and November) and several in December and January. The majority of these individuals had rudimentary or developed hind limbs and appeared to have overwintered in this stage. (Bobzien *et al.* 2000).

Sexual maturity can be attained at 2 years of age by males and 3 years of age by females (Jennings and Hayes 1985); adults may live 8 to 10 years (Jennings *et al. in litt*. 1992), although the average life span is probably much lower (N. Scott pers. comm. 1998). Schmieder and Nauman (1994) reported that California red-legged frog larvae are highly vulnerable to fish predation, especially immediately after hatching, when the nonfeeding larvae are relatively immobile.

Activity Patterns and Movements. Hayes and Tennant (1985) found juvenile frogs to be active diurnally and nocturnally, whereas adult frogs were largely nocturnal. The season of activity for the California red-legged frog seems to vary with the local climate (Storer 1925); individuals from coastal populations, which rarely experience low temperature extremes because of the moderating maritime effect, are rarely inactive. Individuals from inland sites, where temperatures are lower, may become inactive for long intervals (Jennings *et al. in litt*. 1992) and no information is available on the activity levels of California red-legged frogs at higher elevations.

Feeding. The diet of California red-legged frogs is highly variable. The foraging ecology of larvae has not been studied, but they are thought to be algal grazers (Jennings *et al. in litt*. 1992). Hayes and Tennant (1985) found invertebrates to be the most common food items of adult frogs. Vertebrates, such as Pacific tree frogs (*Hyla regilla*) and California mice (*Peromyscus californicus*), represented over half of the prey mass eaten by larger frogs, although invertebrates were the most numerous food items. Feeding typically occurs along the shoreline and on the surface of the water; juveniles appear to forage during both daytime and nighttime, whereas subadults and adults appear to feed at night (Hayes and Tennant 1985). Radio-tracking studies suggest that frogs also forage several meters into dense riparian areas (G. Rathbun pers. comm 1993, as cited in U.S. Fish and Wildlife Service 1996a).

F. REASONS FOR DECLINE AND THREATS TO SURVIVAL

The California red-legged frog is threatened by human activities, many of which operate synergistically and cumulatively with each other and with natural disturbances (i.e., droughts or floods). Factors associated with declining populations of the frog include degradation and loss of its habitat through agriculture, urbanization, mining, overgrazing, recreation, timber harvesting, non-native plants, impoundments, water diversions, degraded water quality, use of pesticides, and introduced predators. The reason for decline and degree of threats vary by geographic location. California red-legged frog populations are threatened by more than one factor in most streams. The following discussion is organized according to the five listing criteria under section 4(a)(1) of the Endangered Species Act.

1. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range.

Curtailment of Range and Alteration, Fragmentation, Degradation, and Loss of Habitat. Habitat loss and alteration are the primary factors that have affected the California red-legged frog negatively throughout its range. For example, in the Central Valley of California, over 90 percent of historic wetlands have been diked, drained, or filled for agricultural and urban development (U.S. Fish and Wildlife Service 1978, Dahl 1990). This has resulted in a large loss of frog habitat throughout this species' range.

California red-legged frog habitat has become isolated and fragmented along many stream courses. Patches of suitable habitat represent remnants of a much larger historical habitat, which once covered entire drainages. With habitat fragmentation, dispersal opportunities are reduced and interactions between sub-populations can be precluded, jeopardizing the viability of metapopulations. Isolated populations are vulnerable to extinction through random adverse environmental events and human-caused impacts (Soulé 1987). Further, dispersal between fragments exposes frogs to increased risk of predation (G. Rathbun *in litt.* 1998).

In addition to the isolation of populations, the range of the California red-legged frog has been severely reduced. While numerous localities exist along the Pacific coast from Point Reyes south through Santa Barbara County, few localities exist in the Sierras and southern California.

Urbanization. Current and future urbanization poses a significant threat to the California red-legged frog. In 1995, approximately 27 percent of the known occurrences were associated with urbanization threats and many areas within the range of the frog were slated for development (U.S. Fish and Wildlife Service 1996a). Urban and suburban developments often leave isolated habitat fragments and create barriers to frog dispersal. Numerous studies, as discussed below, have demonstrated the impacts of fragmentation on other frog and toad species. Urban populations of common frogs (*Rana temporaria*) were more genetically distinct than rural populations (Hitchings and Beebee 1997). Based on genetic analysis, Reh and Seitz (1990) found that highways effectively isolated common frog populations. Kuhn (1987, in Reh and Seitz 1990) estimated that 24 to 40 cars per hour killed 50 percent of common toad (*Bufo bufo)* individuals migrating across a road, while Heine (1987, in Reh and Seitz 1990) found that 26 cars per hour could reduce the survival rate of toads crossing roads to zero. Fahrig *et al.* (1995) found a significant negative correlation between traffic density and the density of anuran (frog and toad) populations. Thus, roads are an important human-caused landscape component hindering amphibian movement and thereby fragmenting amphibian populations.

Because urbanization typically results in additional water sources into wetlands and stream courses, due to irrigation and home use activities, another consequence of urbanization is the change in hydroperiod of historically ephemeral drainages to perennial streams (often due to wastewater outflows). This change allows the proliferation of non-native predators (M. Moore and M. Westphal *in litt.* 1997). Richter and Azous (1997) observed wetlands adjacent to undeveloped upland areas were more likely to have richer populations of native amphibians. The reduced richness of amphibians in wetlands with highly urbanized watersheds is likely due, in part, in part, to differences in hydrologic patterns related to land use.

In addition to the modification of hydroperiod, development within the watershed can also affect water and habitat quality. As watersheds are developed, the amount of impervious surface increases, resulting in an increase of sediments containing organic matter, pesticides, and fertilizers, heavy metals such as hydrocarbons, and other debris into streams and wetlands (Environmental Protection Agency 1993). Skinner *et al.* (1999) found developed watersheds had greater concentrations of toxic effluents than less developed areas with more open space. The decrease in water quality can have profound impacts on native amphibians and other wetland vertebrates. Other consequences include channelization of creeks (which reduces or eliminates breeding sites) and increased suitability for predators such as non-native fish, bullfrogs, and raccoons, all of which thrive in disturbed conditions (Harris 1998).

Agriculture. Agricultural practices pose a threat to the California red-legged frog populations due to loss or modification of frog habitats. Many crops (e.g., row crops) are stands of monotypic vegetation, which replace varied natural habitats. Fisher and Shaffer (1996) studied historic records and conducted surveys for amphibians in the Sacramento Valley, San Joaquin Valley, and Coast range. In the San Joaquin Valley, drastic declines of both native and non-native amphibians were noted. The authors suggest that the declines may be due to intense farming rendering the few remaining ponds and pools on the valley floor uninhabitable even for introduced species. Agricultural practices typically include the use of fertilizers and pesticides including herbicides and fungicides, that may pose contamination threats to the frog. Impacts include deformities, abnormal immune system functions, diseases, injury, and death (see Appendix B) (K. Woodburn *in litt.* 1996, Schneeweiss and Schneeweiss 1997). An important factor in the decline of the California red-legged frog may be exposure to wind-borne agrochemicals. A number of studies have documented transport and deposition of pesticides from the Central Valley to the Sierra Nevada mountain range (Zabik and Seiber, 1993, Aston and Seiber 1997, Datta 1997, McConnell *et al* 1998 as cited in Davidson *et al.* 2001). There is a strong relationship between increasing levels of upwind agriculture and the percentage of extirpated California red-legged frog population sites; this relationship is particularly pronounced within the Sierra Nevada-Central Valley region where agriculture is the greatest (Davidson *et al.* 2001). In this region, the percentage of upwind land in agriculture for sites where the California red-legged frog has disappeared is 6.5 times greater than for sites where they persist (Davidson *et al.* 2001). Similarly, Sparling *et al.* (2001) noted that the most severe declines of amphibians, including California red-legged frogs, are in the Sierra Nevada mountains east of the central valley and downwind of the intensely agricultural San Joaquin valley. In contrast, coastal and more northern populations across from the less agrarian Sacramento valley are stable or declining less precipitously.

Water diversion and impoundment for irrigation, can reduce the flows necessary to support adequate aquatic habitat for frogs and other species. The California coast supports several agricultural activities including artichoke production, flower nurseries, and other irrigated crops that require the use of irrigation ponds. Water is collected during the winter months from rainfall and is also pumped out of coastal drainages into ponds. These ponds typically grow shoreline vegetation such as cattails, tules (*Scirpus* spp.), and horsetails (*Equisetum* spp.), and with proper water management can provide high quality breeding habitat. However, farmers often start irrigating crops during the late spring, and continue through summer. As water is drawn down, egg masses can be exposed and desiccate. Although the outlets may be screened, the pumps used are powerful enough to suck tadpoles and juveniles against the screen and can crush individuals. Depending upon their size, ponds also may be drawn down to such an extent that they completely dry out or are shallow enough to allow significant predation of frogs (particularly tadpoles that have not fully metamorphosed) by waterbirds. Ponds that are not drawn down all the way often support predatory sunfish (*Lepomis* spp.), largemouth bass (*Micropterus* spp.), and bullfrogs (S. Larsen *in litt.* 1998). Some agricultural activities (e.g., nurseries) provide a large flush of pesticides into stream systems during rain events and may pose a threat to frogs (C. McCasland *in litt*. 1998b). The effects of agricultural activities are especially intense in the Central Valley, Salinas Valley, the coastal plain of Monterey County, and parts of San Luis Obispo and Santa Barbara Counties.

Impoundments and Water Management. In the Central Valley and surrounding foothills the construction and filling of large reservoirs, which are typically situated at or just below the juncture of several tributaries, either directly eliminated, fragmented, or isolated populations of the California red-legged frog. Examples include the construction of Lake Oroville (Butte County), Whiskeytown Reservoir (Shasta County), Folsom Reservoir (Placer, El Dorado Counties), Lake Berryessa (Napa County), and San Luis Reservoir (Merced County) within the Central Valley hydrologic basin (Jennings *et al. in litt.* 1992). At least 40 percent of the historically suitable California red-legged frog habitat on the Los Padres National Forest has been fragmented by the placement of dams on streams. The major existing dams include San Clemente and Los Padres Dams on the Carmel River; Twitchell Dam and Reservoir on the Cuyama and Alamo watersheds; Bradbury, Gibraltar, and Juncal Dams on the Santa Ynez River; Matilija Dam on Matilija Creek; and Santa Felicia and Pyramid Dams on Piru Creek (S. Chubb *in litt.* 1998).

Lind *et al.* (1996) studied the effects of a dam on the foothill yellow-legged frog (*Rana boylii*) in the Trinity River (Trinity County). Unlike the California red-legged frog, this species is typically associated with stream riffles. Here, dams reduced breeding habitat due to changes in channel morphology and eliminated entire cohorts due to unseasonable high flow releases. Other dam-related factors that may have influenced the breeding ecology of the foothill yellow-legged frog are water temperature, exotic species, and changes in prey base. Hayes and Jennings (1988) found that California red-legged frogs generally were extirpated from downstream portions of a drainage 1 to 5 years after filling of a reservoir, depending on the size of the drainage. However, in some larger drainages, isolated populations have been observed to persist upstream of a reservoir.

Some populations of frogs are known to use reservoirs at least in the adult stage (e.g., Jamieson Reservoir on the Santa Ynez River). On Los Padres National Forest, plunge pools and seepage pools that occur at the base of most dams are prime California red-legged frog habitat, and viable populations have persisted despite dams (S. Chubb *in litt.* 1999). It is not clear if these reservoirs are a source or sink to the overall California red-legged frog population in these areas; the suitability may depend on the presence of non-native species and/or other land-use disturbances such as recreation. Reservoirs are typically stocked with non-native predatory fishes. Bullfrogs were stocked in the past and continue to spread. These species often disperse upstream and downstream into California red-legged frog habitat and disrupt natural community dynamics.

Many small impoundments are situated on private and public lands. For example, on Los Padres National Forest, there are 150 small impoundments, over 500 small water diversions exist, and approximately 190 springs are diverted. Most of these diversions and impoundments are operated as temporary storage of surface water run-off in ephemeral drainages for livestock and/or wildlife watering. Impoundments can structurally block or hinder dispersal. Further, they can eliminate the high flows needed to maintain moderately deep holes in stream channels (G. Rathbun *in litt.* 1998). Stock ponds and small reservoirs also typically support populations of non-native fishes and bullfrogs (G. Rathbun and M. Jennings *in litt.* 1993). In contrast, California red-legged frogs frequently use small reservoirs as breeding habitat, and these sites may be good producers of California red-legged frogs with the proper management of water and non-native predators.

Channelization and Flood Control. Routine flood control maintenance, which typically includes vegetation removal, herbicide spraying, shaping and riprapping of banks to control erosion, and dredging of creeks and rivers, can result in degradation of California red-legged frog habitat. Widespread channelization of watercourses for flood control and water diversion has eliminated habitat along small to medium-sized watercourses (Harding 1960), and has allowed the proliferation of non-native aquatic species. Management of water flows for flood control also has the potential to adversely impact California red-legged frogs. For example, in San Mateo County, poorly timed releases of storm water flows from Horse Stable Pond at Sharp Park in February 1992, resulted in exposure and desiccation of 62 California red-legged frog egg masses (T. Steiner *in litt.* 1994).

Mining. Suction dredge mining may threaten California red-legged frog habitat. Jennings *et al.* (*in litt.* 1992) reported heavy siltation in late spring and summer in portions of Piru Creek (Santa Barbara County), which is known to support California red-legged frogs. The siltation resulted from upstream gold mining. Extremely deep holes in streams created by instream suction dredge mining may also provide habitat for non-native predatory fish (U.S. Fish and Wildlife Service 1996a). Creeks, streams, and rivers are open to suction dredging throughout the year in many counties within the range of the California red-legged frog.

Sand and gravel mining practices can alter natural channel morphology in downstream reaches by interrupting the supply of sand and gravel, which is needed for localized shallow, braided channels (Collins and Dunne 1990). Long-term gravel mining on point bars retards the development of appropriate soil conditions for riparian vegetation. Continued instream gravel mining activities without adequate safeguards may preclude favorable habitat conditions for the California red-legged frog. California red-legged frogs have colonized active and inactive sediment basins at two quarries in Santa Cruz County (Bonny Doon Quarry and Wilder Ranch Quarry) and it is possible that frogs inhabit other sediment basins associated with quarries throughout the species' range (M. Allaback *in litt.* 2000). Effluent from mercury mines has created high levels of mercury in the upper Nacimiento River basin (Salinas River drainage), and probably other streams in the Santa Lucia Mountains (N. Scott *in litt.* 1998).

Within Los Padres National Forest, oil and gas development occupies approximately 73 hectares (200 acres) within Sespe and Hopper creeks. There has been one documented oil spill which extended 3 kilometers (2 miles) down Sespe Creek. Los Padres National Forest has since worked with the lessees to establish and implement Best Management Practices and properly cap old wells and remove storage tanks. Oil and gas pipelines also extend across a number of drainages within San Luis Obispo, Santa Barbara, and Ventura Counties. There is always a risk of leakage or breakage near stream crossings (S. Chubb *in litt.* 1999).

Livestock Grazing and Dairy Farming. Livestock grazing is another form of habitat alteration that may be both (1) contributing to declines in the California red-legged frog by decreasing suitability of riparian and aquatic habitat and (2) in many instances, providing frog habitats.

In many cases, California red-legged frogs co-exist with managed livestock grazing. High numbers of frogs are found in areas such as Point Reyes National Seashore, many East Bay Regional Parks, and private land holdings where stock ponds and cattle are prevalent. In many of these areas, California red-legged frogs may be present only because livestock operators have artificially created ponds for livestock water where there were none before and therefore, created frog habitats. In such ponded habitat, grazing may help maintain habitat suitability by keeping ponds clear where they might otherwise fill in with cattails, bulrushes, and other emergent vegetation (S. Bobzien *in litt.* 1998, G. Fellers *in litt.* 1998, N. Scott and G. Rathbun *in litt*. 1998).

In other areas, however, observations suggest that grazing activities pose a serious threat to the suitability of aquatic habitats for California red-legged frogs. For example, exclusion of cattle grazing from the Simas Valley (Contra Costa County) resulted in reestablishment of native trees and native wetland herbs, re-establishment of creek pools, and expansion of frog populations into streams and ungrazed stock ponds (Dunne 1995). Further research is necessary to determine the role of drought and population size in this observed expansion of red-legged frogs into streams, because the exclusion of cattle coincided with the end of a prolonged drought. Other biologists have noted that when cattle drink from small ponds and streams they can draw down water levels, leaving egg masses above the water level and subjecting them to desiccation and/or disease (e.g., fungal infections) (S. Chubb *in litt.* 1998). Grazing cattle can also cause direct impacts to frogs by crushing and/or disturbing egg masses (S. Chubb *in litt.* 1998), larvae, and metamorphosing frogs.

Numerous studies, summarized by Behnke and Raleigh (1978) and Kauffman and Krueger (1984), have shown that livestock grazing can negatively affect riparian habitat, marshes, and ponds. Cattle have an adverse effect on riparian and other wetland habitats because they tend to concentrate in these areas, particularly during the dry season (Marlow and Pogacnik 1985). Poorly managed grazing in riparian areas often results in downcutting and loss of plunge ponds, which in turn, decreases pool habitats for California red-legged frogs. The consequences of these changes in riparian conditions and the effect on the frog are largely unknown.

Unmanaged cattle trample and eat emergent and riparian vegetation, often eliminating or severely reducing plant cover (Gunderson 1968, Duff 1979). Loss of riparian vegetation results in increased water temperatures (Van Velson 1979), which decreases suitability for California red-legged frogs and encourages reproduction of bullfrog and non-native warm water fishes. Effects on riparian vegetation due to cattle grazing include the loss of willows (Duff 1979), which are associated with the highest densities of California red-legged frogs (Hayes and Jennings 1988, Jennings 1988b). Loss of streamside vegetation also reduces habitat for insects and small mammals, which are important dietary components for aquatic and riparian associated species, including the red-legged frog (Cordone and Kelley 1961).

> Livestock grazing is another form of habitat alteration that may be both contributing to declines of the California red-legged frog by decreasing suitability of riparian and aquatic habitat and, in many instances, providing frog habitats.

Cattle overgrazing also results in increased erosion in the watershed (Lusby 1970, Winegar 1977), which accelerates the sedimentation of deep pools (Gunderson 1968) used by California red-legged frogs. High levels of sediment introduced into streams can alter primary productivity and fill interstitial spaces in streambed materials with fine particulates, which impede water flow, reduce dissolved oxygen levels, and restrict waste removal (Chapman 1988). The populations of California red-legged frogs in the Corral Hollow Ecological Reserve and Frank Raines Regional Park are threatened, in part, by sedimentation of aquatic habitats either directly or indirectly caused by grazing (M. Jennings *et al. in litt.* 1992). Livestock grazing can cause a nutrient loading problem due to urination and defecation in areas where cattle are concentrated near the water (Doran *et al.* 1981). The primary contaminant in the tributaries to Tomales Bay (Marin County) is waste from cattle ranches and dairies (San Francisco Chronicle 1998).

Overall, grazing may both enhance California red-legged frog populations and be a detriment to habitat suitability; the effects probably depend on the grazing practices, watershed integrity, and conditions of a particular site. For example, the East Bay Regional Park District uses livestock grazing for vegetation management and habitat enhancement. The vast majority of California red-legged frogs observed on Park District lands are in artificial ponds or in streams that are exposed to livestock grazing (Bobzien *et al.* 2000). While safeguards may be needed to protect riparian and aquatic habitats, with proper management of artificial ponds and appropriate grazing regimes, this land use may prove to be a benefit to this species as witnessed in Alameda, Contra Costa, Marin, Sonoma, Santa Cruz, and San Luis Obispo Counties (N. Scott *in litt.* 1999).

Recreation and Off-Road Vehicles. Routine road maintenance, trail development, and facilities construction associated with parks and other public lands, in or adjacent to California red-legged frog habitat can degrade habitat quality (U.S. Fish and Wildlife Service 1996a). Heavy recreational use of parks (e.g., fishing, hiking, use of developed sites, dispersed camping) can also degrade habitat for the California red-legged frog. People tend to congregate around aquatic areas and can trample vegetation, trample frog eggs and young, increase noise levels, and change the environment. At Big Basin Redwoods State Park in Santa Cruz County, heavy recreational use may have contributed to the disappearance of California red-legged frogs from Opal Creek (U.S. Fish and Wildlife Service 1996a).

Unmanaged off-road vehicles can damage riparian vegetation, increase siltation in pools, compact soils, disturb the water in stream channels, and crush frogs. California red-legged frogs were eliminated, in part by off-road vehicle activities, at the Mojave River above Victorville, and at Rincon Station on the West Fork of the San Gabriel River (U.S. Fish and Wildlife Service 1996a).

Mountain bikes may also pose a threat to California red-legged frogs. Wilder Ranch (Santa Cruz County) is used by a high number of mountain bikers daily. In 1996, a sub-adult red-legged frog was observed on a bike trail along Baldwin Creek. Where bike paths are regularly used at night on the University of California Santa Cruz campus, there have been reported deaths of California red-legged frogs due to bike strike (M. Allaback *in litt.* 2000).

Recreational activities such as angling often result in the introduction of non-native species either through the artificial stocking of streams, lakes, and ponds or the use of non-native species as bait. These non-native species, such as bass and sunfish, can prey upon and ultimately eliminate native species. Mechanical disturbances of habitats, such as trampling of vegetation, can increase the proliferation of non-native vegetation. Littering associated with recreational activities can also introduce toxic substances such as motor oil, antifreeze, and other substances or items that are harmful to the aquatic and riparian community (S. Chubb *in litt.* 1998).

Timber Harvesting. Timber operations and related practices occurring on commercial, private, and public timberlands within watersheds inhabited by the California red-legged frog may contribute to the degradation of instream and riparian habitat and the decline of California red-legged frog and other aquatic species. The effects that degrade habitat include increased sedimentation of gravels and pools, removal of trees that provide instream and streamside habitat structure and shade, and changed patterns of runoff (U.S. Fish and Wildlife Service 1996a, 1996b). Access roads, haul roads, skid trails, and ground based (tractor) yarding systems have great impacts related to sedimentation and compaction. Wet weather operations also have more potential for impacts. Timber harvesting in upland habitat can also impact California red-legged frogs by causing direct harm or injury to frogs that may be dispersing or sheltering.

Within the current range of the California red-legged frog, timber harvest activities are most likely to occur in the following areas: (1) the Sierra Nevada foothills; (2) along the coast in Santa Cruz County; and (3) in certain watersheds in Sonoma, Napa, and Lake Counties. Timber harvest activities occur in many areas within the California red-legged frog's historic range, but outside the known current range. These areas include Glenn, Tehama, Shasta, Lassen, and Plumas Counties, and the counties on the west slope of the Sierra Nevada south to Tulare County. South of Santa Cruz County, the majority of timber harvest activities relate to fuelwood gathering, and pose a minimal threat to watersheds (S. Chubb *in litt.* 1999) although this practice may remove cover and refugia that frogs may rely upon.

2. Overutilization for Commercial, Recreational, Scientific, or Education Purposes

Exploitation. Exploitation of California red-legged frogs for food began during the period following the gold rush of 1849 (Jennings and Hayes 1984, 1985). By the mid-1870s, it was recognized that their numbers were diminishing in the vicinity of San Francisco (Lockington 1879). Overharvest, driven by a significant commercial demand, was indicated by a sharp reduction in frog harvest size in the late 1880s, and by the attempt to compensate for depleted wild stocks of the California red-legged frog, by introducing bullfrogs (Jennings and Hayes 1984, 1985). Commercial exploitation reduced lowland populations, particularly those on the floor of the Central Valley, to low levels (Jennings 1988b). This past exploitation is not a factor that is causing current declines, as commercial harvesting of California red-legged frogs has not occurred for a number of years.

Scientific Take. Qualified individuals may obtain permits to conduct scientific research activities on California red-legged frogs under section 10(a)(1)(A) of the Endangered Species Act. Specific activities that may be authorized include: capturing, handling, weighing, measuring, radiotracking studies, genetic studies, contaminant studies, and behavioral, ecological, and life history studies. Short term impacts of these activities may include harassment and possible accidental injury or death of a limited number of individual frogs. The long-term impacts will be to benefit recovery of the species by facilitating development of more precise scientific information on status, life history, and ecology.

3. Disease and Predation

Disease. Pathogens and parasites have been implicated in the decline of other frog species, but there has not been an extensive examination of how disease may adversely affect California red-legged frog populations. Currently, the San Francisquito drainage population in Los Angeles County is being monitored for disease and parasites which are the suspected cause of this population's decline (R. Fischer pers. comm 2001). It has been suggested that increased levels of UV-B radiation or air pollutants cause a weakening of the immune system which could increase the susceptibility of frogs to natural diseases (Blaustein and Wake 1995, P. Montague *in litt.* 1998). Another hypothesis, supported by observations, is that disease carried by planted trout may attack and kill amphibian eggs and larvae (Blaustein *et al.* 1994). Lefcort and Blaustein (1995) documented the effects of the yeast *Candida humicola*, which is a naturally occurring pathogen, on northern red-legged frogs. Infected frogs were more susceptible to predation due to changes in their ability to detect predators and changes in their thermoregulatory behavior. Little information exists concerning the distribution of this pathogen. A high incidence of parasites has been observed in bullfrogs that coexist with California red-legged frogs (>90 percent of sampled population with evidence of infection) in southern California. Data have not yet been collected to determine if California red-legged frogs are also contaminated in these areas; however, adult red-legged frogs appear to be in poor condition with low body weight.

Chytrid fungus has been found in a number of amphibian populations that are known to be declining. Signs of amphibian chytridiomycosis include deformed mouthparts in tadpoles; most individuals that are infected as tadpoles die when they metamorphose. Infected boreal toads (*Bufo boreas boreas*) found in Rocky Mountain National Park, Colorado, showed few clinical signs of the disease but many appeared weak or lethargic, exhibited excessive shedding of skin and were reluctant to flee at the approach of humans (U.S. Geological Service 2000). Chytrids are widespread in the environment where they act as decomposers of keratin, chitin, cellulose, and other plant material. Chytrids are also known parasites of fungi, algae, higher plants, protozoa, and invertebrates, but none were known to infect vertebrates until recently. Chytrid fungi reproduce asexually by means of minute, fragile, motile spores, and are probably spread directly from amphibian to amphibian in water. Chytrids probably move from one water source to another on migrating amphibian, or on waterbirds or flying insects (Daszak *et al.* 1999).

Chytrid fungus in amphibians was first identified in 1998 by an international team of scientists from Australia, the United States, and Great Britain. This team discovered that the fungus had most likely been responsible for large amphibian die-offs in pristine areas of Panama and Australia. It also was a factor and probable cause of recent die-offs in remaining populations of the endangered boreal toad (*Bufo boreas boreas*) in the southern Rocky Mountains. Dead and dying Chiricahua leopard frogs (*Rana chiricahuensis*) at study sites in Arizona were diagnosed with a chytrid fungal skin infection (Colorado Herpetological Society 2000). Here, entire populations have been lost or reduced to very low numbers by an outbreak of chytrid fungus. Furthermore, two amphibian species in the Sierra Nevada (i.e., mountain yellow-legged frog (*Rana muscosa)* and the Yosemite toad (*Bufo canoris*)) have been observed to be infected by a chytrid fungus (G. Fellers pers. comm. 1999). A California red-legged frog tadpole was collected with a chytrid fungus infection in Calabasas Pond on the Ellicott Slough National Wildlife Refuge in Santa Cruz County (G. McLaughlin *in litt.* 2000). While it is not yet clear what role the fungus plays in the decline of California red-legged frogs, it is appropriate to take some precautions against spreading fungus between sites (U.S. Geological Survey 2000). The disease is now being studied in detail to understand its origin, incidence, distribution and control methods.

Predation by Introduced Species. Introduced bullfrogs, crayfish, and species of fish have been a significant factor in the decline of the California red-legged frog. All of these species were introduced into California in the late 1800s and early 1900s, and through range expansions and transplants have become established throughout most of the State (Riegel 1959, Bury and Luckenbach 1976, Moyle 1976). Introduced aquatic vertebrates and invertebrates are predators on one or more of the life stages of California red-legged frogs. These include bullfrogs, African clawed frogs (*Xenopus laevis*), red swamp crayfish (*Procambarus clarkii*), signal crayfish (*Pacifastacus leniusculus*), and various species of fishes, especially bass, catfish (*Ictalurus* spp.), sunfish, and mosquitofish (*Gambusia affinis*) (Hayes and Jennings 1986).

Several researchers in central California have noted the decline and eventual disappearance of California red-legged frogs once bullfrogs become established at the same site (Moyle 1976, S. Barry *in litt*. 1992, L. Hunt *in litt.* 1993, Fisher and Schaffer 1996). Changes in habitat that are unfavorable to California red-legged frogs tend to be favorable to a suite of introduced non-native aquatic predators, making it difficult to identify detrimental effects of specific introduced species on California red-legged frogs. Bullfrogs prey on California red-legged frogs (Twedt 1993), and may have a competitive advantage over California red-legged frogs because of their larger size (Figures 10 and 11), generalized food habits (Bury and Whelan 1984), extended breeding season (Storer 1933) that allows for production of two clutches of up to 20,000 eggs during a breeding season (Emlen 1977), and the unpalatability of their larvae to predatory fish (Kruse and Francis 1977). Lawler *et al.* (1999) found that fewer than 5 percent of California red-legged frogs survived in ponds with bullfrog tadpoles, and the presence of bullfrogs delayed frog metamorphosis.

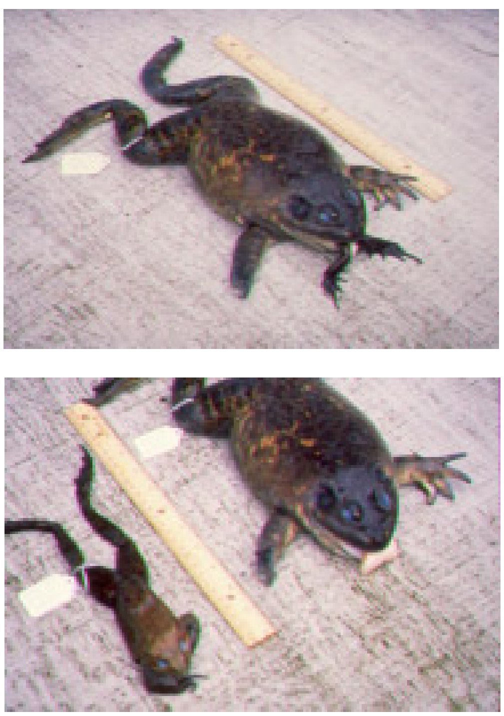
Hayes and Jennings (1986, 1988) found a negative correlation between the abundance of introduced fish species and California red-legged frogs. Jennings (1988b) suspected that native frogs do poorly where introduced fishes are abundant because the placement of native ranid eggs and activities of tadpoles in shallow near-shore habitats may predispose them to predation. However, this may be unlikely given that introduced fish are not typically associated with shallow, near-shore habitat (G. Rathbun, *in litt.* 1999). The interaction between tadpoles and predatory fish may be exacerbated when they are crowded into small pools lacking habitat complexity (Hews 1995). Bradford (1989) also reported a lack of co-occurrence of native frogs and non-native fish in the same habitat areas, which may be due to predation by introduced fish. Many sites, particularly in the Sierra Nevada, are now unsuitable for California red-legged frogs because of the presence of non-native fish. On Vandenberg Air Force Base (Santa Barbara County), the reproductive success of California red-legged frogs in dune ponds with both non-native fish and bullfrogs was nearly eliminated; in ponds with bullfrogs but no fish, reproduction of California red-legged frogs was evident, though low. Reproductive rates were very high in ponds with neither non-native fish nor bullfrogs (S. Christopher *in litt.* 1998).

Mosquito abatement efforts in California include stocking water bodies with mosquitofish. Mosquitofish (*Gambusia affinis*) are native to the eastern United States and have been introduced to wetlands worldwide as biological control agents for mosquito larvae. This practice is a concern to conservationists because introduced mosquitofish can harm amphibians. Mosquitofish are considered opportunistic feeders foraging on over 50 recorded types of plant and animal life, including micro- and macro-invertebrates (Graf 1993).

Several studies have attempted to demonstrate the relationship between mosquitofish and amphibians. Studies have also been conducted in Australia on the effects of a closely related species, *Gambusia holbrooki*, on frog tadpoles (*Crinia glauerti*, *C. insignifera*, and *Heleioporus eyrei*) under

Figure 10. Comparison of California red-legged frog (smaller) and bullfrog
Photo © Galen Rathbun

Figure 11. Predation of a California red-legged frog by a bullfrog (larger frog)
Photos © David Cook



experimental conditions and on frog species richness and abundance in the field. These studies (Blyth 1994, Webb and Joss 1997) showed direct predation on tadpoles, injuries to tadpoles in tanks or ponds with *Gambusia*, and reduced survival and recruitment. Analysis of field data from Australia (Webb and Joss 1997) demonstrated a significant drop in the abundance of frogs when *Gambusia* were present. Results of a study in artificial ponds showed that mosquitofish and bluegill (*Lepomis machrochirus*) were significant predators of California red-legged frog larvae (Schmieder and Nauman 1994). Mosquitofish may also compete with California red-legged frogs by consuming aquatic insects that are potential food sources for postmetamorphic frogs. Lawler *et al.* (1999) observed that mosquitofish did not affect the recruitment of red-legged frogs from natural, spatially complex ponds. However, although mosquitofish did not affect red-legged frog survival, juveniles emerging from ponds with mosquitofish metamorphosed later and weighed an average of one-third less than those raised without fish. Laboratory trials showed that young tadpoles were less active (i.e., exhibited lower foraging levels) in the presence of fish. Lowered activity levels could have caused a decrease in their initial growth rate; injuries are also known to decrease the growth of tadpoles (Lawler *et al.* 1999). As has been noted with other amphibians, smaller metamorphs mature later and lay fewer eggs; California red-legged frogs may be vulnerable to this problem if they cannot grow quickly enough in the terrestrial environment to compensate for their initially smaller size. Thus, sublethal effects of mosquitofish have been demonstrated and may provide reason enough to consider other mosquito-control methods in amphibian habitat and surrounding watersheds. Effects of mosquitofish may be greater than experimentally demonstrated if mosquitofish are more abundant in natural ponds when tadpoles are small. Overall, this evidence that mosquitofish may play a role in the decline of the red-legged frog is inconclusive because it is based on correlations between species distributions, predation trials in arenas where habitat and community structure were simplified, and, in some cases, similar *Gambusia* species rather than *Gambusia affinis,* specifically.

California red-legged frog larvae have been found with mosquitofish in Corral Hollow Creek (Alameda and San Joaquin Counties) (T. Strange pers. comm. 1994) and in some waterbodies in Contra Costa County (K. Swaim *in litt*. 1994, Malamud-Roam *in litt.* 1994). California red-legged frogs may be coexisting successfully with mosquitofish in these cases because winter rains may flush mosquitofish out of creeks, thus eliminating or reducing the physical, sublethal effects noted by Lawler *et al.* (1999) in pond environments.

Overall, while California red-legged frogs are occasionally known to persist in the presence of either bullfrogs or mosquitofish (and other non-native species), the combined effects of both non-native frogs and non-native fish often leads to extirpation of red-legged frogs (Kiesecker and Blaustein 1998, Lawler *et al.* 2000, S. Christopher *in litt.* 1998).

In addition to non-native animals, a number of non-native plants may threaten the integrity of aquatic systems by out-competing and replacing native plants and thus decreasing plant diversity. For example, species such as tamarisk (*Tamarix* sp.), giant reed also called arundo (*Arundo donax)*, and cape ivy (*Delaria odorata*) have made sizeable inroads into native willow-cottonwood-sycamore communities in California. These species not only change the structure and function of a riparian corridor, but also can result in losses of surface water due to their increased transpiration rates (S. Chubb *in litt.* 1998). Biologists have noted that California red-legged frogs may be avoiding creeks and stream pools dominated by eucalyptus (*Eucalyptus* spp.). The aromatic leaves of eucalyptus trees may secrete toxic chemicals into the water, which may decrease the suitability of the area for frogs (Bobzien *in litt.* 1998). Some biologists, however, have also reported high numbers of frogs in areas with poor water quality due to a dominance of eucalyptus (e.g., West of Bayshore property at San Francisco Airport, Pescadero Marsh) (M. Allaback *in litt. 2000*, S. Orlorff *in litt.* 2000). The relationship between the presence of non-native plants and habitat suitability for California red-legged frogs, however, is currently unknown.

Predation by Native Species. Several native predators, including raccoons (*Procyon lotor*), great blue herons (*Ardea herodias*), American bitterns (*Botaurus lentiginosus*), black-crowned night herons (*Nycticorax nycticorax*), red-shouldered hawks (*Buteo lineatus*), and garter snakes (*Thamnophis* spp.) eat adult frogs (Jennings and Hayes 1990, Rathbun and Murphy 1996). Other potential predators include opossums (*Didelphis virginiana*), striped skunks (*Mephitis mephitis*), and spotted skunks (*Spilogale putorius*) (Fitch 1940, Fox 1952, Jennings and Hayes 1990).

It has been noted that the release of translocated predators, which is a common practice of municipal animal control districts, may threaten California red-legged frogs. For example, in Los Padres National Forest, a high number of raccoons and opossums were observed in riparian areas where they were preying upon arroyo southwestern toads (*Bufo microscaphus californicus*) and preventing successful reproduction of pond turtles. The high number of raccoons and opossums were due to county and city districts practice of releasing trapped urban wildlife into the riparian areas of the National Forest (S. Sweet *in litt.* 2000).

Some native fish may also eat tadpoles (N. Scott *in litt.* 1998). Reis (1999) found that tadpoles were more likely to be absent from study plots at Pescadero Marsh (San Mateo County) when predaceous invertebrates were present. These invertebrates include diving beetles (family Dytiscidae), dragonflies (order Odonata), and backswimmers (family Notonectidae).

4. The Inadequacy of Existing Regulatory Mechanisms

Although the California red-legged frog is classified as a species of special concern by the State of California and may not be taken without an approved scientific collecting permit, this designation provides no special, legally mandated protection of the species and its habitat.

The Endangered Species Act is the primary Federal law that provides protection for the California red-legged frog since its listing as a threatened species in 1996. Since this designation, many projects have undergone section 7(a)(2) consultation. Section 7(a)(2) of the Endangered Species Act requires Federal agencies to consult with us prior to authorizing, funding, or carrying out activities that may affect listed species. The section 7(a)(2) consultation process provides protection for California red-legged frogs through reasonable and prudent measures that minimize the amount or extent of incidental take of the species due to project impacts. While projects that are likely to result in adverse effects include such minimization measures, we are limited to requesting minor modifications to the project description, as proposed. Reasonable and prudent measures, along with the terms and conditions that implement them, cannot alter the basic design, location, scope, duration, or timing of the action and may involve only minor changes. The minimization measures typically include: (1) pre-construction surveys, (2) capture of frogs from the construction site and relocation into Service-approved on-site watercourses, and (3) protection, enhancement, and/or creation of habitat. The later recommendation includes protection of California red-legged frog habitat that already exists or creation of new habitat which in most cases has not been proven to be successful (i.e., California red-legged frogs have, for the most part, not colonized or survived in newly created wetlands usually due to the proximity of the created ponds to development). Therefore, there is typically a net loss of California red-legged frog individuals and habitat with each authorized project. Most of these conservation measures have not been thoroughly studied for effectiveness and therefore, may not fully mitigate the effects of the proposed project. Monitoring to determine the effectiveness of these actions is required of permit holders; however, in general neither we nor the permit holders have fully implemented such monitoring.

Section 404 of the Clean Water Act is another Federal law that potentially provides some protection for aquatic habitats of the California red-legged frog, if the habitats are determined to be jurisdictional areas (i.e., waters of the United States) by the U.S. Army Corps of Engineers. Upland habitats adjacent to riparian zones and other wetlands are not provided any protection by section 404 of the Clean Water Act. Upland areas provide important dispersal, estivation and summer habitat for this species.

5. Other Natural, or Manmade Factors Affecting Their Continued Existence

Drought. Populations of most species are cyclic in nature or fluctuate in response to natural factors such as weather events, disease, fire, and predation. Natural events, including long-term drought or extreme rainfall, have a less negative overall effect on a species when the species is widely and continuously distributed. Small, fragmented, or isolated populations of a species are more vulnerable to extirpation by random events. As water demands increase in California due to increasing human populations, the interactions of those demands with natural drought cycles may further reduce the extent and quality of California red-legged frog habitat and the size of remaining populations.

Decreased rain and snowfall can lead to premature drying of streams and ponds and subsequent death of frog eggs and larvae, and reduced survival of subadults and adults. Decreased surface flows in some coastal streams [e.g., Pescadero Creek (San Mateo County), San Simeon Creek (San Luis Obispo County)] during drought years, coupled with agricultural, industrial, and residential ground water demands can result in desiccation or increased salinity of water sufficient to kill most if not all of 1 year's reproduction. Drought conditions have the potential to eliminate a high proportion of the reproductive effort of California red-legged frogs in the coastal region where the largest populations of the species remain (Jennings and Hayes 1989). On the other hand, since California red-legged frogs metamorphose in 1 year and bullfrog larvae require at least 2 years (Jennings 1988), occasional droughts can benefit California red-legged frogs by reducing the numbers of exotic fish and bullfrogs. For example, this benefit has been noted in the lower reaches of Brush Creek (Contra Costa County) which dries roughly every 3 to 5 years (M. Allaback *in litt.* 2000).

Contaminants. Amphibians, in general, typically have complex life cycles and thus more opportunities for exposure to chemicals and more potential routes of exposure than other vertebrates. The California red-legged frog continues to be exposed to a variety of toxins throughout its range. The sensitivity of this species to pesticides, heavy metals, air pollutants, and other contaminants is largely unknown. Studies using other species of amphibians, however, provide toxicity data that are relevant to the potential vulnerability of the California red-legged frog, as cited below.

As mentioned above, agricultural practices typically use pesticides including herbicides. While some amphibian larvae (e.g., anuran tadpoles) are resistant to some cholinesterase inhibitors (the class of pesticides used most often), some results indicate that this resistance does not apply to all amphibian species and chemicals (Sanders 1970, Cook 1981). According to Berrill *et al.* (1993), ranid tadpoles are likely to be killed or paralyzed by some herbicides (e.g., triclopyr) and insecticides (e.g., fenitrothion). Some pesticides mimic estrogen in vertebrates and this has been proposed as a hypothesis for amphibian declines (Jennings 1996). There are approximately 150 pesticides or herbicides used in the same 2.6 square kilometers (1-square mile) surveyed section as known California red-legged frog sites or their habitat (California Department of Pesticide Regulation 1997). The chemicals of greatest concern that are used within the range of the frog are listed and described in Appendix B.

In addition to pesticides and herbicides, mineral fertilizers are used throughout the range of the California red-legged frog on crops, household lawns, and golf courses. In a study by Schneeweiss and Schneeweiss (1997) in Germany, up to 100 percent of amphibians were dead in pitfall traps located on fields that were mineral fertilized. In contrast, no dead or injured amphibians were found during simultaneous monitoring of non-fertilized fields. Marco *et al.* (1999) found increased mortality of northern red-legged frog larvae when exposed to nitrite below the levels allowed for drinking water. Additionally, Marco and Blaustein (1999) found that Cascades frog *(Rana cascadae)* larvae exposed to sublethal concentrations of nitrite exhibited changed morphology (delayed metamorphosis) and changed behavior (shallow water occupancy) that increased their vulnerability to predation.

Mercury mines have contaminated several areas within the range of the frog (e.g., Lake Nacimiento, Cache Creek), and chlorine has been introduced to breeding sites via spills and flushing of pipes used for wastewater and drinking water treatments (e.g., Chorro Creek). Industrial chemicals, such as these, that are released into the environment may damage the immune systems of frogs. For example, one class of chemicals, known as retinoids, causes severe defects in young frogs; exposure to retinoids can also make frogs more susceptible to infectious diseases (Montague *in litt.* 1998). Oil seeps (either due to natural leaks or by accidents at oil extraction facilities) contaminate California red-legged frog habitats. For example, possible damage to red-legged frog tadpoles could occur in Tar Creek, a tributary of Sespe Creek, where an obvious oil sheen was noticed (S. Chubb *in litt.* 1999).

Airborne pollutants are considered to be a likely cause of decline of amphibians in the Central Valley and Sierra Nevada range. For example, basins that face the Central Valley are nearly devoid of mountain yellow-legged frogs and the California red-legged frog is found in only a few locations in the western slope of the Sierra Nevada range. The most drastic declines of amphibians are found in the Sierra Nevada mountains lying east of the San Joaquin Valley; in the San Joaquin Valley agriculture is intense and vast quantities of pesticides are applied. For example, in 1998, 60 percent of all active ingredient pesticides used in the State of California were applied in the San Joaquin Valley (Sparling *et al.* 2001). Particulate matter, ozone, nitrogen oxides, herbicides, pesticides, and other air pollutants are transported from the Central Valley into the Sierra Nevada. Some sources of air pollution are generated within the Sierra Nevada, such as particulate matter generated by smoke from forest fires and nutrient loads and gases produced by urban areas (i.e., use of fertilizers, traffic) (Cahill *et al.* 1996). Further, the pattern of recent frog extinctions in the southern Sierra Nevada appear to correspond with the pattern of highest concentrations of air pollutants from automobile exhaust (Jennings 1996).

Researchers measured the contaminants levels in frog and fish tissue in the Sierra Nevada range to determine the extent of transport and absorption. Results showed that the concentrations and frequency of detections for pesticides in amphibian tissue follow north-south and west-east patterns consistent with intensified agriculture upwind of the areas with the most serious amphibian declines (Sparling *et al.* 2001). Some of the pesticides are reducing cholinesterase activity in tadpoles of the Pacific treefrog. Depressed cholinesterase has been associated with reduced activity, uncoordinated swimming, increased vulnerability to predators, depressed growth rates, and greater mortality in tadpoles (Sparling *et al.* 2001). *Rana* species such as the California red-legged frog may be more at risk from aqueous pesticides than the Pacific treefrog because they are more reliant on aquatic environments and use aquatic habitat in more life stages (i.e., Pacific treefrogs use aquatic habitat only during breeding whereas *Rana* species use aquatic habitat as tadpoles and adults).

G. REGULATORY PROTECTION AND CONSERVATION MEASURES

Since the 1996 listing of the California red-legged frog, several conservation efforts have been undertaken by various Federal, State, and local agencies and private organizations. The following briefly describes some regulatory protection and conservation measures accomplished to date.

Federal Regulatory Protection. Section 9 of the Endangered Species Act of 1973, as amended, prohibits any person subject to the jurisdiction of the United States from taking (i.e., harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting) listed wildlife species. It is also unlawful to attempt such acts, solicit another to commit such acts, or cause such acts to be committed. Regulations implementing the Endangered Species Act (50 Federal Register 17.3) define “harm” to include significant habitat modification or degradation that results in the killing or injury of wildlife, and intentional or negligent “harassment” as acts that significantly impair essential behavioral patterns (i.e., breeding, feeding).

Section 10(a)(1)(A) of the Endangered Species Act and related regulations provide for permits that may be granted to authorize activities otherwise prohibited under section 9, for scientific purposes or to enhance the propagation or survival of a listed species. Section 10(a)(1)(B) of the Endangered Species Act allows permits to be issued for take that is “incidental to, and not the purpose of, carrying out an otherwise lawful activity” if we determine that certain conditions have been met that will minimize the impacts to the listed species. Under this section, an applicant must prepare a habitat conservation plan (HCP) that specifies the impacts of the proposed project and the steps the applicant will take to minimize and mitigate the impacts. There are several habitat conservation plans currently being developed that will include measures to protect the California red-legged frog.

As previously described in section F. Threats and Reasons for Decline, section 7(a)(2) of the Endangered Species Act requires Federal agencies, including us, to ensure that actions they fund, authorize, or carry out do not destroy or adversely modify critical habitat to the extent that the action appreciably diminishes the value of the critical habitat for the survival and recovery of the species. Individuals, organizations, states, local governments, and other non-Federal entities are affected by the designation of critical habitat only if their actions occur on Federal lands, require a Federal permit, license, or other authorization or involve Federal funding.

Since the listing, we have entered into section 7(a)(2) consultations with other Federal agencies on numerous project proposals per the requirements of the Endangered Species Act. Examples include interagency section 7(a)(2) consultations on proposed road construction and maintenance, housing developments and golf courses that involve wetland fill, timber harvest activities, livestock grazing practices, and other activities within the current and historic range of the species.

On March 13, 2001, we finalized the designation of critical habitat for the California red-legged frog (U.S. Fish and Wildlife Service 2001). Critical habitat is defined as specific areas that have been found to be essential to the conservation of the species and which may require special management considerations or protection. The primary constituent elements for California red-legged frogs are aquatic and upland areas where suitable breeding and nonbreeding habitat is interspersed throughout the landscape and is interconnected by unfragmented dispersal habitat. Specifically, to be considered to have the primary constituent elements an area must include two (or more) suitable breeding locations, a permanent water source, associated uplands surrounding these water bodies up to 91 meters (300 feet) from the water's edge, all within 2 kilometers (1.25 miles) of one another and connected by barrier-free dispersal habitat that is at least 91 meters (300 feet) in width. When these elements are all present, all other essential aquatic habitat within 2 kilometers (1.25 miles), and free of dispersal barriers, will be afforded some protection under section 7(a)(2) of the Endangered Species Act.

Federal Conservation Measures. Section 7(a)(1) of the Endangered Species Act requires that Federal agencies use their authorities to further the conservation of listed species. Section 7(a)(1) obligations have caused Federal land management agencies to implement California red-legged frog protection measures that go beyond those required to avoid take. Some of these conservation measures are described below.

Los Padres National Forest has completed a forest-wide Riparian Conservation Strategy that augments and amends the Forest Land and Resource Management Plan (U.S. Forest Service 1988). This management plan (with the added riparian conservation strategy) provides management guidelines for the conservation of riparian habitats and associated species. Conservation actions include: riparian management guidelines, administration of water flow and use, management of non-native species, reintroduction of native species, recreational guidelines, livestock grazing guidelines, mining and prospecting guidelines, road maintenance guidelines, land exchanges, acquisition and sales programs, management of watershed activities, and species and habitat inventories. Pursuant to the Los Padres National Forest Plan Riparian Conservation Strategy and anadromous steelhead recovery efforts, landscape-based watershed analyses of the Sespe, Santa Paula, Ventura, Santa Ynez, and Arroyo Seco watersheds have been conducted. These efforts are likely to benefit the California red-legged frog through more effective and efficient protection measures and coordinated restoration projects. Other beneficial activities which have been conducted on this Forest include non-native species removal (e.g., bullfrogs and green sunfish), streambank stabilization and revegetation, road closures, modifications to permitted water diversions (e.g., Upper Santa Ynez River), restrictions on recreational activities, educational programs, and assessment and monitoring of California red-legged frog abundances and habitat use. In this region, Vandenberg Air Force Base has also been protecting California red-legged frogs and their habitats.

The Cleveland National Forest has completed extensive surveys of historic and potential habitat for California red-legged frogs, but no frogs were located. However, the Forest has management direction, such as livestock grazing guidelines and management practices, to maintain suitability of riparian corridors. The Cleveland National Forest has excluded grazing from most perennial riparian habitats on the forest. Where exclusion is not feasible, the Forest has changed the season of use to winter; presumably cattle graze to a lesser degree in breeding habitats during the winter because forage is available in the uplands during the moist winter season. Further, the Forest is removing non-native species (e.g., arundo, tamarisk, bullfrogs) and redesigning road crossings on Pine, Morena, and Santa Ysabel Creeks (S. Chubb *in litt.* 1998).

The Cleveland, San Bernardino, Angeles, and Los Padres National Forests have completed a Southern California Mountain and Foothills Assessment, which has added standards, guidelines, and conservation measures to protect and recover wetland and upland habitats of importance to California red-legged frogs and associated species (S. Chubb *in litt.* 1998). This program has gone through our section 7 consultation process.

The Sierra National Forest is currently surveying for California red-legged frogs. This Forest is also implementing our recommendations related to timber sales, and is developing a management plan for off-highway vehicles that should minimize impacts to California red-legged frogs. Similarly, the Tahoe National Forest is conducting forest-wide surveys for California red-legged frogs and other amphibians. In addition to following the Forest's general guidelines, which include management and protection of riparian habitats and protection of threatened and endangered species, the Tahoe National Forest has proposed projects to plant riparian vegetation along streams and fences with potential California red-legged frog habitat and to exclude recreational activities.

The Eldorado National Forest, with assistance from the Biological Resources Division of the U.S. Geological Survey, has conducted surveys for California red-legged frogs in streams that have potential habitat. No red-legged frogs have been observed during any of the surveys, and the habitat suitability is poor. Near Eldorado National Forest, the American River Conservancy has taken the lead in facilitating the purchase of 20 hectares (55 acres) of land that encompasses Spivey Pond on the North Fork of Weber Creek, the location of a breeding California red-legged frog population. A memorandum of understanding was signed by the U.S. Bureau of Land Management American River Conservancy, California Department Water Resources, U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, and El Dorado Irrigation District to support a management plan for the property and the frog population (S. Chubb *in litt.* 1999). This management plan is currently being crafted and the U.S. Bureau of Land Management is now the property owner.

The Bureau of Land Management has developed, and is implementing, national standards and guidelines for livestock grazing. The standards and guidelines relate to vegetative ground cover, riparian-wetland function, stream morphology, water quality, and threatened and endangered species recovery. Several of the guidelines should indirectly help maintain California red-legged frog habitat quality. Assessments of whether grazing allotments are meeting these guidelines are expected to be completed within 5 years; allotments not meeting the standards will be subject to additional management. In 1991, the Bureau of Land Management developed a Riparian-Wetland Initiative that established national goals and objectives for managing riparian-wetland resources on public lands. One of the chief goals of this initiative is to restore and maintain riparian-wetland areas so that at least 75 percent or more are in proper functioning condition. Riparian areas that meet the proper functioning condition, or are restored to such condition, may provide the habitat quality necessary for successful colonization and/or reintroduction of California red-legged frogs (E. Lorentzen *in litt.* 1998).

The National Resource Conservation Service has carried out the Elkhorn Slough Watershed Project. This program was established with farmers within the watershed to implement measures to reduce sedimentation and runoff and to restore habitat.

The Golden Gate National Recreation Area (National Park Service) has developed several programs that provide benefits to the California red-legged frog. Several site management plans have been developed that will provide protection for California red-legged frogs. For example, the Milagra Ridge and Wolfback Ridge Management Plans include plans for removal of non-native plant species from riparian corridors, revegetation with native riparian plants, maintenance of water-diversion structures to improve water flow, soil erosion control, and outreach/ environmental education (National Park Service 1995, 1996). Further, the Golden Gate National Recreation Area has initiated a tiered, volunteer-based monitoring program for surveying for frogs during the winter in three watersheds (Tennessee, Lower Redwood/Big Lagoon, and Rodeo Valley). The Golden Gate National Recreation Area has also developed plans to restore several areas within its jurisdiction, such as Mountain Lake in the Presidio in coordination with the City of San Francisco, and Big Lagoon in Marin County. The Golden Gate National Recreation Area is also implementing non-native aquatic animal control programs in Tennessee and Oakwood valleys to protect California red-legged frogs and western pond turtles (Shinomoto and Fong 1997, D. Fong, *in litt.* 1998).

The CALFED Program is a comprehensive, 30-year plan to restore ecosystems and improve water management for beneficial uses of the San Francisco Bay and Sacramento-San Joaquin River Delta. The CALFED Program is managed cooperatively by 14 Federal and State agencies with management responsibilities in the Bay-Delta region. The CALFED Program vision for the California red-legged frog is to maintain populations. The CALFED Program is expected to restore aquatic, wetland, and riparian habitats in the Sacramento-San Joaquin Delta Ecological Management Zone and other ecological management zones which will help in the recovery of the frog by increasing habitat quality, connectivity, and area (CALFED Bay-Delta Program 2000). Specifically, the CALFED Program included in the Multi-Species Conservation Strategy goals to enhance or restore suitable habitats near occupied habitat and to avoid or minimize CALFED actions that could increase or attract non-native predator populations to occupied habitat (CALFED Bay-Delta Program 2000).

Measures Implemented by California State Resource Agencies. The California red-legged frog is classified as a "Species of Special Concern" by the State of California (Steinhart 1990). This designation provides no special, legally mandated protection of the species and its habitat, but does mandate that the species not be taken without an approved scientific collecting permit. In 1972, the California Fish and Game Commission amended its sport fishing regulations to prohibit take or possession of California red-legged frogs (Bury and Stewart 1973). The designation of species of special concern can confer additional protection to species via section 15380 of the California Environmental Quality Act guidelines. This section requires lead agencies under the California Environmental Quality Act to treat species as *de facto* State threatened or endangered if they appear to meet listing requirements. For many unlisted species which are currently species of special concern, this designation can afford additional consideration under California Environmental Quality Act review.

Section 1600 of the California Fish and Game Code authorizes the Department of Fish and Game to enter into agreements with parties seeking to perform activities within the bed, bank, or channel of any stream, lake or river. Section 1603 of the California Fish and Game Code authorizes the Department of Fish and Game to regulate streambed alteration for private entities or individuals. The Department must be notified, and approve any work that substantially diverts, alters, or obstructs the natural flow or substantially changes the bed, channel or banks of any river, stream, or lake. If an existing fish or wildlife resource may be substantially adversely affected by a project, the Department must submit proposals to protect the species within 30 days; this regulatory procedure should provide some protection for California red-legged frog populations and habitat.

In 1996, the California Department of Forestry and Fire Protection requested our assistance in determining protective measures for timber harvest plans and non-industrial timber management plans to avoid take of the California red-legged frog. Through this process, we developed guidelines that can be applied, by California Department of Forestry and Fire Protection inspectors or other forest professionals, to any timber harvest plan or non-industrial timber management plans within the range of the frog. In addition to providing a dichotomous key to assessing potential impacts to the California red-legged frog, the guidelines also recommend avoidance measures, which reduce the likelihood of incidental take of the species (U.S. Fish and Wildlife Service 1996c).

California Department of Forestry and Fire Protection enforces the California Forest Practice Rules (California Department of Forestry and Fire Protection 1999), which provide prescriptive and procedural rules that protect watercourses and lakes, and provide some protection for California red-legged frog against timber harvest and related activities. Conservation measures were developed by the California Department of Forestry and Fire Protection and the California Department of Fish and Game pursuant to the California Endangered Species Act consultation process, for Registered Professional Foresters. These are to be applied in areas immediately adjacent to coho salmon (*Oncorhynchus kisutch*) habitat south of San Francisco Bay. The protection measures for coho salmon will benefit California red-legged frogs occurring in Pescadero, Gazos, San Gregario, and Butano Creeks in San Mateo County; and Aptos, Scott, Soquel, San Vincente, and Waddell Creeks and the San Lorenzo and Pajaro Rivers in Santa Cruz County (B. Valentine *in litt.* 1998).

The California Department of Parks and Recreation has programs that benefit the California red-legged frog. Special park designations (i.e., Natural Preserves and State Reserves), provide increased protection of the land and for resident sensitive species, including the California red-legged frog. Development of general plans, resource management plans, site management plans, and resource inventories are ongoing within the Department and allow planning for special status species. Other planning efforts include developing habitat conservation plans with us. Currently, a regional habitat conservation plan is being developed for San Luis Obispo Coast and Oceano Dunes districts, and another is being developed for Carnegie State Vehicular Recreation Area. Both will benefit the California red-legged frog.

Restoration and enhancement efforts in many State park areas include riparian and wetland habitats. The following are some examples of park wetland restoration projects that benefitted the California red-legged frog. At Pescadero Marsh Natural Preserve, within Pescadero State Beach, the California Department of Parks and Recreation developed and implemented a wetland restoration project to enhance habitat suitability for the California red-legged frog. Restoration actions include enlargement of existing breaches in the levees, and connection of remnant channels, removal of a tide gate, excavation of channels, management of the Nunziatti trout ponds, and a one-season experimental bullfrog control program in Pescadero Marsh (T. Sasaki *in litt.* 1999). Año Nuevo State Reserve has undertaken intensive bullfrog removal efforts in ponds inhabited by California red-legged frogs (I. Loredo *in litt.* 1998). The Santa Cruz District completed a 7 hectare (20 acre) restoration project at Wilder Creek Natural Preserve, converting 3.5 hectares (10 acres) of lowland and streamside agricultural fields to willow and wetlands, allowing Wilder Creek to escape the dredged channel during high water events. California red-legged frogs appeared and reproduced in high numbers shortly after the project began, and the frogs continue to use the area (T. Sasaki *in litt.* 1999). M. Allaback (*in litt.* 2000) observed numerous frogs before the restoration in the early 1990s suggesting that a significant population was already present. The San Simeon District is currently restoring wetlands adjacent to San Simeon Creek, and is in the process of requesting funds to purchase a small, unnamed drainage used by red-legged frogs during periods of high salinity in the lagoon. This district also conducts biannual surveys to monitor California red-legged frogs and bullfrogs, removes non-native plant species, removes predators such as raccoons and feral cats, and monitors water quality (G. Smith pers. comm. 1998).

The California Army National Guard has sponsored California red-legged frog surveys at Camp Roberts (San Luis Obispo and Monterey Counties) and at Camp San Luis Obispo (San Luis Obispo County) (N. Scott *in litt.* 1999). These surveys are used to monitor red-legged frog numbers at known and potential sites, status of habitat, reproduction and occurrence of red-legged frog predators. In 1994, the California Army National Guard fenced a section of riparian habitat along Chorro Creek at Camp San Luis Obispo to eliminate cattle grazing; approximately 4,500 native plants were planted within the exclosure to restore riparian habitat. This exclosure has enhanced habitat for the California red-legged frog. The California Army National Guard also began a bullfrog eradication program and a giant reed and invasive plant removal program in 1999, at known and potential red-legged frog sites at Camp San Luis Obispo. In this area, the National Guard has also repaired roads and trails, eroded areas and reduced sedimentation into creeks, ponds, and reservoirs, and has planted willows; all of these actions have increased habitat suitability by enhancing aquatic and riparian habitats.

Section 6(d) of the Federal Endangered Species Act allows us to provide financial assistance to the State to assist in development of programs for the conservation of endangered and threatened species or to assist in monitoring the status of candidate species. Through this program we, along with the California Department of Fish and Game, have funded several projects that have benefitted the California red-legged frog. For example, surveying and monitoring of the Sierra Nevada foothills have been funded through section 6(d), as were restoration activities at Calabasas Pond (Santa Cruz County).

Municipal Protection Measures. Regional, county, and city park districts and regional water and municipal utility districts have played a role in conserving habitat for the California red-legged frog. Some counties are preparing county-wide habitat conservation plans that will benefit the California red-legged frog (e.g., San Benito County, Contra Costa County). The East Bay Regional Park District encompasses 59 regional parks, recreation and wilderness areas, shorelines, preserves and other land bank areas in Contra Costa and Alameda Counties, covering over 33,000 hectares (91,000 acres). The East Bay Regional Park District has surveyed ponds and streams within its jurisdiction, has restored several ponds and streams, and plans to restore additional areas, to benefit California red-legged frogs. Biologists from the Santa Clara Valley Water District and East Bay Municipal Utility District have surveyed many areas within the districts for California red-legged frogs; the Santa Clara Valley Water District has plans to expand the survey program in upcoming years (D. Padley pers. comm. 1998). The Contra Costa Water District actively manages the Los Vaqueros watershed (Upper Kellogg Creek drainage) for California red-legged frogs by adjusting water levels in ponds, removing predatory fishes, reducing grazing impacts, minimizing human disturbances, planting wetland and riparian vegetation, offering public education programs and developing guidelines for fire management practices to decrease incidental impacts to California red-legged frogs. These activities have contributed to the expansion of the range of the frog within the watershed and have helped to increase breeding success (J. Alvarez *in litt.* 2000).

Protection on Private Lands. Private landowners interested in conservation efforts for riparian habitats have made important contributions to recover the California red-legged frog. Since 1990, our Partners for Fish and Wildlife program has provided cost-share monies and technical assistance to private landowners throughout the state who undertake fish and wildlife habitat restoration projects. To date, the Partners for Fish and Wildlife program has helped fund six projects to improve habitat in creeks that support California red-legged frogs. In 1997, three projects were carried out in Toro Creek in San Luis Obispo County. Restoration activities included stabilization of eroding streambanks and planting of riparian vegetation. In Sonoma County, eroding streambanks were stabilized and riparian vegetation was planted in 1996 and 1997 in Stemple Creek (D. Strait *in litt.* 1998).

In 1995, the livestock industry agreed to become involved in developing a cooperative approach to meet the regulatory requirements in place for nonpoint source pollution associated with rangeland practices by allowing land owners to voluntarily develop and implement California Rangeland Water Quality Management Plans. The plans are limited to non-Federal rangelands, pasture and other grazed lands of California (G. Humiston *in litt.* 1995).

Interagency and Private Cooperative Efforts. Throughout the range of the California red-legged frog there are many cooperative efforts aimed at restoring and preserving wetland ecosystems and maintaining or increasing biodiversity. These groups or projects are typically comprised of some combination of Federal, State, and municipal agencies as well as non-government organizations and private citizens. They demonstrate the commitment that the private sector exhibits regarding conservation as well as the productivity that can result when multiple groups collaborate. One example includes the project named Biodiversity in the Santa Cruz Mountains. This project is involved in an inventory of biodiversity in the Santa Cruz mountains as well as a threats assessment. Cooperators include us, the California Department of Fish and Game, and the Santa Cruz Mountains Bioregional Council. Another example is the Carmel River Watershed Management Plan, which aims to assess conditions in the watershed and recommend a water management plan that will restore the river to a level of productivity while benefitting wildlife species including the California red-legged frog. Cooperators involved in this effort include the California Department of Fish and Game, the U.S. Forest Service, and the Monterey Peninsula Water Management District. The Watsonville Slough's Water Resources Management Plan is being developed to improve water quality in Watsonville Sloughs freshwater marsh system. This effort involves Federal, State, and municipal agencies as well as the University of California, and Watsonville Wetland Watch. The Elkhorn Slough Watershed Project's purpose is to reduce sediment and pesticide delivery to wetlands by working cooperatively with private landowners and tenants to reduce agricultural erosion and runoff. Similarly, the Pajaro River Management Plan is being developed by a large group of collaborators to address flood control and environmental preservation of this river. Many other examples exist as listed by the Information Center for the Environment, which maintains a website that includes the California Watershed Projects Inventory (http://ice.ucdavis.edu).

Surveys and Research. In addition to the efforts of Federal, State, local, and private entities, status surveys for California red-legged frogs and research on the ecology of this species have been conducted by several research groups. The Western Ecological Research Center of the Biological Resources Division (part of the U.S. Geological Survey) has several ongoing research projects. The Piedras Blancas Field Station of the Western Ecological Research Center has a research program in progress that is focused on radio-tracking the movements of adult California red-legged frogs in pastures and forested habitats in both San Luis Obispo and Santa Cruz Counties. Another project, which involves monitoring population dynamics and ecology of California red-legged frogs in coastal streams in San Luis Obispo County, is contributing data on population fluctuations and turnover, movements, and reproductive behavior. This research group is also examining the effects of non-native frogs and fishes on California red-legged frogs on Vandenberg Air Force Base, Santa Barbara County. The Western Ecological Research Center field station at Point Reyes National Seashore is conducting surveys for California red-legged frogs in the Sierra Nevada foothills. In addition, they are investigating the interactions between California red-legged frogs and livestock in pond sites at Point Reyes National Seashore, Marin County, and are tracking frogs to determine habitat use at breeding sites and to monitor dispersal habits in the Olema Valley. Research groups associated with many universities (e.g., University of California at Davis, Sonoma State University, San Jose State University) are investigating the genetics and life history of California red-legged frogs and providing valuable information regarding distribution, systematics, habitat requirements, and life history (Cook 1997).

We have been actively working with multiple conservation partners in southern California on developing a captive rearing and propagation program to augment existing populations of red- legged frogs and re-establish frogs into historic localities. These partners include the Los Angeles Zoological Society, The Nature Conservancy, The Las Virgenes Institute, and Center for Scientific Research and Higher Education in Ensenada, Baja California, Mexico. These efforts have concentrated on two separate programs.

The first program is the augmentation and re-establishment of the red-legged frog at the Santa Rosa Plateau Ecological Reserve in southwestern Riverside County. This effort has concentrated on a cooperative effort with The Los Angeles Zoo, The Nature Conservancy, and the Center for Scientific Research and Higher Education in Ensenada, Baja California, Mexico, to collect frogs from an apparently genetically similar (genetics to be verified) breeding population in Baja California to re-establish a breeding population at the Reserve. Once re-established and stabilized, this population will be used as a source population to re-establish frogs into appropriate habits in southern California.

The second program consists of a cooperative effort between us, the Los Angeles Zoo, and the Las Virgenes Institute to monitor an extant breeding population in the Los Angeles basin and develop a captive rearing, propagation, and release protocol. After monitoring the population for several years to establish the size and breeding success, several metamorphs were brought into captivity to develop a captive rearing protocol and head-start program. This effort was expanded to include tadpoles and will be further expanded to include captive rearing and breeding ponds. Frogs from these ponds will eventually be used to re-establish frogs into historic localities in the norther portion of the Los Angeles basin.

Table 2. Sensitive fish species and wildlife associated with the California red-legged frog.

Taxa (Scientific name)	***Federal Status/State Status***
California freshwater shrimp (*Syncaris pacifica*)	endangered/endangered
Tomales asellid (*Caecidotea tomalensis*)	species of concern/no status
California tiger salamander (*Ambystoma californiense*)	candidate/species of special concern
Distinct Population Segment in Santa Barbara County	endangered/species of special concern
Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*)	endangered/endangered
foothill yellow-legged frog (*Rana boylii)*	species of concern/species of special concern
mountain yellow-legged frog (*Rana muscosa*)	species of concern/species of special concern
arroyo southwestern toad (*Bufo microscaphus californicus)*	endangered/species of special concern
western spadefoot toad (*Scaphiopus hamondii*)	species of concern/species of special concern
Alameda whipsnake (*Masticophis lateralis euryxanthus)*	threatened/threatened
two-striped garter snake (*Thamnophis hammondii*)	species of concern/no status
San Francisco garter snake *(Thamnophis sirtalis tetrataenia*)	endangered/endangered
western pond turtle (*Clemmys marmorata*)	species of concern/species of special concern
tidewater goby (*Eucyclogobius newberryi)*	endangered/species of special concern
unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*)	endangered/endangered
coho salmon (*Oncorhynchus kisutch*)	varies by evolutionarily significant unit
steelhead trout (*Oncorhynchus mykiss*)	varies by evolutionarily significant unit
tricolored blackbird (*Agelaius tricolor*)	species of concern/species of special concern
little willow flycatcher (*Empidonax traillii brewsteri*)	species of concern/endangered
southwestern willow flycatcher (*Empidonax traillii extimus*)	endangered/endangered
saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*)	species of concern/species of special concern
least Bell's vireo (*Vireo bellii pusillus*)	endangered/endangered
marsh sandwort (*Arenaria paludicola*)	endangered/endangered
Gambel's watercress (*Rorippa Gambellii)*	endangered/threatened

The knowledge learned through both of these programs will facilitate the development of standardized protocols for rearing, breeding, and re-establishment efforts for the red-legged frog that can be used throughout the species' range in California and possibly Mexico.

H. ASSOCIATED SPECIES

We are committed to applying an ecosystem approach to conservation to promote efficient and effective conservation of our Nation's biological diversity (U. S. Fish and Wildlife Service 1994b). In recovery plans, it is our policy to incorporate ecosystem considerations by:

1) Developing and implementing recovery plans for communities or ecosystems where multiple listed species and species of concern occur;

2) Developing and implementing recovery plans for threatened and endangered species in a manner that restores, reconstructs, or rehabilitates the structure, distribution, connectivity, and function upon which those listed species depend. In particular, these recovery plans shall be developed and implemented in a manner that conserves the biotic diversity of the ecosystems upon which the listed species depend;

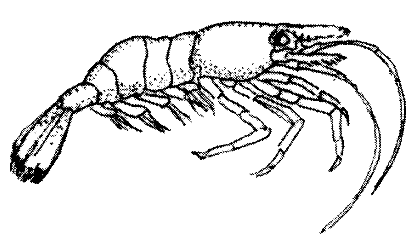
> Recovery plans shall be developed and implemented in a manner that conserves the biotic diversity of the ecosystem upon which the listed species depend.

3) Expanding the scope of recovery plans to address ecosystem conservation by enlisting local jurisdictions, private organizations, and affected individuals in recovery plan development and implementation; and

4) Developing and implementing agreements among multiple agencies that allow for sharing of resources and decision making on recovery actions for wide ranging species.

The current emphasis on multiple species protection and management reflects a recognition of the way organisms interact with each other and their environments. By developing and implementing conservation measures aimed at restoring and protecting the processes that maintain healthy ecosystems, future listings may be prevented. There are several listed, proposed, or candidate fish, wildlife and plant species that occur in, or near, streams and wetlands that either historically supported, or currently support California red-legged frog populations (Table 2). Some of these species are included in existing or developing recovery plans. In these cases, actions taken to recover the California red-legged frog will also contribute to implementation of these recovery plans (e.g., California freshwater shrimp, southwestern willow flycatcher, least Bell's vireo, arroyo southwestern toad). Other species that are not covered by regulatory processes or existing recovery planning efforts (e.g., foothill yellow-legged frog, mountain yellow-legged frog, western pond turtle, California tiger salamander, neotropical migratory songbirds), should also benefit from implementation of the California red-legged frog recovery plan through improvements in wetland habitats where the ranges overlap with California red-legged frogs.

California freshwater shrimp. The California freshwater shrimp (*Syncaris pacifica*) is endemic to perennial streams in Marin, Napa, and Sonoma Counties, California, and is the only existing species in the genus *Syncaris.* The species is adapted to freshwater environments and has not been found in brackish or estuarine environments. The shrimp is found in low elevation (less than 16 meters [52 feet]) and low gradient (less than 1 percent) streams where banks are structurally



diverse with undercut banks, exposed roots, overhanging woody debris, or overhanging vegetation (Eng 1981, Serpa 1986, 1991). The shrimp is threatened by several types of human activities (e.g., urbanization, in-stream gravel mining, overgrazing, agricultural development and activities, impoundments, water diversions, water pollution, and introduced predators). Many of these threats operate synergistically and cumulatively with each other and with natural disturbances such as floods and droughts (U.S. Fish and Wildlife Service 1997a).

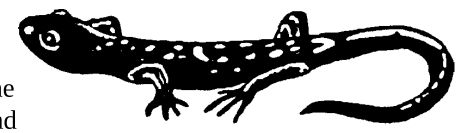
Tomales asellid. The asellid (*Caecidotea tomalensis*), an aquatic sowbug, inhabits moist soils or water bodies with perennial flows although it has been found in seasonal wetlands (Shinomoto and Fong 1997). In general, freshwater isopods, such as the Tomales asellid, are associated with shallow waters less than 1 meter (3 feet) deep, and are found under rocks, vegetation, and debris (Serpa 1991). The Tomales asellid is known from just 11 sites within California, from Mendocino County to San Mateo County (Serpa 1991).

California tiger salamander. The historic distribution of the California tiger salamander (*Ambystoma californiense*) apparently included large portions of the Central Valley of California, from the southern Sacramento Valley north of the Sacramento River delta into the southern San Joaquin Valley. The salamander also was found in the lower foothills along the eastern side of the Central Valley and in the foothills of the Coast Ranges (U.S. Fish and Wildlife Service 1994c).

The salamander occurs in grasslands and open oak woodlands. Necessary habitat components include rodent burrows for underground retreats and breeding ponds, such as artificial stockponds, seasonal wetlands, vernal pools, or slow-moving streams, that do not support fish. Because the salamander may migrate up to a mile (approximately 1.5 kilometers) from its underground retreats to breeding ponds, unobstructed migration corridors are also required (U.S. Fish and Wildlife Service 1994c).

Most of the remaining range of the California tiger salamander is threatened by urban development, conversion of natural habitat and grazing lands to seasonal crops, vineyards, and orchards, introduction of non-native predatory animals, construction of reservoirs, poisoning campaigns to destroy rodents, environmental pollution, and other anthropogenic factors (U.S. Fish and Wildlife Service 1994c, Stebbins and Cohen 1995).

Santa Cruz long-toed salamander. The Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*) spends most of its life underground in small mammal burrows and along the root systems of plants in upland chaparral and woodland areas of coast live oak (*Quercus agrifolia)* or Monterey pine (*Pinus radiata*) as well as in riparian strips of arroyo willows (*Salix lasiolepis*). The breeding ponds are usually shallow, ephemeral, freshwater ponds or quiet, marshy areas of sloughs. Adult Santa Cruz long-toed salamanders leave their upland chaparral and woodland summer retreats with the onset of the rainy season in mid- to late-November or December, and begin their annual nocturnal migration to the breeding pond (Anderson 1960).



Breeding of Santa Cruz long-toed salamanders has been documented at Valencia Lagoon, Ellicott, Seascape, Calabasas, Buena Vista, Green, and Rancho Road ponds in Santa Cruz County and at McClusky, Moro Cojo, and Bennett sloughs, and McClusky vernal pool in Monterey County. However, many of these sites have not been surveyed recently and may no longer support breeding populations. Juvenile Santa Cruz long-toed salamanders have also been found at several other sites in Santa Cruz and Monterey Counties (Natural Diversity Database 2001).

The extremely restricted and disjunct distribution of the Santa Cruz long-toed salamander has made the species particularly susceptible to population declines resulting from both human-associated and natural factors, including habitat loss and degradation, predation by introduced and native organisms, and weather conditions. Highway construction, urban and agricultural development, siltation, off-highway vehicles, non-native fish and vegetation, and saltwater intrusion are some of the perturbations affecting Santa Cruz long-toed salamander habitat.

Foothill yellow-legged frog. Within the range of the California red-legged frog, the foothill yellow-legged frog (*Rana boylii)* occurs along the central coast and in the Sierra Nevada (Leonard *et al*. 1993). The foothill yellow-legged frog is confined to the immediate vicinity of permanent streams, including those that may be reduced to water holes connected by trickles during the dry season. The frogs are most common along streams having rocky, gravelly, or sandy bottoms, but they may occur in those having muddy bottoms (Nussbaum *et al.* 1983). Introduced predators, habitat fragmentation, and disease seem to be important factors in the decline of this species (Jennings 1996).

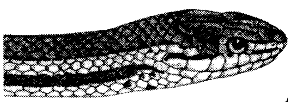
Mountain yellow-legged frog. Before the late 1960s, mountain yellow-legged frogs (*Rana muscosa*) were abundant in southern California stream drainages. The mountain yellow-legged frog originally inhabited riverbanks, meadow streams, isolated pools, and lake borders in the Sierra Nevada above 1,370 meters (4,500 feet) from Butte Creek, Plumas County, south to Taylor Meadow, Tulare County, California and also occurred in streams in the Palomar, San Bernardino, San Gabriel, and San Jacinto mountain ranges in southern California between 400 meters (1,300 feet) and 2,300 meters (7,500 feet) (Jennings and Hayes 1994). The southern California population of mountain yellow-legged frogs has probably been extirpated from more than 99 percent of its historic range (U.S. Fish and Wildlife Service 1997b). This species is threatened by non-native aquatic predators, changes in streamflows, land use practices, loss of habitat, possibly a sensitivity to ultraviolet radiation and urban atmospheric pollution, and various other natural and human caused factors throughout its range (U.S. Fish and Wildlife Service 1997c).

Arroyo southwestern toad. The arroyo southwestern toad (*Bufo microscaphus californicus)* is restricted to rivers that have shallow, sandy to gravelly pools adjacent to sandy terraces. Breeding occurs on small to medium streams and rivers with persistent water from late March until mid-June (Sweet 1989). Historically, arroyo southwestern toads were found in coastal drainages in southern California from San Luis Obispo County to San Diego County and in Baja California, Mexico (US Fish & Wildlife Service 1999). In Orange and San Diego Counties, the species occurred in low gradient stream reaches. Arroyo southwestern toads now survive primarily in the headwaters of coastal streams as small isolated populations. In 1996, they were discovered on Fort Hunter Liggett in Monterey County. Urbanization and dam construction beginning in the early 1900s in southern California caused most of the extensive habitat degradation. Mining, livestock grazing, and recreational activities in riparian areas have also degraded habitat (U.S. Fish and Wildlife Service 1994d). Arroyo southwestern toads historically occurred with California red-legged frogs in the Transverse and Peninsular ranges. They still occur in the same streams on the Los Padres National Forest.

Western spadefoot toad. Spadefoot toads are olive-brown or gray, with dark blotches and little red bumps. Adults have a light-colored, hourglass pattern on their back. In adult males, the smooth skin of the throat is charcoal-gray. The young are nearly the same color as adults, but they do not have the hourglass pattern on their backs. They have a tiny black shovel (spade) on each hind foot.

Spadefoot toads use grasslands and breed in natural vernal pools and man-made stock ponds. Western Spadefoots have now largely disappeared in lowland southern California, although populations remain in other parts of the State. Western spadefoot toads occur in the same areas as California red-legged frogs in several areas including the Corral Hollow watershed (Alameda and San Joaquin Counties), Sunol Regional Wilderness (Alameda County), and Simon Newman Ranch (Santa Clara County).

Alameda whipsnake. The Alameda whipsnake (*Masticophis lateralis euryxanthus)* occurs in northern coastal scrub, chaparral, and adjacent habitats in the inner coast ranges of western and central Contra Costa and Alameda Counties. Five populations of the whipsnake are centered in the (1) Sobrante Ridge, Tilden/Wildcat Regional Parks area to the Briones Hills, in Contra Costa County, (2) Oakland Hills, Anthony Chabot area to Las Trampas Ridge, in Contra Costa County; (3) Hayward Hills, Palomares area to Pleasanton Ridge, in Alameda County; (4) Mount Diablo vicinity and the Black Hills, in Contra Costa County; and (5) Wauhab Ridge, Del Valle area to the Cedar Mountain Ridge, in Alameda County. The Alameda whipsnake and its habitat are threatened by commercial and residential development, fire suppression, overcollecting, competition from alien plants, inappropriate grazing levels, off-road vehicle use, and random chance events by virtue of their small numbers and small, fragmented population sizes (U.S. Fish and Wildlife Service 1996d).



Two-striped garter snake. The two-striped garter snake (*Thamnophis hammondii*) lacks a middorsal stripe, having pale to indistinct lateral stripes on an olive, brown, or brownish-gray background color. Individuals usually have dark spots dorsal to the lateral stripes, but no red on the sides. The species occurs in or near permanent fresh water streams in coastal, transverse, and peninsular ranges from Monterey County, California, to northwestern Baja California. Two-striped garter snakes forage on all life stages of toads and frogs (including California red-legged frogs), fish, fish eggs, and earthworms. The species' range has been greatly reduced by housing and urban development, and by water control projects that reduce summer flows. The introduction of non-native predators such as bullfrogs and crayfish may have had additional impacts.

San Francisco garter snake. The San Francisco garter snake's *(Thamnophis sirtalis tetrataenia*) preferred habitat is densely vegetated ponds that are located near open hillsides or levees. Hillsides and levees are also used by the snake for basking, feeding, and cover (e.g., rodent burrows). Threats to the San Francisco garter snake include loss of habitat from agricultural, commercial, and urban development. The decline of the California red-legged frog (an important prey species of the San Francisco garter snake) and the introduction of bullfrogs into San Francisco garter snake habitat are additional threats (S. Larsen pers. comm. 1998). Currently, this species is found in only a few localities in San Francisco and San Mateo Counties.

Western pond turtle. The western pond turtle (*Clemmys marmorata*) is currently divided into two subspecies: the northwestern pond turtle (*Clemmys marmorata marmorata*), which occurs from the vicinity of the American River in California northward to the lower Columbia River (Oregon-Washington), and the southwestern pond turtle (*Clemmys marmorata pallida*), found in coastal drainages from the vicinity of Monterey, California south to northwestern Baja California, Mexico. There is an intergrade zone south of the American River and north of Monterey (Stebbins 1985).

Western pond turtles are habitat generalists and occur in a wide variety of permanent and intermittent aquatic habitats (Holland 1991). In streams and rivers, turtles generally avoid fast-moving and shallow waters and are concentrated in pools and backwater areas. Turtles are uncommon in heavily shaded areas and prefer openings in the streamside canopy that provide sufficient sunlight for basking.

Threats to the turtles include introduced and native predators, habitat alteration, urbanization, poaching, historic commercial exploitation, water pollution, and disease. Excessive grazing activities in riparian areas adversely impact turtle populations by collapsing undercut banks used as shelter, and by consuming emergent vegetation used as habitat by hatchling and first-year turtles (Holland 1991).

Tidewater goby. Tidewater gobies (*Eucyclogobius newberryi)* inhabit sandy and silty bottoms of lagoons, shallow bays, and estuaries. The tidewater goby ranged from Lake Earl, Del Norte County south to Agua Hedionda Creek, Carlsbad, San Diego County (Irwin and Soltz 1984). They are common in San Luis Obispo and Santa Barbara County streams (Moyle 1976, Swift *et al.* 1989) where California red-legged frogs are also abundant. Threats include coastal development, dredging of coastal waterways, coastal road construction, and upstream diversions (U.S. Fish and Wildlife Service 1994e).

Unarmored threespine stickleback. Unarmored threespine sticklebacks (*Gasterosteus aculeatus williamsoni*) are small fish measuring up to 60 millimeters (2 inches). They inhabit slow moving reaches or quiet water microhabitats of streams and rivers. Favorable habitats usually are shaded by dense and abundant vegetation, but in more open reaches, algal mats may provide refuge for the species. Unarmored threespine sticklebacks reproduce throughout the year with a minimum of breeding activity occurring from October to January. Historically, they were distributed throughout southern California but are now restricted to San Antonio and Cañada Honda Creeks on Vandenberg Air Force Base, in Santa Barbara County, the upper Santa Clara River and its tributaries in Los Angeles and Ventura Counties, Shay Creek in San Bernardino County, and San Felipe Creek in San Diego County. The range overlaps with California red-legged frogs in the central coast, particularly in Santa Barbara County. Competition with non-native fish, interbreeding with other subspecies of sticklebacks, and loss of habitat to urbanization are factors associated with its decline.

Coho salmon. The general biology of coho salmon (*Oncorhynchus kisutch*) is described in detail in McMahon (1983), Hassler (1987), and Sandercock (1991). The coho salmon is

an anadromous species; coho salmon generally return to their natal streams to spawn after spending 2 years in the ocean. The spawning migrations begin after heavy late-fall or winter rains breach the sandbars at the mouth of coastal streams, allowing the fish to move into them. Spawning occurs in small to medium-sized gravel at well-aerated sites, typically near the head of a riffle (Moyle 1976). These streams have summer temperatures seldom exceeding 21 degrees Celsius (70 degrees Fahrenheit). Emergent fry use shallow near-shore areas, whereas optimal habitat conditions for juveniles and sub-adults seem to be deep pools created by rootwads and boulders in heavily shaded stream sections (U.S. Fish and Wildlife Service 1996a). The distribution and habitat of coho juveniles partially overlaps with that of the California red-legged frog.

Because of dramatic declines in population numbers, the National Marine Fisheries Service was petitioned to list this species coast-wide. Several runs were listed along the central California coast and include regions occupied by California red-legged frogs. Causes of coho salmon declines in California include incompatible land-use practices such as logging and urbanization, loss of wild stocks, introduced diseases, over harvesting, and climatic changes.

Steelhead trout. Steelhead trout (*Oncorhynchus mykiss*) are anadromous rainbow trout; adult steelhead typically spawn in gravel riffles in the spring, from February to June. Optimum temperatures for growth range from 13 to 21 degrees Celsius (55 to 70 degrees Fahrenheit) (Moyle 1976). Steelhead fry reside in near-shore areas. Steelhead juveniles tend to use riffles and pool margins, potentially overlapping with California red-legged frog tadpoles.

The National Marine Fisheries Service was petitioned to list this species coast-wide. Steelhead trout is federally listed as threatened, along the northern, central, and south-central California coast, and listed as endangered in southern California and the Central Valley.

Tricolored blackbird. Tricolored blackbirds (*Agelaius tricolor*) are colonial passerines that require several habitat components for suitable breeding colony sites. These include open accessible water, a protected nesting substrate, and suitable foraging space within a few kilometers (approximately 2 miles) of the nesting colony (Beedy and Hamilton 1997). Most breeding colonies are in freshwater marshes dominated by tules (*Scirpus* sp.) and cattails, some use willows (*Salix* spp.), blackberries (*Rubus* sp.), thistles (*Cirsium* and *Centaurea* spp.), or nettles (*Urtica* sp.) (Neff 1937). Results from a statewide 1997 survey for tricolored blackbirds, coordinated by the California Department of Fish and Game, indicate that the population numbers of tricolored blackbirds declined by about 37 percent compared to results of a 1994 survey. The greatest declines occurred in Sacramento, Fresno, Kern, and Merced Counties (Beedy and Hamilton 1997). Threats to the tricolored blackbird include nest failure due to predation, habitat loss and alteration, contaminants, and pollution. The current ranges of the tricolored blackbird and the California red-legged frog overlap in Alameda, Santa Clara, Monterey, San Luis Obispo, and Merced Counties.

Little willow flycatcher. This subspecies *(Empidonax traillii brewsteri)* is distinguished from the southwestern willow flycatcher (*Empidonax traillii extimus)* primarily by subtle differences in color, morphology and song (Unitt 1987). The breeding range of the little willow flycatcher extends from central/coastal California north through western Oregon and Washington to Vancouver Island, Canada. The range of the little willow flycatcher overlaps with portions of the current and historic range of the California red-legged frog (i.e., Coast range and Sierra Nevada foothills). The little willow flycatcher uses similar habitat components of the riparian corridor as the southwestern willow flycatcher and is threatened by similar factors including brood parasitism, grazing, and loss of riparian habitat.

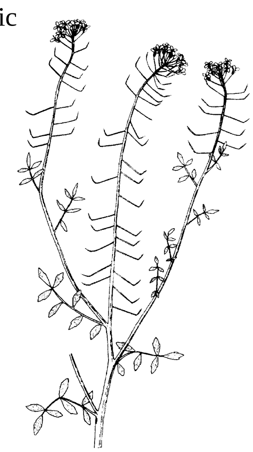
Southwestern willow flycatcher. The southwestern willow flycatcher (*Empidonax traillii extimus*) is a small bird, with a grayish-green back and wings, whitish throat, light grey-olive breast, and pale yellowish belly. The range includes southern California, Arizona, New Mexico, and portions of Nevada, Utah, and western Texas (Unitt 1987, Tibbitts *et al.* 1994). It occurs in riparian habitats along rivers, streams or other wetlands, where dense growth of willows, tamarisk, or other riparian plants are present, often with a scattered overstory of cottonwood (*Populus* spp.). The southwestern willow flycatcher has experienced extensive loss and modification of habitat (in both breeding habitat in North America and wintering habitat in Mexico and Central America) and is also endangered by brood parasitism by the brown-headed cowbird (*Molothrus ater*). Several populations occur within the current and historic range of the California red-legged frog including populations located on the Santa Margarita, Santa Ynez, Santa Ana, San Luis Rey, and Kern Rivers (U.S. Fish and Wildlife Service 1995).

Saltmarsh common yellowthroat. The saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*) is a small marsh dwelling warbler of the subfamily Parulinae. It is also referred to as the San Francisco common yellowthroat. Saltmarsh yellowthroats nest in a variety of habitats. In a study conducted by the San Francisco Bird Observatory (Hobson *et al*. 1986), yellowthroat nesting territories were observed in five habitat types including brackish marsh, salt marsh, riparian woodland or swamp, freshwater marsh, and upland/or grassland. Yellowthroats frequently use borders between various plant communities and territories often straddle the interface of riparian corridors and ecotones between freshwater or tidal marsh and the upland vegetation of weedy fields or grassland (Hobson *et al.* 1986). Extensive changes have occurred in San Francisco Bay since the turn of the century that have resulted in reductions in the extent and suitability of habitat for the yellowthroat. The remaining habitat is under threat from a number of sources which range from land development to flood control actions. Surveys conducted in 1977, 1985 (Hobson *et al.* 1986), and 1996 (Nur *et al.* 1997) for the saltmarsh common yellowthroat, indicate that the species is present in the following counties: Sonoma, Napa, Solano, Marin, San Francisco, Contra Costa, Alameda, San Mateo, and Santa Clara. Saltmarsh common yellowthroat occurrences overlap with the California red-legged frog in riparian and freshwater marsh habitats.

Least Bell's vireo. The least Bell's vireo (*Vireo bellii pusillus*) is a small gray, migratory passerine. It was once widespread and abundant as a nesting species throughout the Central Valley and other low-elevation riverine valleys. Its historic range extended from interior northern California (near Red Bluff, Tehama County) to northwestern Baja California, Mexico. It is assumed to be extirpated from the Sacramento and San Joaquin valleys, and its breeding range seems to be restricted to Inyo, Santa Barbara, Ventura, Los Angeles, San Bernardino, San Diego, and Riverside Counties (Goldwasser 1978). Recent evidence of breeding has been documented in San Benito and Monterey Counties (L. Hays pers. comm. 1998) and Santa Clara County (D. Padley pers. comm. 1998). The vireo's range overlaps with the California red-legged frog in Santa Barbara County (e.g., Santa Ynez River), Ventura County (e.g., Santa Clara River near Lake Piru), and San Benito, Monterey, and Santa Clara Counties. The vireo primarily inhabits dense, willow-dominated riparian habitats with lush understory vegetation. It is threatened by loss of habitat, grazing of riparian corridors, and brood parasitism by the brown-headed cowbird (U.S. Fish and Wildlife Service 1998).

Marsh sandwort. The marsh sandwort (*Arenaria paludicola*) is a herbaceous green perennial often supported by surrounding vegetation, with angled or grooved stems. The species blooms from May to August. Flowers are small, white, and borne singly on long stalks. Only two of California's seven historical populations of marsh sandwort are know to exist today, near the southern San Luis Obispo County coast at Black Lake Canyon on the Nipomo Mesa and at Oso Flaco Lake further south. Recently, another occurrence of the Arenaria paludicola was found in MacKerricher State Park, Mendocino County. Marsh sandwort is found in freshwater marshes. Immediate threats to its survival include habitat degradation or destruction and competition with exotic species for light, water, nutrients, and space. Other threats to the survival of the species may be related to biological and genetic factors and the occurrence of sudden disastrous events.

Gambel's watercress. The Gambel's watercress (*Rorippa gambellii*) is a member of the mustard family (Brassicaceae) and is an herbaceous perennial that produces dense white flowers from April to June. This plant is found in freshwater or brackish marsh habitats at the margins of lakes or along slow-flowing streams. Three known populations occur in San Luis Obispo County at Black Lake Canyon, Oso Flaco Lake, and lands owned by the California Department of Parks and Recreation (Pismo Beach State Vehicle Recreation Area). This species faces threats from alteration of hydrology, competition with encroaching eucalyptus trees (*Eucalyptus globulus*), urban development, and stochastic extinction due to the small number of individuals and populations that remain.



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II. Recovery

A. RECOVERY OBJECTIVES AND STRATEGIES

The objective of this recovery plan is to delist the California red-legged frog. Eight recovery units have been established for the California red-legged frog. Because of the varied status of this subspecies and differing levels of threats throughout its range (Table 3), recovery strategies differ per recovery unit to best meet the goal of delisting the species. For example, in areas where California red-legged frog populations appear to be stable, recovery strategies will be to protect existing population numbers, whereas in areas where frogs have been extirpated or are declining, strategies will be to stabilize, increase, augment, or reestablish populations. Differences within recovery units are also evident. Thus, recovery actions such as implementing land use guidelines are not expected to be applied across-the-board within each recovery unit or throughout the range of the frog; recovery implementation will be focused within suitable habitat in each recovery unit. Recovery unit boundaries and a detailed description of recovery units follows in section C of this Recovery section (Figure 11).

Overall, the strategy for recovery of the California red-legged frog will involve: 1) protecting existing populations by reducing threats; 2) restoring and creating habitat that will be protected and managed in perpetuity; 3) surveying and monitoring populations and conducting research on the biology of and threats to the subspecies; and 4) reestablishing populations of the subspecies within its historic range.

Protection of existing populations will occur through preservation (e.g., fee title acquisition, conservation easements, conservation agreements) and management of occupied drainages and cor areas. Reduction of threats will focus on reversing the apparent loss and

Table 3. Threats to California red-legged frogs and their recovery status per recovery unit.

Recovery Unit	*Threats*	*Recovery Status*
1. Sierra Nevada Foothills and Central Valley	Ag, Li, Mi, Nn, Re, Ti, Ur,Wa	Low
2. North Coast Range Foothills and Western Sacramento River Valley	Ag, Li, Nn, Ti, Ur	Low
3. North Coast and North San Francisco Bay	Li, Nn, Ur, Wa	High
4. South and East San Francisco Bay	Li, Nn, Ur, Wa,	High
5. Central Coast	Ag, Li, Mi, Nn, Re, Ti, Ur, Wa	High
6. Diablo Range and Salinas Valley	Ag, Li, Mi, Nn, Re, Ur, Wa	Med
7. Northern Transverse Range and Tehachapi Mountains	Ag, Mi, Nn, Re, Wa,	High
8. Southern Transverse and Peninsular Ranges	Ag, Li, Mi, Nn, Re, Ur,Wa	Low

Threats: Ag=Agriculture, Nn=Non-native species, Li=Livestock (cattle grazing and/or dairies), Mining=Mi, Re=Recreation, Ti=Timber, Ur=Urbanization, Wa=Water Management/Diversions/Reservoirs

Recovery Status:
Low: Few existing populations, high levels of threats and, in general, medium habitat suitability
Med: Numerous existing populations, some areas of medium habitat suitability, high levels of threats
High: Many existing populations, many areas of high habitat suitability, low to high levels of threats

degradation of habitat by improving the quality and connectivity of aquatic and upland habitats within core watersheds. Efforts are needed to decrease the impacts of urbanization and the conditions that allow the proliferation of non-native aquatic predators. In addition, research is necessary to develop solutions to the pollution which may be detrimental to all life stages of the California red-legged frog.

Habitat needed by the California red-legged frog for reproduction, development, and survival is dependent on the dynamic nature of aquatic systems (riparian, sag ponds, springs, lagoons, marshes, vernal pools, etc.). Therefore, recovery will be achieved when breeding habitats are created and maintained naturally by fluctuating hydrological, geological, and ecological processes. In regulated bodies of water where natural processes are interrupted, water management regimes and land use practices appropriate to maintain habitat suitability must be demonstrated over the long term, prior to delisting. Habitat protection and restoration will be achieved by controlling non-native predators, managing flows in ways that are beneficial for frogs, controlling erosion and sedimentation, replanting wetland vegetation, and increasing connectivity of habitat between known breeding areas. One component of the recovery strategy will be to encourage private landowners and public land managers that have existing man-made ponds (e.g., stock ponds) to modify pond structure and management such that they best provide breeding habitat for frogs. While the focus of recovery is on natural, dynamic aquatic systems and healthy uplands, in some recovery units (e.g., south and east San Francisco Bay, Diablo Range), the importance of artificial pond management is expected to be high. These artificial ponds may prove to be critical in years where conditions in natural aquatic systems are unsuitable by providing alternative habitat for dispersing juveniles and adults. In both natural and artificial habitats, protection via conservation easements, acquisition, or other mechanisms is expected to provide long-term benefits to the species.

Upon completion of the tasks aimed at removing threats and increasing habitat protection, recovery is expected to occur through natural recolonization and population expansion. This may be highly unlikely, however, in portions of the historic range where frogs are absent or nearly absent. In these areas, determining the reasons for local or regional extirpation will be necessary followed by implementation of the appropriate recovery tasks to increase suitability and reduce threats. Upon achieving the necessary habitat conditions, pilot re-establishment programs may help to increase the current range and recover the red-legged frog. Re-establishment is not expected to be implemented in recovery units where California red-legged frog populations are numerous unless large distances occur between populations and natural dispersal/ expansion is unlikely to occur. In largely unoccupied areas where isolated, unstable populations exist, population augmentation (i.e. adding individuals to the population) may be appropriate.

B. RECOVERY CRITERIA

Delisting of this species will be considered when:

1) Suitable habitats within all core areas (described in section D below) are protected and/or managed for the California red-legged frog in perpetuity, and the ecological integrity (e.g., water quality, uplands condition, hydrology) of these areas is not threatened by adverse anthropogenic habitat modification (including indirect effects of upstream/ downstream land uses);

2) Existing populations, throughout the range, are stable (i.e., reproductive rates allow for long term viability without human intervention). Because population numbers do not necessarily indicate stability (i.e., a population may have large numbers of individuals one year then decline precipitously as documented at the Santa Rosa Plateau locality), long term evidence of successful reproduction (e.g., presence of juveniles) and survivorship into different age

classes provides a better indication of stability, persistence, and population resilience. Therefore, population status will be documented through establishment and implementation of a scientifically acceptable population monitoring program for at least a 15-year period (four to five generations) that includes an average precipitation cycle (a period when annual rainfall includes average to 35 percent above-average through greater than 35 percent below-average and back to average or greater; the direction of change is unimportant in this criterion).

3) Populations are geographically distributed in a manner that allows for the continued existence of viable metapopulations despite fluctuations in the status of individual subpopulations (i.e., when populations are stable at each core area);

4) The subspecies is successfully reestablished in portions of its historic range such that at least one reestablished population is stable/increasing in each core area where frogs are currently absent; and

5) The amount of additional habitat needed for population connectivity, recolonization, and dispersal has been determined, protected, and managed for the California red-legged frog. There will be varying scales of connectivity needed including at the level of a local population (i.e., connectivity of habitat within a drainage) up to the needs of a metapopulation (many linked drainages over large regions such as recovery units). This will provide dispersal opportunities for population viability, genetic exchange, and recolonization.

Criteria for delisting will be revised and quantified as additional information is provided by research projects and monitoring programs. If it is determined through research that distinct vertebrate population segments exist, delisting may be considered independently for each distinct vertebrate population (see section C below). If recovery criteria are met, rangewide delisting of the California red-legged frog could occur by 2025.

The five listing criteria under section 4(a)(1) describe the reasons for decline and threats that led to the listing of the California red-legged frog. These are described, in detail, in Section F, Reasons for Decline and Threats to Survival in Section I, Introduction. The above recovery criteria relate to these listing factors in that they will reverse the negative effects of these threats and result in recovery of this species. Each recovery criterion (delisting criterion) can be met via implementation of the recommended recovery tasks as described in the Outline of Recovery Actions in Section III (see Table 4). Land use guidelines are provided in the Outline of Recovery Actions that should be used when developing watershed management and protection plans that are required of Tasks 1.0, 2.0, and 3.0; these guidelines will also be useful in implementing many other tasks. General recovery goals that address metapopulation viability, dispersal, and reestablishment within the historic range will provide the California red-legged frog with the stability needed to survive fluctuating environmental conditions and thus reduce susceptibility to manmade and natural effects (e.g., drought, invasions of predators).

C. RECOVERY UNITS

Initial Recovery Units. In the May 23, 1996, Final Rule listing the California red-legged frog as federally threatened, the following recovery units were established:

1. The western foothills and Sierra Nevada foothills to approximately 1,500 meters (5,000 feet) in elevation in the Central Valley hydrographic basin.

2. The Central Coast ranges from San Mateo and Santa Clara Counties south to Ventura and Los Angeles Counties.

3. The San Francisco Bay/Suisun Bay hydrologic basin.

4. Southern California, south of the Tehachapi Mountains.

5. The northern coast range in Marin and Sonoma Counties.

Based on conservation needs, ecology, and distribution, the recovery units as described in the final rule (U.S. Fish and Wildlife Service 1996a) were revised, to facilitate recovery of the California red-legged frog (Figure 11). The eight recovery units are essential to the recovery of this subspecies; throughout implementation of this recovery plan and in other planning efforts (e.g., section 7 consultations pursuant to the Endangered Species Act), the status of the frog will be considered within the smaller scale of recovery units as opposed to the statewide range, and therefore, will benefit from a region-specific approach to conservation. As the recovery units reflect areas with similar conservation needs and population statuses, appropriate means of implementation and monitoring of the recovery plan will be facilitated. Individual recovery units of the California red-legged frog may be considered for delisting if research shows that they may be regarded as distinct vertebrate population segments. Distinct population segments are

Table 4. Recovery Goals and Tasks Aimed at Reducing or Eliminating Threats

Listing Criterion and Threats	*Recovery Criterion (Delisting Criterion)*	*Tasks Within Recovery Plan that Address Threat Reduction or Elimination*
1. Present or threatened destruction, modification, or curtailment of habitat or range		
Curtailment of Range	4	10.1, 10.2, 10.2.1, 10.3.2, 10.3.3
Urbanization	1	1.0, 2.0, 3.0, 4.0, 5.0, 6.1
Agriculture	1	1.0, 2.0, 4.0, 11.7
Water Management	1	1.0, 2.0, 3.0, 4.0, 7.0
Flood Control	1	1.0, 2.0, 3.0, 4.0, 5.0
Mining	1	1.0, 7.0
Grazing	1	1.0, 11.13, 11.13.2
Recreation	1	1.0, 4.0
Timber	1	1.0
2. Overutilization for commercial, recreational, scientific, or education purposes		
Exploitation	2	12.1
Scientific Take	2	9.1, 9.2, 11.1
3. Disease and Predation		
Disease	3	9.1, 9.2
Predation by Introduced Species	1,3	1.0, 11.8, 11.9, 11.15
Predation by Native Species	1,3	1.0, 1.3
4. Inadaquacy of existing regulatory mechanisms		
Section 7(a)(2) of ESA	1,3,5	6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9
5. Other natural or manmade factors		
Drought	3,4	4.0, 11.3.2, 11.3.3, 11.5, 11.6
Contaminants	1	1.0, 4.0, 5.0, 7.0, 8.0, 11.7

defined by us for the purposes of listing, delisting and reclassification of vertebrate fish or wildlife taxa. To be determined a distinct population segment, the portion of the taxon under consideration must be 'discrete' and 'significant' in relation to the remainder of the taxon. A portion of a taxon may be considered discrete if it is separated from other portions of the taxon by geographic, genetic, physiological, behavioral, or ecological factors. The portion of the taxon is considered 'significant' if it occupies a setting that is unusual or unique for the taxon, if its loss would result in an appreciable gap in the range of the taxon, or if it is substantially different genetically from the rest of the taxon. If a population segment is both discrete and significant, then it qualifies as a distinct population segment, and it may be considered independently for listing or delisting (U.S. Fish and Wildlife Service 1996e). The eight recovery units identified in this plan are delineated by watershed boundaries as defined by U.S. Geological Survey hydrologic units and the limits of the range of the California red-legged frog (i.e., 1,500-meter [5,000-foot] elevation). The following lists the U.S. Geological Survey hydrologic units included in each recovery unit.

Revised Recovery Units.

1. ***Sierra Nevada Foothills and Central Valley.*** The eastern boundary is the 1,500-meter (5,000-foot) elevation. Watersheds include: Sacramento Headwaters, McCloud, Lower Pit, Sacramento-Lower Cow-Lower Clear, Upper Cow-Battle, Mill-Big Chico, Upper Butte, North Fork Feather, East Branch North Fork Feather, Middle Fork Feather, Honcut Headwaters, Upper Yuba, Upper Bear, Upper Coon-Upper Auburn, North Fork American, South Fork American, Lower Butte, Lower Feather, Lower Yuba, Lower Bear, Lower American, Upper Kern, South Fork Kern, Upper Poso, Upper Deer-Upper White, Upper Tule, Upper Kaweah, Mill, Upper Dry, Upper King, Tulare-Buena Vista Lakes, Middle San Joaquin-Lower Chowchilla, Middle San Joaquin-Lower Merced-Lower Stanislaus, Upper San Joaquin, Upper Chowchilla-Upper Fresno, Upper Merced, Upper Tuolumne, Upper Stanislaus, Upper Calaveras, Lower Cosumnes-Lower Mokelumne, Lower Calaveras-Mormon Slough, Upper Mokelumne, and Upper Cosumnes.

2. ***North Coast Range Foothills and Western Sacramento River Valley.*** Watersheds include: Lower Cottonwood, Sacramento-Lower Thomes, Lower Sacramento, Lower Cache, Sacramento-Upper Clear, Cottonwood Headwaters, Upper Elder-Upper Thomes, Upper Stony, Sacramento-Stone Corral, Upper Cache, and Upper Putah.

3. ***North Coast and North San Francisco Bay***. Watersheds include: Tomales-Drakes Bays, San Pablo Bay (partial), and Suisun Bay (partial).

4. ***South and East San Francisco Bay.*** Watersheds include: Suisun Bay (partial), San Pablo Bay (partial), San Francisco Coastal South (partial), San Francisco Bay, Coyote, and San Joaquin Delta.

5. ***Central Coast.*** Watersheds include: San Francisco Coastal South (partial), San Lorenzo-Soquel, Central Coastal, and Carmel.

6. ***Diablo Range and Salinas Valley.*** Watersheds include: Panoche-San Luis Reservoir, Pajaro, Upper Gatos, Estrella, Tulare-Buena Vista Lakes (partial), Carrizo Plain, Alisal-Elkhorn Sloughs, and Salinas.

7. ***Northern Transverse Ranges and Tehachapi Mountains.*** Watersheds include: Middle Kern-Upper Tehachapi-Grapevine, Santa Maria, Santa Ynez, Cuyama, San Antonio, Santa Barbara, Ventura, Santa Clara, and Antelope-Fremont Valleys (partial).

8. ***Southern Transverse and Peninsular Ranges.*** Watersheds include: Calleguas, Santa Monica Bay, Los Angeles, San Gabriel, Antelope-Fremont Valleys (partial), Santa Ana, San Jacinto, Seal Beach, Newport Bay, Aliso-San Onofre, Santa Margarita, San Luis Rey, San Diego, Cottonwood-Tijuana, Whitewater River, San Felipe Creek, and Salton Sea (partial).

D. CORE AREAS AND PRIORITY WATERSHEDS FOR FOCUSED RECOVERY EFFORTS

Core Areas:
While a goal of the recovery plan is to protect the long-term viability of all existing populations within each recovery unit, several areas have been identified as core areas where recovery actions will be focused (Figure 12 and Appendix C). The core areas, which are distributed throughout portions of the historic and current range, represent a system of areas that, when protected and managed for California red-legged frogs, will allow for long-term viability of existing populations and reestablishment of populations within the historic range. The core areas were chosen for focused recovery either because they represent viable populations (possibly even source populations for larger metapopulations), or because the locations will contribute to the connectivity of habitat and thus increase dispersal opportunities between populations. Preservation and enhancement of each core area is important to maintain and expand the distribution of California red-legged frog populations rangewide. Core areas will require long-term protection and management so that existing and reestablished populations remain viable. Recovery and delisting will be facilitated by meeting recovery criteria in all core areas.

In many recovery units, core areas represent areas of high California red-legged frog densities (e.g., Pescadero Marsh); some core areas, however, do not currently support the California red-legged frog (e.g., most Sierra Nevada and southern California watersheds). Core areas located in the historic range represent areas where restoration of habitat is most feasible, where pilot reestablishment efforts are most likely to be successful, and where natural recolonization is expected. Inclusion of the core areas in the historic range will prevent further range collapse (i.e., prevent the California red-legged frog from becoming merely a distinct vertebrate population segment along the coast from Point Reyes south to Santa Barbara County). The core areas in the historic range also represent important elements of the historic ecosystems used by the California red-legged frog (i.e., inclusion of non-coastal ecosystems). These unoccupied areas will require varying degrees of rehabilitation with the expectation of future recolonization or reestablishment efforts when habitat suitability has been restored.

While core areas are mapped in Figure 12, the entire area described as a core area may not represent suitable California red-legged frog habitat. Habitats within core areas should be assessed for suitability. This is especially important in areas between the elevations of 1,050 and 1,500 meters (3,500 and 5,000 feet). At these elevations, known localities are rare and suitable habitat appears to be less abundant. In addition to elevational constraints, many portions of the mapped core areas are agricultural lands and urban developments which, in most cases, will be considered unsuitable and excluded from the recovery efforts. Recovery goals should be implemented only where suitable or potentially suitable habitat is present.

Results of monitoring and habitat management will reveal, in time, whether core areas will provide suitable habitat. If selected drainages are unlikely to support frogs, alternative core areas will be identified. In recovery units where the status of the California red-legged frog is largely unknown (e.g., Sierra Nevada foothills, North Coast Range), additional or replacement core areas may be identified to best protect existing populations and focus recovery efforts after survey results are obtained. This will provide flexibility in implementing the recovery plan by adjusting the locations and numbers of core areas if they are not providing suitable habitat after restoration attempts.

Because core areas typically include entire watersheds and thus include both public and private lands, cooperative agreements among public land managers, local planning departments, resource conservation districts, and private landowners will be relied upon to ensure that these areas are managed to support the California red-legged frog.

Core areas include many watersheds within

Figure 12. California red-legged frog core area distribution.

the boundaries. They were mapped by selecting the appropriate Hydrologic Sub-Areas per the California Watershed Map (CALWATER version 2.2).

Core areas were selected based on several criteria as described below. Table 5 lists which selection criteria applies to each core area and demonstrates the importance of each core area to recovery of the California red-legged frog.

The delineation of core areas, however, will not limit the scope of recovery plan implementation. Areas of suitable or potentially suitable habitat outside designated core areas (particularly priority 2 and 3 watersheds) are also expected to be examined for possible recovery plan implementation and managed according to appropriate land-use guidelines.

Priority 2 Watersheds:
Many watersheds that are not listed as core areas currently support the California red-legged frog. These watersheds are in need of conservation and appropriate management (conservation needs vary per watershed) and are considered priority 2 watersheds. The number of priority 2 watersheds will most likely change according to the status of the frog; as more localities are identified, these should be included as priority 2 watersheds and managed according to the appropriate recovery strategies for this species. Protection of priority 2 watersheds will provide the necessary habitat connectivity between core areas and is an important contribution to the recovery of the California red-legged frog throughout its range.

Priority 3 Watersheds:
Priority 3 watersheds are areas that historically harbored California red-legged frogs. These areas will need (in most cases) extensive rehabilitation prior to recolonization or reestablishment. These are considered as priority 3 because in these watersheds, the likelihood of successful recovery is less than in core areas and priority 2 watersheds. However, with intensive efforts and public support, conservation of habitat in these watersheds is possible and may contribute to

Selection Criteria for Core Areas

Occupied. Some core areas were selected because they had one or more occupied drainages. Drainages are considered currently occupied if there are frog sightings from 1985 or later. Historic and current distribution information for watersheds that are included in core areas can be found in Section C. Historic and Current Distribution and by referring to the Natural Diversity Database which is maintained by the California Department of Fish and Game (Natural Diversity Database 2001). Extant populations found on the periphery of the current range were included as core areas.

Historically occupied. Many watersheds are currently unoccupied but appear to be important to recovery due to the numerous historic records that exist for these areas. Restoring habitat in historically occupied watersheds and possibly reestablishing California red-legged frogs in the appropriate, restored areas is important to recovery as this will restore the distribution of the species to the historic range and reverse the observed range collapse and concentration of populations along the Pacific coast.

Source populations. Based on discussions with California red-legged frog experts and analyses of survey data, watersheds were chosen as core areas if data suggested that the watershed harbored a source population which provide colonizers to nearby areas, showed reproductive success over an extended period of time (i.e., frogs and young present since 1985 or longer) and appeared to be stable in population size or growing.

Potential for Reestablishment. As mentioned before, some core areas are unoccupied but appear to be restorable and/or represent important segments of the historic range. Some unoccupied watersheds that are listed as core areas represent areas in which reestablishment efforts are considered most likely to succeed.

Connectivity. Some core areas, whether occupied or unoccupied, provide the necessary connectivity between known populations. Connectivity is important in maintaining viable metapopulations throughout the range of the species.

Other. As noted above, some core areas were chosen despite being currently unoccupied. In some of these cases, particular watersheds appear to be highly restorable. For example, some watersheds have been listed as having high ecological integrity and are classified as an Aquatic Diversity Management Area by Moyle *et al.* (1996). Aquatic Diversity Management Areas represent watersheds that have, among other characteristics, high values for aquatic biodiversity, are dominated by native aquatic species, and have terrestrial and riparian ecosystems that are in fairly good condition. Extant and extirpated areas were included if they represent the historic distribution of the species.

Table 5. Selection criteria for core areas and importance of core areas for recovery.

Core Area	Selection Criteria					
	Currently Occupied (post-1985)	Historically Occupied	Source Population	Potential for Reestablishment or Augmentation	Connectivity	Other
Feather River	x		x	x		
Yuba River - South Fork Feather				x		Indian Creek listed as Aquatic Diversity Management Area because it contains nearly pristine habitat, threatened amphibians, and dominated by native fish
Middle Fork American	x			x	x	
Cosumnes River-South Fork American River	x		x	x		Rock Creek listed as an Aquatic Diversity Management Area because native frogs and fish are present, Cosumnes River is focus of restoration effort led by The Nature Conservancy
South Fork Calaveras		x		x		Extirpated but represents historic range
Tuolumne River		x		x		Extirpated but represents historic range
Piney Creek		x		x		Extirpated but represents historic range
Cottonwood Creek	x			x		Extant on periphery of range
Putah Creek-Cache Creek		x		x	x	
Tributaries to Lake Berryessa	x		x		x	Extant on periphery of range
Upper Sonoma Creek	x		x			
Petaluma Creek-Sonoma Creek	x		x		x	
Point Reyes Peninsula	x		x			
Belvedere Lagoon	x		x		x	
Fagan-Jameson Canyon-Lower Napa River	x		x		x	
East San Francisco Bay	x		x		x	
Santa Clara Valley	x		x		x	
South San Francisco Bay	x		x		x	

Table 5 *(continued)*. Selection criteria for core areas and importance of core areas for recovery.

Core Area	Selection Criteria: Currently Occupied (post-1985)	Historically Occupied	Source Population	Potential for Reestablish-ment or Augmentation	Connectivity	Other
Salinas River-Pajaro River	x		x		x	
Carmel River-Santa Lucia l	x		x		x	
Gablan Range	x		x		x	
Estero Bay	x		x		x	
Arroyo Grande Creek	x				x	
Santa Maria - Santa Ynez River	x		x		x	
Sisquoc River	x		x		x	
Ventura River - Santa Clara River	x				x	
Santa Monica Bay-Ventura Coastal Streams	x		x		x	Extant on periphery of range
Estrella River	x				x	
San Gabriel Mountains		x		x		
Mojave River		x		x		Extirpated but represents historic range
Santa Ana Mountain		x		x		Extirpated but represents historic range
Santa Rosa Plateau	x			x		Extant on periphery of range
San Luis Rey		x		x	x	Extirpated but represents historic range
Sweetwater River		x		x	x	Extirpated but represents historic range
Laguna Mountain		x		x	x	Extirpated but represents historic range

the overall distribution and recovery of this species.

Critical Habitat. On March 13, 2001, a final designation of critical habitat was made for the California red-legged frog. The critical habitat designation has been challenged in court; the status of the case has not been resolved as this plan goes to press. The legal ramifications of critical habitat designations are described below. Approximately 1,674,582 hectares (4,140,440 acres) of land fall within the critical habitat designation. Specifically, aquatic and upland areas where suitable breeding and nonbreeding habitat is interspersed throughout the landscape and is interconnected by unfragmented dispersal habitat is critical habitat.

Core areas and critical habitat areas were selected based on similar criteria. The main criteria used for both were to capture areas: 1) that are occupied by California red-legged frogs, 2) where populations of California red-legged frogs appear to be source populations, 3) that provide connectivity between source populations, and 4) that represent areas of ecological significance. For the selection of core areas, areas of ecological significance include: watersheds that represent the limits of the current and historic range and/or that appear to be restorable and thus good sites for reestablishment projects. Unlike the selection of core areas, it is a requirement that primary constituent elements be defined for critical habitat. These primary constituent elements are described in this recovery plan in Section I, part G. Regulatory Protection and Conservation Measures and are present in all critical habitat areas and core areas.

The core areas and critical habitat areas differ in several ways. Unlike core areas which have no legal mandate for protection under the Endangered Species Act and solely rely upon voluntary implementation, the designation of critical habitat requires Federal agencies to consult with us regarding any action that could destroy or adversely modify critical habitat. Adverse modification of critical habitat is defined as any direct or indirect alteration that appreciably diminishes the value of the habitat for both the survival and recovery of the species.

Critical Habitat

Critical habitat affects Federal agencies by requiring them to evaluate the effects that any activities they fund, authorize, or carry out may have on listed species. Agencies are required to ensure that such activities are not likely to jeopardize the survival of a listed species or adversely modify (e.g., damage or destroy) its critical habitat. By consulting with us, Federal agencies can usually minimize or avoid any potential conflicts; activities have almost always been allowed to proceed in some form. It should be noted that critical habitat designation does not create a wilderness area, preserve, or wildlife refuge. It applies only to activities sponsored at least in part by Federal agencies. Such federally-permitted land uses as grazing and recreation may take place if they do not adversely modify critical habitat. Designation of critical habitat does not constitute a land management plan nor does it signal any intent of the government to acquire or control the land. Therefore, if there is no Federal involvement (e.g., Federal permit, funding, or license), activities of a private landowner, such a farming, grazing or constructing a home, generally are not affected by a critical habitat designation, even if the landowners' property is within the geographical boundaries of critical habitat. Without a Federal connection to a proposed action, designation of critical habitat does not require that landowners of State or other non-Federal lands do anything more than they would otherwise do to avoid take under provisions of section 9 and 10 of the Endangered Species Act.

E. EFFECTS OF THE RECOVERY STRATEGY ON ASSOCIATED SPECIES

Many of the threats facing the California red-legged frog have also resulted in declines of other native, coexisting species. Therefore, improved habitat conditions for co-occurring species are expected to occur through attainment of the recovery objectives. Monitoring of co-occurring species is recommended as a task of this plan, and California red-legged frog recovery actions that may have adverse effects on associated sensitive species should be adjusted to reduce impacts. However, the net effect on native species of implementing this plan is expected to be predominantly positive. The following describes potential effects of recovery tasks on specific taxa.

California freshwater shrimp. Protection and improvement of riparian habitat will increase vegetative cover required for protection from predators. Control of non-native fish and crayfish may also decrease the occurrences of predation and thus increase survivorship of California freshwater shrimp.

Tomales asellid. The Tomales asellid relies upon the presence of dense mats of marsh pennywort (*Hydrocotyle* spp.) and submerged decaying leaves; California red-legged frogs have been observed utilizing marsh pennywort as a substrate for egg mass attachment (S. Christopher *in litt*. 1998). Restoration or protection of habitat conditions for the California red-legged frog will result in increased streamside vegetation and thus a source of fallen, decaying leaves, and in some areas, mats of marsh pennywort. Benefits for Tomales asellid are expected in the Golden Gate National Recreation Area and Point Reyes National Seashore where the ranges of the species overlap.

California tiger salamander. California tiger salamanders and California red-legged frogs are often found coexisting in stock ponds and other artificial impoundments in the San Francisco Bay region. Improved management of artificial ponds for the benefit of the California red-legged frog is expected to increase suitability of these habitats for tiger salamanders and decrease the suitability of these ponds for non-native aquatic predators. Because California tiger salamanders often estivate by using small mammal burrows adjacent to waterways, care must be taken to avoid trapping salamanders in burrows while managing ponds for California red-legged frogs.

Santa Cruz long-toed salamander. Removal of non-native aquatic predators for the California red-legged frog will benefit the salamander where the two species overlap. Restoration of flows to coastal sloughs will slow saltwater intrusion and benefit this species. In addition, management of shallow, ephemeral, freshwater ponds will increase the suitability of habitat for this species, while decreasing the proliferation of non-native aquatic predators.

Foothill yellow-legged frog and mountain yellow-legged frog. Both of these species have experienced population declines due to the presence of non-native aquatic species, particularly in the Sierra Nevada and Coast Range foothills. Predator control and reduced stocking of non-native fish should increase the breeding success and survival of these species. Further, restoration of streams and creeks should result in water flow regimes and vegetative cover that provide suitable habitat for these species.

Arroyo southwestern toad. Protection and enhancement of stream systems for the California red-legged frog should also provide the necessary components of arroyo toad breeding habitat, such as shallow pools in streams and dense riparian vegetation. Many of the land uses that threaten the California red-legged frog also threaten arroyo toads. Thus, implementation of appropriate land use guidelines and best management practices will benefit both species. This is particularly true if guidelines for off-road vehicles, mining, and grazing are implemented. Control of non-native aquatic predators will also benefit both species.

Western spadefoot toad. A large portion of habitat restoration for California red-legged frog recovery will involve the creation of-and management of- artificial ponds such as stock ponds. Because western spadefoot toads are associated with stockponds they may benefit from the increased availability and suitability of such habitat. Many areas that are listed as core areas for protection and management will also benefit the western spadefoot toad. Such areas include large portions of the south and east San Francisco Bay and the vicinity of San Luis Reservoir.

Alameda whipsnake. Protection of large tracts of land including uplands that connect breeding areas for the California red-legged frog should provide protected areas of coastal scrub and chaparral required by the Alameda whipsnake. Benefits to the Alameda whipsnake will particularly be high in Alameda and Contra Costa Counties, where protection and management of core areas for the California red-legged frog should result in fairly well connected reserves of uplands and aquatic habitats.

Two-striped garter snake and San Francisco garter snake. One of the goals of this recovery plan is to maintain long-term viability and increased reproductive success of California red-legged frogs despite natural sources of mortality (i.e., predation by native predators). The decline of the California red-legged frog, which is a prey species of the both the two-striped garter snake and the San Francisco garter snake, and the introduction of bullfrogs into aquatic habitats are both threats to these species. Therefore, with implementation of this recovery plan, it is expected that increased numbers of California red-legged frogs will subsequently increase the prey base for garter snakes. Habitat restoration and predator control (e.g., the continued control of bullfrogs at Pescadero Marsh) will benefit both species as well as the California red-legged frog. Further, any measures that reduce the impacts of urbanization (i.e., water management and protection of undeveloped habitat areas) will be beneficial.

Western pond turtle. Management of streams, creeks, and natural and artificial ponds should provide habitat enhancements for western pond turtles. In regulated streams, restoration of natural flow regimes will help to maintain suitability for turtles. Control of bullfrogs and predatory non-native fish will also benefit the western pond turtle.

Tidewater goby. Implementation of tasks to recover frog populations in lagoons and coastal streams should also improve habitat conditions for gobies. Reduction of sediments in creek channels from bank erosion, livestock grazing, timber harvesting, and recreation will benefit the tidewater goby.

Unarmored threespine stickleback. Removal of non-native aquatic predators for the California red-legged frog will benefit the stickleback where the two species overlap. Restoration of habitat in slow moving stream reaches will also benefit this species.

Salmonids. Removal of threats in streams supporting the California red-legged frog is expected to improve aquatic habitat conditions for threatened runs of coho salmon and steelhead where geographic ranges overlap. Protection and restoration of riparian conditions in core watersheds and drainages harboring frog populations will moderate extreme temperature fluctuations, reduce sediment transport to streams, provide terrestrial insects for food, eventually provide in-stream woody debris and undercut banks for cover, and create habitat conditions less favorable to introduced predators.

Tricolored blackbird. The preservation of ponded habitat for the California red-legged frog with emergent vegetation and protective buffers from urban predators (e.g., raccoons) should greatly benefit the tricolored blackbird, which primarily relies upon emergent marsh habitat for breeding.

Southwestern willow flycatcher, little willow flycatcher, and ***least Bell's vireo.*** Care must be taken to avoid disturbing breeding sites of the flycatcher where tamarisk is present. Removal of tamarisk for the benefit of the California red-legged frog must be weighed against any potential losses of breeding habitat for the flycatcher. Monitoring of avian use of tamarisk at a targeted site should decrease the chances that negative impacts may result. Overall, increased streamside habitat and decreased disturbance by recreationists and livestock in stream systems should benefit all of the above avian species. Increased connectivity between drainages will facilitate population expansion of each species as fragmented habitat is one of the factors contributing to declines.

Saltmarsh common yellowthroat. The saltmarsh common yellowthroat utilizes a range of aquatic habitats in the San Francisco Bay area. Because the ranges of the yellowthroat and California red-legged frog overlap in the periphery of San Pablo Bay and its tributaries, in wetlands in Marin County (e.g., Olema Marsh), in southern San Francisco Bay streams (e.g., Coyote Creek), and at Pescadero Marsh, protective measures for the California red-legged frog that enhance or protect riparian corridors and marshes where they interface with salt marshes, should also provide nesting, foraging, and dispersal habitat for the saltmarsh common yellowthroat. These areas will particularly provide suitable habitat for the yellowthroat during high tides when refuge is required for survival.

Marsh sandwort and Gambel's watercress. Recovery efforts that protect habitat areas in San Luis Obispo County will benefit these plant species as well as the California red-legged frog. Further, mitigation of altered hydrology and elimination of non-native plant species (such as eucalyptus where it is deemed a threat to water quality and riparian habitat quality) will restore habitat for each species.

III. Outline of Recovery Actions

A. GUIDANCE FOR DEVELOPMENT OF WATERSHED MANAGEMENT PLANS AND IMPLEMENTATION OF RECOVERY TASKS

The following guidelines should be used when implementing the recovery tasks as outlined in Section B. They provide specific recommendations for minimizing the effects of various land and water uses, predation, and air and water contamination and provide recommendations for habitat preservation. These guidelines will be valuable when developing watershed management and protection plans (see Task #1), developing mitigation measures for development projects, during section 7 consultations under the Endangered Species Act, and for regional conservation planning for the California red-legged frog.

1) Protect suitable habitats and buffers in perpetuity.

a. Encourage and assist counties and owners of large tracts of natural lands to develop preserves, conservation banks, and/or mitigation banks.

Owners of large tracts of natural land (public and private) should be encouraged to participate in conservation planning by establishing preserves or mitigation banks.

b. Purchase conservation easements or parcels from willing sellers where acquisitions may protect existing populations, allow for expansion of metapopulations, and increase the quantity of protected suitable habitat within the range of the species.

Expanding the acreage of protected high quality habitat within core areas and high priority watersheds will contribute to recovery of the California red-legged frog by increasing opportunities for dispersal, population expansion, and recolonization. The delineation of core areas (Figure 12, Table 4, and Appendix C) provides direction on where habitat suitability and connectivity are considered important for long-term recovery of the California red-legged frog and where land acquisition or protection is necessary. In addition to expanding protection within designated core areas, increasing the connectivity between core areas and occupied watersheds may also increase recovery potential. Therefore, lands that are not designated as core areas should also be evaluated using a landscape approach to determine their possible importance to species recovery.

Several areas have been noted as being very important to the ecological function of adjacent sites that currently support the California red-legged frog. For example, protection of lands upstream from the Corral Hollow Ecological Reserve will increase and maintain suitability of this Reserve for frogs. Protection of coastal areas owned by the Hearst Corporation will allow for protection of frogs in the San Simeon vicinity by maintaining contiguous habitat necessary for dispersal and population expansion. Long-term protection of parcels in these, and other areas, should be pursued via conservation easements or other means of permanent protection.

Isolated sites such as stock ponds, which currently support frogs in the Sierra Nevada foothills, are also in need of protection. Protection of at least a 3-kilometer (2-mile) radius from these isolated ponds may contribute to range expansion in the Sierras.

Opportunities to acquire inholdings within National forests should be pursued and vehicles for achieving this may include land swaps. Again, protection of the watershed, including stream reaches up- and downstream of known populations and adjacent uplands, will increase the potential for long term suitability of such sites for the California red-legged frog.

c. **Establish appropriate buffers within urban and agricultural areas on a site-by-site basis**.

Buffers should be established and preserved through the same mechanisms used to secure habitat. Incorporation of research on dispersal habits of the California red-legged frog, and influences of habitat type and gradient, should increase the understanding of appropriate buffers by site. Dispersal habits and habitat needs of the frog should be provided to planning agencies so that appropriately sized buffers, habitat areas, and corridors (i.e., dependent on site-specific conditions, topography, etc.) can be built into project plans.

2) **Develop and implement guidelines for maintaining adequate water flow regimes, particularly in California red-legged frog habitats downstream of impoundments, water diversions, and residential or industrial developments.**

Altered water regimes can result in a multitude of direct and indirect impacts to the California red-legged frog and its habitat, ranging from unseasonable flows that disturb egg masses to loss of aquatic habitat by excessive groundwater withdrawals or stream diversions. Data should be collected to identify the in-stream flow needs necessary to restore natural, seasonal flow cycles and thus maintain optimal habitat for protection and recovery of the California red-legged frog and co-occurring species. Care must be taken to consider the varying needs of co-occurring species and accommodate potential conflicts. While water flows will vary with weather conditions and thus may not be consistently maintained, particularly in drought conditions, measures should be proposed and agreements implemented to secure the needed flows when diversions, impoundments, or urban wastewater flows threaten the integrity of the hydrologic regime.

a. **Provide water budgets to county planners and water districts that identify needs for the California red-legged frog**.

Work with authorities to secure appropriate flows, limit the amount of water pumped from wells during late summer months and drought periods, and/or manage small impoundments in a manner that increases suitability of habitat in reaches up- and downstream of dams. Sites that are in need of water budgets include coastal streams, particularly those in the Central Coast Recovery Unit (i.e., San Simeon Creek and Santa Rosa Creek in San Luis Obispo County).

b. **Manage dams and reservoirs that affect populations of the California red-legged frog**.

Water suppliers and reservoir operators should consider operational changes that result in environmental enhancements while preserving water quality and quantity to the extent consistent with environmental goals. Management actions may include seasonally drawing down water levels to remove non-native aquatic predators or release of flows to create and/or maintain breeding habitat for the California red-legged frog downstream of dams. Goals should include restoring natural hydrographs and minimizing unseasonable flows.

Diversions on the Los Padres National Forest and other public and private lands (i.e., other National Forests, Bureau of Land Management, State Parks) that have not undergone environmental review should be analyzed for impacts to the California red-legged frog and associated species and managed for habitat suitability. Because small impoundments can also create habitat for the California red-legged frog, site-specific determinations of benefits and/or impacts are necessary.

c. Where feasible, remove dams that have eliminated or reduced populations of the California red-legged frog on National Forest lands and other public lands.

Managers of public lands should consider removal of dams and diversions (particularly those that divert springs) that are negatively affecting the extent and suitability of California red-legged frog habitat. In particular, removal should be considered when such facilities no longer serve their useful purpose and when they could feasibly be replaced by other, less environmentally damaging facilities capable of supplying water of equal or better quality compared to the facility proposed for removal.

For example, the Matilija Dam on the Los Padres National Forest has been identified as an obstacle to the flows necessary for suitable breeding habitat for the California red-legged frog in Matilija Creek on the Los Padres National Forest land. Further, careful review of the 190 spring diversions on the Los Padres National Forest, and removal of these diversions where appropriate, is recommended. Where dam removal is not feasible, modification of the structures and systems should be completed to provide suitable habitat for the California red-legged frog.

Other locations where careful review and possible elimination of impoundments is necessary include the tributaries to Año Nuevo State Park. Impoundments here are a source of non-native predators (i.e., warm water fish and bullfrogs) (M. Westphal pers. comm. 1998). Restoration via impoundment removal may be the best long-term solution to the threat of non-native predation on the California red-legged frog at this location.

In some cases, dams provide the requisite impoundment of water that is required for California red-legged frog habitat where none existed before (e.g., stock ponds) so surveys and suitability analyses must be carried out prior to removal.

3) Develop and implement best management practices to prevent or minimize adverse impacts to the California red-legged frog from in-stream and stream bank activities associated with mining operations.

Activities such as gravel mining and suction dredging can degrade California red-legged frog habitat in streams and creeks by altering the morphology and hydrology of these aquatic systems, facilitating the proliferation of non-native aquatic species and increasing sedimentation. Identification of watersheds with this problem is needed for recovery with subsequent development and implementation of measures that reduce effects.

a. Identify streams for which in-stream and stream bank activities associated with mining threaten habitat suitability for the California red-legged frog.

A survey of streams which are subject to gravel mining operations is necessary. Placer mining and gravel extraction impacts may be greatest in the Sierra Nevada foothills.

b. Determine the effects of suction mine dredging, gravel extraction, and placer mining on the California red-legged frog.

An analysis that evaluates the effects of suction mine dredging and placer mining on the California red-legged frog and its aquatic habitat is necessary. While many water quality impacts have been identified (e.g., increased sedimentation), determining the relationship between degraded water quality and frog reproduction and survival will aid development of management guidelines and minimization measures to protect the subspecies.

c. Develop gravel mining guidelines for streams where gravel mining is identified as a threat to the suitability of habitat for the California red-legged frog.

Upon identification of streams for which these activities are a threat to the suitability of habitat for the frog, measures may be necessary to minimize the impacts to aquatic habitat. Minimization measures or guidelines should be applied in suitable habitat for the frog. Management guidelines may include such measures as: removal of artificial pools that have been created by suction dredging and now harbor non-native aquatic species (or may in the future), bank stabilization, reduction and containment of sediments, reduction of highbanking, and removal of gravels and soils above the high water mark and on adjacent terraces.

Appropriate sites for doing impact analyses and applying guidelines include portions of the Los Padres National Forest (portions of the Santa Ynez, Ventura-Matijila, and Piru watersheds), watersheds in the Sierran foothills, and other problem areas as they are identified.

d. Eliminate mining activities in drainages with known California red-legged frog populations.

In identified high use areas, elimination of mining activities within 1.5 kilometers (1 mile) up and downstream of known frog populations will contribute to recovery by eliminating potential negative effects on frog reproduction and survival. Sediment loads should be monitored for mining activities conducted greater than 1.5 kilometers (1 mile) upstream to evaluate whether California red-legged frogs are negatively impacted. If so, minimization measures should be enacted to reduce degradation of water quality. Elimination of mining activities is recommended on all public lands and in core watersheds where California red-legged frogs are threatened by such activities. Where elimination is infeasible due to valid patented claims, and where mining operations are already permitted under the state Surface Mining and Reclamation Act, guidelines should be implemented to avoid impacts.

e. Identify areas where acid mine drainage may be affecting California red-legged frog populations, and identify measures to reduce or eliminate the effects.

Acid mine drainage is associated with the extraction of many metals. High acidity can have direct effects on the frog and their prey base, or indirect effects by interactions with other actual and potential contaminants. Some elimination or reduction of contaminant exposure might be accomplished through zoning regulations. This may entail working with county planning departments and agricultural commission offices to define areas where certain activities are not permitted or certain chemicals are restricted.

4) Control/eliminate non-native species/predators (plants, vertebrates, invertebrates) using methods that are determined to be the most effective.

A large component of the threats to California red-legged frogs involves the presence of non-native predators, particularly warm water fish, crayfish, and bullfrogs. In addition, some regions in southern California may benefit from control of African clawed frogs. Although introduced predators can be considered ubiquitous in many watersheds within the current and historic range of the frog, areas of high concentrations should be identified and the numbers of non-native predators reduced. As a short-term method, physical removal of non-native predators may be most beneficial. However, pro-active means of reducing the conditions in which non-native predators thrive is a long-term priority. Sustainable land uses that maintain high suitability for the California red-legged frog rather than degraded conditions where non-natives have a competitive advantage should be encouraged.

a. Identify sites that require control or elimination of non-native predators.

Through implementation of this recovery plan, many sites needing non-native predator control are expected to be identified. However, based on current information, the following sites have been identified as areas which may benefit from non-native predator removal: Garin Dry Creek and ponds/drainages in Pleasanton Ridge Regional Park (Alameda County), Arroyo Del Valle (Alameda County), upper Alameda Creek and other drainages in the Sunol Regional Wilderness (Alameda County), Bollinger and Brushy drainages (Contra Costa County), Kellogg Creek, Castro Creek and drainages in the Black Diamond Mines Regional Preserve (Contra Costa County), Diablo Foothills Regional Park (Contra Costa County), portions of the Golden Gate National Recreation Area including Tennessee Valley and bordering drainages (Marin County), Mountain Lake in the Presidio, (San Francisco County), Crystal Springs Reservoir and Pilarcitos Lake on San Francisco Water District lands (San Mateo County), the Corral Hollow watershed (San Joaquin County), Oristemba and Garzas Creeks (Stanislaus County), Año Nuevo State Park and Reserve (Santa Cruz County), ponds and lakes in Henry W. Coe State Park (Santa Clara County), ponds and lakes on Palassou Ridge (Santa Clara County), Romero Creek and ponds on Romero Ranch (Santa Clara and Merced Counties) Fort Hunter Ligget (San Antonio and Nacimiento drainages, Monterey County), Little Oso Flaco Lake (San Luis Obispo County), and areas within the Los Padres National Forest, Yosemite National Park, Eldorado National Forest, and Plumas National Forest.

b. Eliminate predators utilizing various methods to determine the most effective means.

Many methods for controlling/eliminating non-native predators exist and yield differing results (i.e., pond drainage, physical removal, rotenone). Various methods should be tested to determine which are the most successful and cost effective.

c. Eliminate breeding habitat of non-native predators.

In identified problem areas, potential and known breeding sites of non-native aquatic predators (e.g., stock ponds, small reservoirs) should be eliminated near known or potential California red-legged frog habitat. Physical removal (i.e., filling in a stock pond known to be infested with non-native species) may be necessary; this may be more cost effective and productive over the long-term than removing individuals.

Surveys should be conducted prior to such actions to ensure that the California red-legged frog is not breeding in these areas.

d. Maintain watersheds that are free from non-native predators.

Some ponds (e.g., Mud Dam Pond on San Francisco Public Utility Commission Lands and some ponds on East Bay Regional Park District lands) support the California red-legged frog and are not infested with non-native predators. Careful monitoring and preventative management should be carried out to avoid invasions.

e. Use appropriate animal control measures to reduce impacts of raccoons and other predators associated with urbanization.

Preventative and reactive measures taken within urbanized areas may decrease the proliferation of predators. Such measures may include waste management in public parks and housing developments, control of feral pets, discouraging the public from accidentally or intentionally feeding wild predators such as raccoons, and animal removal if predator populations appear to be significantly detrimental to the California red-legged frog breeding success and survival.

f. Remove arundo, tamarisk, cape ivy, and other non-native plant species if they are threatening habitat suitability.

In addition to non-native animals, a number of non-native plants threaten the integrity of the frog's habitat in aquatic systems. These non-native plants can out-compete, and ultimately replace, native plants resulting in the loss of plant species diversity and wildlife habitat. The relationship between the presence of non-native plants and habitat suitability for the frog should be investigated. If these plants threaten habitat suitability, they should be removed. In the case of non-native plant removal, the effectiveness of eradication should be verified and post-treatment revegetation efforts should be conducted promptly to ensure adequate vegetative cover in treated areas. Areas identified thus far as having an intense invasion of non-native plants include the following aquatic systems: Santa Ynez, Ventura-Matilija, Santa Paula, Sespe, and Piru watersheds on the Los Padres National Forest, San Simeon and Santa Rosa Creeks in San Luis Obispo County, areas in the San Gabriel Mountains and most southern California sites. More sites are expected to be identified in the future.

g. Decrease the extent of and/or cease artificial stocking of non-native fish.

Stocking of non-native fish should occur only in aquatic systems that have been surveyed for sensitive native aquatic species and where these sensitive species are deemed absent. Surveys should be conducted upstream and downstream from a stocking site prior to stocking. Watersheds that support the California red-legged frog should be allowed to revert to either a fishless system or a community of native aquatic species, depending on the historic conditions. Stocking of non-native fish should be discontinued in National Park waters, State and Regional Parks, Vandenberg Air Force Base, and core watersheds.

h. Remove restrictions on the take of feral pigs and encourage their removal from red-legged frog habitat including associated uplands.

i. Eliminate practice of releasing translocated urban predators such as raccoons, skunks, and opossums into California red-legged frog habitat areas.

5) Reduce the detrimental effects of livestock grazing and increase incidental benefits associated with livestock grazing on public and private lands.

Although research is necessary to understand the interactions between livestock grazing and the frog, and to determine the optimum grazing regimes for California red-legged frog habitat suitability and survival (see task 10.12 below), opportunities currently exist to manage grazed lands in a manner that reduces impacts to or enhances frog habitats.

a. Implement guidelines for construction, maintenance, and management of artificial ponds.

Because of the variability of aquatic systems from either natural climatic changes or anthropogenic effects, the survival of populations in all aquatic habitats may depend on the continued presence of ponds, springs, or pools that are disjunct from streams. In many California red-legged frog metapopulations, artificial ponds maintained for watering livestock are the principal sources of the young frogs that annually repopulate the watershed. Appendix D provides guidelines that may be used to create and manage artificial ponds for the benefit of California red-legged frogs and/or enhance existing ponds to increase suitability. Private landowners should be encouraged to implement the recommended pond guidelines on a voluntary basis, and public managers should implement these guidelines where California red-legged productivity is low due to poor breeding habitat conditions in natural aquatic systems. Areas where pond construction and maintenance are expected to benefit California red-legged frogs include cattle ranches, dairy farms, and nurseries (particularly nurseries along the central coast south of Half Moon Bay). At existing and future nurseries, supplemental irrigation ponds can be constructed for use by frogs when irrigation ponds are drawn down. Cost sharing incentives and safe harbor agreements may be appropriate for landowners who choose to participate in habitat enhancements such as pond creation (see Appendix E).

b. Increase the number of private landowners who develop and implement California Rangeland Water Quality Management Plans.

Landowners should be encouraged to develop California Rangeland Water Quality Management Plans. Because the primary goals of these plans are to maintain and improve the quality of surface water, implementation of such self-initiated plans will improve habitat conditions for the California red-legged frog.

c. Test grazing strategies to determine grazing regimes that are most compatible with California red-legged frog breeding and survival and habitat suitability.

Several grazing strategies and guidelines may minimize impacts to the frog. Strategies that should be analyzed include rest-rotation and deferred utilization, varied livestock types (i.e., change from cow-calf operation to steers or breeds which utilize dry habitats), and/or lowered stocking rates for lighter utilization levels to limit forage removal.

d. Develop and implement grazing guidelines or enhance existing guidelines for public lands which have been identified as having habitat quality concerns due to livestock grazing.

Guidelines must be site-specific and could include actions such as: fencing, relocation of water and salting sites away from wetlands, maintenance of stream bank stability (i.e., no more than 10 percent of natural stream bank stability altered by livestock trampling, chiseling, and sloughing), management of upland herbaceous vegetation such that utilization does not exceed 50 percent of annual growth (depending on the site conditions), and monitoring of utilization and subsequent habitat suitability for frogs.

Areas needing grazing guidelines to reduce impacts to frogs and increase suitability of habitat include the following: portions of the East Bay Regional Park District (i.e., Garin Dry Creek Regional Park), areas of high levels of grazing on National forests (i.e., portions of the Carmel, Cuyama, Sisquoc, and Piru watersheds on the Los Padres National Forest), State parks, and publicly owned portions of core areas. Additional areas should be included if overgrazing is negatively affecting the California red-legged frog.

e. Reduce water quality degradation associated with livestock grazing and horse corrals.

Areas in which livestock and horses congregate typically experience high levels of nutrients due to urination and defecation by these animals. This has been identified as a problem on the Golden Gate National Recreation Area and Point Reyes National Seashore, and it is likely that this problem exists in other areas throughout the range of the frog. Measures should be implemented to alleviate water quality degradation. Suggestions include limiting the extent of time that livestock/horses are allowed to congregate in watersheds harboring the California red-legged frog. If a demonstrated threat to California red-legged frogs exists, horse corrals should be moved to at least a 150-meter (500-foot) distance from known and potential breeding sites until appropriate buffers are determined through experimental research.

6) Reduce the effects of timber harvest activities on the California red-legged frog and its habitat.

Timber harvest activities are considered a threat to watershed integrity when guidelines are not in place to reduce adverse impacts. This is a particularly important issue in the North Coast foothills and the Sierra Nevada foothills.

a. Develop and implement timber harvest guidelines to reduce impacts to the California red-legged frog and their habitat.

Guidelines for minimizing impacts associated with timber harvest activities should be developed for each timber region within the current and historic range of the frog. Implementation of guidelines should be refined for individual sites (i.e., based on topography, watershed conditions).

b. Develop regional dichotomous keys for assessing potential effects of proposed timber harvest plans.

As described in section I, part G of the Introduction (Regulatory Protection and Conservation Measures), a dichotomous key exists to assist land managers and timber harvesters in the analysis of potential project impacts. This key has been successfully used by foresters, and is viewed as a means for harvesters to actively take part in the analysis with a full understanding of the rationale for assessing impacts. This dichotomous key should be refined for each recovery unit so that the key is more specific to regional habitat conditions and harvest practices. Specifically, a refined key should be developed for the Sierra Nevada foothills, North Coast foothills, and the Northern Transverse and Tehachapi ranges recovery units.

c. Design and maintain roads in a manner that reduces impacts.

Erosion control features should be established on skid trails and tractor roads immediately upon completion of yarding on them in wet weather conditions. Road surfaces should maintain a hard surface (e.g., rock hardness) during periods of road use. Roads should be designed with the minimum width necessary to support the proposed use, roads on steep slopes (greater than 50 percent) should be full-bench design, and spoils should be disposed on grounds that are less than 30 percent slope and remote from watercourses. New roads and those requiring reconstruction should be out-sloped with rolling lips. The California Forest Practice Rules should be consulted for additional measures to reduce impacts and sedimentation.

7) Develop site-specific guidelines for recreational activities to reduce or eliminate impacts to the California red-legged frog where these activities pose an on-going threat to habitat quality.

Hiking, fishing, horseback riding, and back country camping occur over large areas on public lands such as National Forest, Bureau of Land Management, State, and regional park lands. Habitat impacts associated with use of trails and roads, use of developed recreation sites, and dispersed use include wetland vegetation trampling, soil compaction, sedimentation, bank destruction, dammed pools, vegetation clearing, introduction of contaminants, and introduction of non-native fish and wildlife species. Impacts to the California red-legged frog may include direct loss of egg masses and tadpoles due to trampling and decreased suitability of aquatic habitats due to the proliferation of non-native predators, sedimentation of pools, vegetation clearing or trampling, and decreased water quality.

a. Reduce the impacts of trail and road use on California red-legged frog habitat within public lands.

Again, depending on the site-specific needs for California red-legged frogs, trails and roads may need to be rerouted to avoid stream crossings and rerouted a distance of at least 150 meters (500 feet) from wetlands (i.e., springs, wet meadows, ponds, marshes). Where stream crossings are absolutely necessary, measures that ensure that crossings do not degrade frog habitat should be implemented. Vehicular activities should be excluded from riparian and other wetland areas unless adequate stream crossings exist to prevent sedimentation. Roads near known source populations of the California red-legged frog should be closed annually, if feasible, during the late winter and spring to prevent the killing of subadult and adult frogs on roads. With each of these actions, care must be taken to avoid impacting other species.

Management plans should include impact minimization actions such as: (1) closure or reroutes of trails or trail segments that cause degradation of aquatic systems, (2) development of trails and overlooks which provide the public opportunities to view unique resources without impacting those resources, (3) closure and relocation of campgrounds and other developments to areas that are within a 150-meter (500-foot) distance from wetlands, (4) development of interpretive trails and signs to educate the public about sensitive resources and habitats, (5) restoration of aquatic and upland areas that have been heavily degraded by recreational activities, and (6) installation of space barriers installed as appropriate to protect sensitive habitat areas. Existing guidelines for road development, maintenance, drainage, and surfacing should be followed to decrease impacts to the California red-legged frog habitats.

b. Minimize off-highway vehicle impacts.

A high priority is to develop management guidelines for off-road vehicle uses where recreation activities have resulted in sedimentation of streams and ponds and the degradation of upland habitats. Off-road vehicle activities upstream of the Corral Hollow Ecological Reserve are decreasing the suitability of the ecological reserve due to high rates of sedimentation during peak stream flows. In addition, many areas in National forests need management of off-road vehicle use in suitable and occupied habitats to decrease impacts to the California red-legged frog and other sensitive species. Sediment monitoring guidelines, permanent or seasonal closures, and development and maintenance of siltation ponds are needed in these areas.

c. Reduce impacts on the California red-legged frog from developed recreation sites and dispersed recreational use on public lands.

Developed sites, including day use areas and campgrounds, often attract congregations of people around water. Management plans for developed recreational sites on National Forest, State park, and Regional park lands are needed to minimize impacts to the frog. Developed recreational sites in need of management include areas along Arroyo Seco, Santa Ynez, Ventura-Matilija, Sespe, and Piru drainages on the Los Padres National Forest. On the Los Padres National Forest, areas with greatest concentrations of dispersed use include portions of the Carmel, Arroyo Seco, Big Sur, Sisquoc, Santa Ynez, Ventura-Matilija, Santa Paula, Sespe, and Piru drainages. Other areas of high priority that need management plans include State and Regional parks that currently support populations of the California red-legged frog.

8) Decrease the exposure of the California red-legged frog and their habitat to contaminants.

Currently, the sensitivity of the California red-legged frog to pesticides, herbicides, heavy metals, air pollutants, and other contaminants is largely unknown. Research on the relationship between the frog and pollutants is necessary and will contribute to the knowledge base required for development of management guidelines with respect to contaminants. Several contaminated areas have been identified (e.g., Vandenberg Air Force Base) where the California red-legged frog may be exposed to toxins; at these sites, contaminants should be removed and other measures that decrease exposure of the frog should be undertaken.

a. Use habitat-based measures to prevent contamination of California red-legged frog habitat.

Habitat-based recovery actions that prevent the movement of pesticides into the aquatic environment should be used to reach this goal. For example, well-vegetated riparian areas and/or vegetation buffers around natural and artificial ponds should be protected and/or enhanced in agricultural, urban, and suburban areas to prevent aerial drift and overland flow of chemicals into wetlands. Intensive farming should be avoided within a 500-meter (1,500-foot) buffer from wetlands.

b. Develop contingency guidelines for hazardous material spills.

Measures to avoid contact with hazardous material will preserve the integrity of aquatic systems and habitats needed by the frog. Having contingency plans in place will reduce the likelihood that unexpected spills will negatively affect the California red-legged frog and associated species.

c. Identify point and non-point source pollution and develop guidelines to reduce impacts.

Identification of pollution sources will provide the focus for implementation of appropriate guidelines and impact minimization measures. Some point-sources have been identified and include Las Tables Creek in the Lake Nacimiento drainage (Monterey County) which receives acid mine drainage from the Buena Vista and Klau Mercury mines, Chorro Creek (San Luis Obispo County) which received high levels of chlorinated water (50 parts per million) in 1997, the Guadalupe Oil Field (San Luis Obispo County), San Justo Reservoir (San Benito County) which has high selenium levels, the Goleta vicinity (Santa Barbara County) where sediment and water samples show high levels of benzene, arsenic, and selenium from past oil industry activities, and ponds on Vandenberg Air Force Base (Santa Barbara County). Identification of non-point sources should include waste water discharges and areas in which use of agricultural chemicals is concentrated.

d. Clean aquatic habitats that support the California red-legged frog and are known to be contaminated.

As noted above, several areas within the current range of the California red-legged frog are known to support the subspecies despite high levels of contaminants. Clean up and remediation are necessary at each site. For example, some ponds on the Vandenberg Air Force Base are contaminated but support the frog. Researchers have noted physical deformities and research is necessary to determine the causes. California red-legged frogs should be removed from the site while clean up occurs and either relocated or allowed to disperse back into ponds once water quality has been improved.

e. Substitute strongly caustic fertilizers or their components with less dangerous substances.

Amphibian mortality, skin lesions, and burns have been associated with the caustic materials found in mineral fertilizers (Schneeweiss and Schneeweiss 1997). Less dangerous substances should be used in place of these chemicals.

f. Stop contamination of riparian areas from the direct application of herbicides and pesticides by road crews (e.g., county departments of transportation, Caltrans)

The use of materials known to be toxic to aquatic and riparian species are routinely applied for control of roadside weeds and other unwanted vegetation. This is particularly important where ditches, riparian areas, and springs occur at roadsides.

9) Develop guidelines for fire management practices (i.e., prescribed burns, emergency fire suppression, emergency water use) to decrease incidental impacts to the California red-legged frog.

Many public lands do not currently have specific guidelines for fire management activities. Routine and emergency plans should be modified to include protective measures for the frog while maintaining fire fighter safety and protecting life and property.

Prescribed burning should be used when doing so will enhance ecosystem health (e.g., reduce fuels, control non-native plants) and decrease chances of catastrophic fires. However, prescribed burning should be carried out in upland habitats during seasons when frogs are not likely to be dispersing or estivating in uplands, if ecologically appropriate.

Guidelines for emergency fire suppression could include such actions as: restricting the use of fire retardant drops in wetland habitat areas; avoiding breeding pool habitat for water supply sites; avoiding establishment of staging areas within a minimum of 150 meters (500 feet) from California red-legged frog habitat; prohibiting solid and sanitary waste facilities in the vicinity of aquatic habitats; signing, fencing, or closing areas of California red-legged frog breeding habitat; developing inspection and monitoring requirements for operating plans; and briefing hand crews on locations and types of frog habitats.

The current fire management guidelines used by State parks should be evaluated for compatibility with the California red-legged frog and revised in a manner that enhances the ecosystem and watersheds upon which the frog relies. This should also be done for National forests and lands managed by the Bureau of Land Management where the California red-legged frog is present. A priority is the implementation of best management practices by California State Park staff in implementation of the State-wide burn program.

10) Develop and implement best management practices to prevent or minimize adverse impacts to the California red-legged frog from in-stream and stream bank activities associated with flood control actions.

Guidelines on flood control measures should be developed and implemented on public lands. Guidelines could include actions such as: maintenance of appropriate levels of down woody material in riparian zones and within a 150-meter (500-foot) distance from ponds, marshes, and other aquatic habitats; avoidance of seeding/revegetating treated areas with non-native species (including using mulch that may contain non-native seed species); contour felling of trees within or just outside riparian zones to help reduce runoff and sedimentation of streams; and monitoring to verify effectiveness of actions. Guidelines should address impacts of flood control activities carried out upstream of California red-legged frog habitat.

11) Implement watershed management and protection plans using cooperative agreements and existing incentive programs.

Traditional fee title acquisition by government or private resource interests is an effective, but expensive, way of protecting resources. Other mechanisms to protect habitat on private lands include: 1) local zoning restrictions that prevent incompatible uses, 2) transfer of development rights, 3) fee title donations, 4) sale or donation of conservation easements, 5) land swaps, 6) sale and back lease or resale programs with restrictive covenants, and 7) use of existing incentive programs (described in Appendix E). Support and assistance of private landowners in conserving and recovering the frog may be gained by developing economic and other incentive programs (relief from taxes, tax credits, tax deductible habitat management expenses, safe harbor agreements).

B. RECOVERY TASKS

1.0 Develop and implement watershed management and protection plans for core areas.

While the California red-legged frog uses streams, ponds, and other wetlands to varying degrees, an assumption of this recovery plan is that a varied landscape with multiple opportunities for breeding within a watershed is optimum. For example, these frogs may rely on artificial ponds for the majority of reproductive output but move into streams in wet years or when suitability is increased via restoration. Thus, having both habitat types in optimum condition within the landscape/watershed will provide the variety of available habitats on which California red-legged frogs typically rely. Watershed improvements are expected to increase habitat for the California red-legged frog by providing suitable aquatic sites for breeding that are maintained by hydrological balance and located within a matrix of adjacent uplands that are managed appropriately (i.e., have stabilized soils and are not fragmented).

Management and protection plans should be developed for each core area as listed in Table 6. Watershed assessments will be necessary to determine restoration and land management needs for each watershed. Methods to enhance habitat and minimize or eliminate identified threats should be included in the management and protection plan. Each plan should include proposals to incrementally protect, via conservation easements, fee title, acquisitions, or other mechanisms, important breeding and dispersal habitats. The *Guidance for Development of Watershed Management Plans and Implementation of Recovery Tasks* (section III.A) should be used to assess the needs within a particular drainage and to develop appropriate land use guidelines, threat minimization measures, and/or land protection and restoration measures.

Because ownership within targeted watersheds is likely to encompass multiple land owners, multi-entity cooperative watershed management plans will be necessary to secure appropriate flows, control predators that may disperse into frog breeding habitats from within or outside a watershed, combine restoration and enhancement efforts, and manage use of uplands to allow for maintenance of suitable wetlands.

2.0. Develop and implement watershed management and protection plans for each watershed that currently supports populations of the California red-legged frog (priority 2 watersheds).

Within priority 2 watersheds, known or potential California red-legged frog habitat should be managed in a manner which maintains or enhances the suitability for this species. Land use guidelines should be implemented, as appropriate, to minimize impacts to California red-legged frog populations (see *Guidance for Development of Watershed Management Plans and Implementation of Recovery Tasks*). Preservation of habitat, via acquisition or easements, may further protect the species in priority 2 watersheds.

3.0 Develop and implement watershed management and protection plans for each watershed that was historically occupied by the California red-legged frog (priority 3 watersheds).

Priority 3 watersheds are areas that historically harbored California red-legged frogs. In priority 3 watersheds, the likelihood of successful recovery is less than in core areas and priority 2 watersheds. These areas will need (in most cases) extensive rehabilitation

Table 6. Core areas targeted for development and implementation of management and protection plans for the California red-legged frog.

Recovery Task #	*Core Area*	*Conservation Needs*
1.1	Feather River	Protect existing populations, remove non-native predators, protect and restore wetlands within watershed, reestablish populations within this watershed and/ or augment existing populations with additional individuals.
1.2	Yuba River-South Fork Feather	Protect existing populations, remove non-native predators, protect and restore wetlands within watershed, reestablish populations within this watershed and/ or augment existing populations with additional individuals.
1.3	Middle Fork American River	Control bullfrogs, reestablish populations within this watershed.
1.4	Cosumnes River-South Fork American River	Protect existing populations, restore additional habitat, protect connectivity, reestablish populations and/or augment existing population.
1.5	South Fork Calaveras	Control bullfrogs, minimize effects of off-road vehicle use by eliminating vehicle trails in California red-legged frog habitat, reestablish populations.
1.6	Tuolumne River	Control non-native fish and amphibians, reestablish populations (e.g., at Swamp Lake, Miguel Meadows).
1.7	Piney Creek	Control bullfrogs, reestablish populations.
1.8	Cottonwood Creek	Control bullfrogs.
1.9	Putah Creek-Cache Creek	Reduce impacts of land uses, protect and restore wetland habitats, reestablish populations.
1.10	Tributaries to Lake Berryessa	Protect existing populations, reduce impacts of recreation, augment existing populations.
1.11	Upper Sonoma Creek	Protect existing populations, conduct subwatershed assessments and management, control bullfrogs, maintain dams.
1.12	Petaluma Creek-Sonoma Creek	Protect existing populations; reduce impacts of urban development; protect, restore, and/or create breeding and dispersal habitat.
1.13	Point Reyes Peninsula	Protect existing populations, control bullfrogs, continue genetics research on *R.a. aurora* and *R.a. draytonii*, manage livestock and horse corrals to prevent nutrient loading problems.
1.14	Belvedere Lagoon	Encourage voluntary creation and/or management of habitat on private lands.
1.15	Fagan-Jameson Canyon-Lower Napa River	Protect existing populations from current and future urbanization, create and manage alternative breeding habitats, protect dispersal corridors.
1.16	East San Francisco Bay	Protect existing populations; control non-native predators; study effects of grazing in riparian corridors, ponds and uplands (e.g., on East Bay Regional Park District lands); reduce impacts associated with livestock grazing; protect habitat connectivity; minimize effects of recreation and off-road vehicle use (e.g., Corral Hollow watershed); avoid and reduce impacts of urbanization; protect habitat buffers from nearby urbanization.
1.17	Santa Clara Valley	Protect existing populations, control non-native predators.

1.18	South San Francisco Bay	Protect existing populations, control non-native predators, increase connectivity between populations, reduce erosion, implement guidelines for recreation activities to reduce impacts, implement forest practice guidelines, reduce impacts of urbanization.
1.19	Watsonville Slough-Elkhorn Slough	Protect existing populations, protect habitat connectivity, reduce impacts of agriculture, improve water quality, reduce impacts of urbanization .
1.20	Carmel River-Santa Lucia	Protect existing populations, restore Carmel River watershed.
1.21	Gablan Range	Protect existing populations, protect habitat connectivity, restore and create habitat.
1.22	Estero Bay	Protect existing populations, protect habitat connectivity, control non-native predators, reduce water diversions to ensure adequate flows (e.g., Villa Creek, Ellysly Creek).
1.23	Arroyo Grande	Restore habitat, protect habitat connectivity.
1.24	Santa Maria-Santa Ynez River	Protect existing populations; reduce contamination of habitat (e.g., clean contaminated ponds on Vandenberg Air Force Base); control non-native predators; implement management guidelines for recreation; cease stocking dune ponds with non-native, warm water fish; manage flows to decrease impacts of water diversions; implement guidelines for channel maintenance activities; preserve buffers from agriculture (e.g., in lower reaches of Santa Ynez River and San Antonio Creek).
1.25	Sisquoc River	Restore habitat, control non-native predators, maintain Mono Debris Dam to prevent the spread of bullfrogs, implement recreation guidelines, eliminate off-road vehicle use of habitat areas, implement guidelines for placer mining and suction dredging.
1.26	Ventura River-Santa Clara River	Restore habitat, control non-native predators and non-native plants, remove Matilija Dam.
1.27	Santa Monica Bay-Ventura Coastal Streams	Protect existing populations (e.g. East Las Virgenes Creek), restore habitat, reestablish populations, augment existing population.
1.28	Estrella River	Restore habitat.
1.29	San Gabriel Mountains	Restore habitat, eliminate non-native predators, assess suitability for reestablishment of populations, reestablish populations where appropriate.
1.30	Mojave River	Restore habitat, assess suitability for reestablishment of populations, reestablish populations where appropriate.
1.31	Santa Ana Mountain	Restore habitat, assess suitability for reestablishment of populations, reestablish populations where appropriate.
1.32	Santa Rosa Plateau	Protect existing population, augment existing population with individuals, remove non-native predators.
1.33	San Luis Rey	Restore habitat, assess suitability for reestablishment of populations; reestablish populations where appropriate
1.34	Sweetwater River	Restore habitat, assess suitability for reestablishment of populations, reestablish populations where appropriate.
1.35	Laguna Mountain	Restore habitat, assess suitability for reestablishment of populations, reestablish populations where appropriate.

prior to recolonization or reestablishment. However, with intensive efforts and public support, conservation of habitat in these watersheds is possible and may contribute to the overall distribution and recovery of this species. Priority 3 watersheds include unoccupied watersheds within the historic range including watersheds in the southern Sierra Nevada and wetlands within the Central Valley (particularly wetlands that are on U.S. National Wildlife Refuges).

4.0 Develop and implement conservation plans (e.g., Habitat Conservation Plans) for the California red-legged frog on all State and regional parks and water/utility district lands within the historic and current range.

Many State parks occur within the range of the frog and are key to providing habitat and protective measures necessary for recovery of the frog. Parks that provide important frog habitat include: Henry W. Coe State Park, Big Basin Redwoods State Park, Butano State Park, Wilder Ranch State Park, and numerous others. Regional Park districts and water and municipal utility districts that harbor frogs should also develop and implement conservation plans, if existing land management plans are inadequately protecting the California red-legged frog or have not yet been developed.

5.0 Work with county planners and local water districts to minimize the effects of urban and suburban development and associated activities by developing regional plans and/or habitat conservation plans.

City and county governments, as the primary agencies making land use decisions, need to be involved in recovery planning. Cooperative programs and regional plans are needed to coordinate local, public, and private land use planning with State and Federal land use and recovery efforts for the California red-legged frog. Regional plans and/or habitat conservation plans should incorporate recovery goals by including dispersal opportunities between California red-legged frog populations, protecting large areas of habitat (both breeding and dispersal) without fragmentation and edge effects, by controlling exotic predators, and by implementing land use guidelines. Cooperative programs should encourage and promote development of regional plans for cities and counties in the area covered by this recovery plan. Development of cooperative programs based on counties or at the watershed level may be most feasible.

6.0 Implement regional ecosystem strategies via existing regulatory processes to minimize the effects of incidental take resulting from land uses and development activities, and optimize benefits to the California red-legged frog derived from mitigation and compensation actions.

Use of local, State, and Federal laws, regulations, and policies to protect the California red-legged frog and its habitat provide existing, in-place conservation mechanisms. To ensure that projects subject to these regulations do not preclude, but rather facilitate recovery, project planning, and mitigation planning should utilize an ecosystem and/or regional approach and include adaptive management.

6.1 Emphasize the connectivity of affected habitat areas or populations by analyzing impacts and developing mitigation recommendations at the regional level.

Numerous developments in a region are likely to result in intense cumulative impacts such as large areas of habitat loss and fragmentation. Thus, a landscape approach to impact analysis and mitigation planning is necessary. Conservation measures should enhance connectivity between habitat areas and should enhance the effectiveness of mitigation sites or measures associated with adjacent (perhaps already permitted) projects.

6.2 Design mitigation plans to enhance the viability of an entire known metapopulation or group of populations.

Analysis of the status of California red-legged frog population distribution is necessary to best manage populations and metapopulations while providing flexibility in planning and mitigation development. Mitigation actions should focus on protecting and enhancing source populations and maintaining connectivity with other subpopulations or suitable habitat. If the impact analysis indicates that a small portion of a known metapopulation (or group of populations if the status of a metapopulation is undocumented or unknown) may be impacted (approximately 10 percent or less of known subpopulations or breeding sites), metapopulation viability may not be precluded with proper protection of the source population(s). If a larger portion of the metapopulation (or group of populations) will be negatively impacted, an emphasis on avoidance of impacts will be necessary as well as appropriate habitat enhancement and preservation to ensure long term viability of the metapopulation. Where dispersal between populations is unclear, connectivity of habitats between known populations should be maintained so that opportunities for interactions between populations are not precluded.

6.3 Analyze project impacts by considering the variable breeding status of the California red-legged frog in response to varying weather conditions.

Project and mitigation planning should include an analysis of the status of the affected population(s) and/or metapopulation(s) to determine the importance of the breeding habitat or subpopulations from one year to another. A historical perspective on habitat use of the area is necessary when sufficient data are available. If a project will negatively affect a number of breeding sites in an area that includes all or part of a known population or group of populations, care should be taken to ensure that despite varying current and future weather conditions (i.e., extremely wet or dry years) there are sufficient breeding sites available, over the long term, to allow for at least an average of 75 percent of subpopulations to be reproductively successful in any given year.

6.4 Implement off-site mitigation when on-site conditions are not likely to be beneficial for the frog.

Many proposed developments lead to unsuitable conditions for the California red-legged frog. For example, housing developments typically result in increased presence of non-native predators, altered flow regimes, and increased human use of aquatic and upland habitats. In these cases, alternative sites for mitigation should be considered to offset the effects of an action. Core areas as identified in each recovery unit should be the focus of off-site mitigation or compensation. Consolidation of mitigation actions may be achieved by development and implementation of cooperative agreements with local and regional agencies. Mitigation banks may be another appropriate vehicle for achieving this goal in some areas.

6.5 Include management and monitoring plans for mitigation measures that rely on habitat construction, enhancement, or preservation.

Acreage that is set aside for frogs may not be adequate without proper management. A management plan and an endowment or other funding mechanism should be included with land preservation to maintain habitat suitability in perpetuity. Management may include predator removal, maintenance of created habitat, maintenance of adequate hydrology, and monitoring.

6.6 Analyze past and future mitigation measures against clearly defined success criteria to determine effectiveness.

While little is known about the optimum reproductive rates required for long-term population viability of the California red-legged frog, post-project surveys should be conducted to document the reproductive status of the frog on mitigation areas. Contingency measures should be implemented if/when it is apparent that the California red-legged frog is not successfully reproducing.

6.7 Establish and maintain a database that tracks the amount of incidental take authorized and the effectiveness of mitigation measures.

This database should be maintained by a central agency, updated and distributed to project planners and reviewers on a regular basis (i.e., yearly), and referred to by project planners and regulators during the project planning and review stage. Incidental take and the effectiveness of mitigation measures should be quantified by recovery unit and tracked for cumulative effects.

6.8 Summarize extent of incidental take previously authorized in biological opinions pursuant to section 7(a)(2) of the Endangered Species Act and describe the status of the species in relation to recovery goals per recovery unit.

Each biological opinion that addresses take of the California red-legged frog and its habitat should provide a summary of the extent of take previously authorized per recovery unit.

6.9 Cease the use of frog barriers as a mitigation measure.

Mortality of the California red-legged frog due to frog barriers has been documented at several locations (Rathbun *et al.* 1997, Rathbun and Scott, *in litt.* 1999). This measure should be discontinued until the design and installation of frog barriers have been refined, tested, and proven safe.

7.0 Develop and implement guidelines for improving water quality within the range of the California red-legged frog.

In the absence of data specific to the California red-legged frog, water quality standards should be developed based on existing data from related species or from standard toxicity tests. The standards can then be used to develop and implement appropriate guidelines for use of chemicals and management of water quality.

8.0 Implement air quality standards where poor quality is contributing to degraded conditions for the California red-legged frog.

The Central Valley is the primary source of ozone and particulate air pollution in the Sierra Nevada foothills (Cahill *et al.* 1996). Summer ozone is transported from the Central Valley resulting in ozone levels in the Sierras that are as severe as those on the valley floor. The proposed Federal standard of 8 parts per million should be met for the Central Valley floor and Sierran foothills, particularly in the summer months when transport is strongest.

9.0 Prevent the spread of disease and parasites in the California red-legged frog.

Observations of diseased and parasite-infected amphibians are now frequent. Amphibian pathogens and parasites can be carried on the hands, footwear, or equipment of field workers. These pathogens and parasites can spread to localities containing species with little or no prior contact. Therefore, it is important for those involved in research in wetland/pond habitats (including research on fish, invertebrates, and plants as well as amphibians) to take steps to minimize the spread of disease agents and parasites.

9.1 Refine guidelines to minimize the spread of disease and parasites.

A Code of Practice, prepared by the Declining Amphibian Populations Task Force of the International Union for the Conservation of Nature and Natural Resources, provides guidelines for use by anyone conducting fieldwork at amphibian breeding sites or other aquatic habitats. The Code is included as Appendix F. Refinement of these guidelines may be necessary to ensure that the most appropriate measures are implemented for research activities affecting the California red-legged frog and its habitats.

9.2 Minimize chances of spreading disease and parasites when conducting field surveys and research activities.

Upon development of disease and parasite minimization guidelines for the California red-legged frog, the guidelines should be adhered to by all researchers and surveyors. The guidelines should be listed as a term and condition for scientific take permits.

10.0 Restore habitat conditions for the California red-legged frog at or near historical localities, and where feasible, reestablish populations at extirpated localities (i.e. unoccupied core areas).

The absence of the California red-legged frog in many areas within their historic range indicates that habitat suitability must be enhanced. In many areas, however, even with improved habitat conditions, natural recolonization is unlikely due to habitat fragmentation and the large distances between known populations. Active augmentation of populations and reestablishments following the guidelines in Appendix G, will be necessary, upon completion of habitat restoration, to facilitate recovery. Reestablishments are not necessary in each recovery unit but will be an important tool to recovering the frog in recovery units 1, 2, and 8. The level of regulatory protection for re-established populations is outlined in section 10(j) of the Endangered Species Act (see Appendix G). Where mixed land ownership occurs, reestablishment efforts should occur on public lands and only on private lands when landowners willingly volunteer their lands for reestablishment efforts.

10.1 Implement site assessments and restoration programs prior to reestablishment of the California red-legged frog.

The following steps may be necessary prior to reestablishment of California red-legged frog populations:

- Comprehensive watershed surveys in areas previously unsurveyed are necessary to determine absence/presence and current habitat suitability.

- Where the frog is absent, analyses of its habitat conditions are necessary to determine reason for its absence.

- Enhancement of habitat suitability, to the extent feasible, may be necessary in areas where the frog is no longer present and habitat appears unsuitable. Construction of breeding ponds and/or enhancement of existing breeding habitat may also be necessary.

- Analysis of the genetic differentiation of California red-legged frogs within regions and between regions (particularly in the Sierra Nevada foothills and southern California).

10.2 Conduct pilot captive rearing and reestablishment efforts to test the effectiveness of methods, and modify protocol as necessary to improve the effectiveness of reestablishments.

Appendix G provides initial guidelines for reestablishment efforts. These guidelines will be refined as necessary. Reestablishment attempts should continue using and testing various methods until at least one population in each currently unoccupied core area is viable.

10.3 Reestablishment efforts should be carried out at each core area that does not currently support the California red-legged frog.

10.3.1 Reestablish the frog in unoccupied core areas in Recovery Unit #1.

Unoccupied core areas in Recovery Unit #1 are: Yuba-South Fork Feather River, South Fork Calaveras River, Tuolumne River, and Piney Creek.

10.3.2 Reestablish the frog in unoccupied core areas in Recovery Unit #2.

The unoccupied core area in Recovery Unit # 2 is the Putah Creek-Cache Creek core area.

10.3.3 Reestablish the frog in unoccupied core areas in Recovery Unit # 8.

Unoccupied core areas in Recovery Unit #8 are: San Gabriel Mountains, Mojave River, Santa Ana Mountain, San Luis Rey River, Sweetwater River, and Laguna Mountain.

11.0 Conduct research on the biology of the California red-legged frog and its habitat requirements.

Much of the current status, general ecology, habitat requirements, and population trends of this subspecies is unknown. Research is necessary in many areas to fully understand the California red-legged frog, its relationship to its environment and its response to various threats. Completion of recommended research projects will provide additional information needed to refine recovery criteria and actions, and assist in determining if and when delisting is appropriate. Data will also provide important guidance for adaptive management.

11.1 Develop a California red-legged frog survey protocol.

A standardized protocol approved by us is necessary for this subspecies.

11.2 Identify areas for which no surveys of the California red-legged frog have been carried out or where data are out-dated; conduct surveys in these areas, obtaining private landowner permission to survey where necessary.

A better understanding of the distribution of the California red-legged frog is needed. Many areas throughout the historic and current range of the frog have not recently been surveyed and in some cases, never been surveyed. Most private lands throughout the range of the California red-legged frog have not been currently surveyed and represent a large gap in the understanding of this subspecies. When potential California red-legged frog habitats are identified and appropriate permissions have been obtained from private landowners, permitted researchers should survey for the frog using the approved survey protocol.

Participation with willing landowners is essential to expand the scope of surveys to private lands. One means may be to develop cooperative arrangements with private landowners and managers of municipal lands. In addition, a joint United States and Mexico effort to survey and protect California red-legged frog populations and their habitat in Mexico is needed.

The following regions have been identified as areas which need current surveys. Additional areas will inevitably be identified throughout implementation of the recovery plan.

11.2.1 Conduct surveys in the Tehachapi Mountains.

11.2.2 Conduct surveys in the Santa Monica Mountains.

11.2.3 Conduct surveys in the Sisquoc River.

11.2.4 Conduct surveys in the upper Salinas River drainage including the Estrella-San Jose system in San Luis Obispo County.

11.2.5 Conduct surveys in the Carrizo Plain and San Juan Creek.

11.2.6 Conduct surveys on Bureau of Land Management lands (particularly in Recovery Unit # 6).

11.2.7 Conduct surveys within the historic and current range in the Sierra Nevada.

11.2.8 Conduct surveys on all other lands identified as unsurveyed or where survey data is not recent (within the last 5 years).

11.3 Monitor known California red-legged frog populations.

A better understanding of the demographics and distribution will give a fuller picture of population viability and threats to California red-legged frog populations. These data are necessary to assess the species' status over time. Identification of source and sink populations should be included under this recovery action.

11.3.1 Develop a population monitoring program.

Protocols for the collection and analysis of qualitative and quantitative monitoring data should be developed. One approach may be to monitor representative populations such that the viability of a group of populations or a known metapopulation can be estimated.

11.3.2 Conduct qualitative assessments of all known populations.

Each population should be monitored to determine its status. Parameters to be noted include presence/absence of suitable habitat, habitat modification, disturbance, threats, and other factors.

11.3.3 Conduct quantitative assessments of representative populations.

Representative populations, in each recovery unit, will be chosen to be monitored in greater detail using a protocol as defined under Task 11.3.1. Quantitative data needs include, but are not limited to, numbers of individuals per age class, reproductive rates, survival, recruitment rates, immigration and emigration rates. This information should allow for the identification of source and sink populations.

11.3.4 Researchers and surveyors should, as a term and condition for holding a section 10(a)(1)(A) scientific take permit, provide survey and monitoring information to us and the California Department of Fish and Game for input into appropriate databases.

Survey data should be provided to the California Department of Fish and Game's Natural Heritage Program for input into their Natural Diversity Database on a yearly basis. In addition, population monitoring data and habitat condition information should be consolidated into a database, and maintained by our Sacramento, Ventura, and Carlsbad Fish and Wildlife offices. This database should be accessible to all interested parties including planning agencies, researchers, and the general public.

11.3.5 Use the results obtained from the monitoring of the California red-legged frog populations to determine where recovery efforts need to be focused and to change prioritization of actions and locations if necessary.

A contingency plan should be developed and implemented to best respond to success and/or failure of previously implemented recovery methods. For example, if bullfrog eradication programs have resulted in expenditure of funds with little success, alternatives should be investigated and implemented. Further, if surveys reveal areas of source populations that are not identified as core areas, the delineations of core areas should be re-defined or expanded as appropriate.

11.3.6 Track status and recovery of California red-legged frog populations per recovery unit and propose delisting where appropriate.

Monitoring of frog population trends, habitat conditions, and status of threats may indicate that delisting is appropriate. It is likely, however, that recovery will occur at different rates per region; recovery units with lower recovery potential will require extensive management and monitoring. If distinct vertebrate population segments are identified, these may be delisted independently when appropriate.

11.3.6.1 Track status and recovery in Recovery Unit # 1.

11.3.6.2 Track status and recovery in Recovery Unit # 2.

11.3.6.3 Track status and recovery in Recovery Unit # 3.

11.3.6.4 Track status and recovery in Recovery Unit # 4.

11.3.6.5 Track status and recovery in Recovery Unit # 5.

11.3.6.6 Track status and recovery in Recovery Unit # 6.

11.3.6.7 Track status and recovery in Recovery Unit # 7.

11.3.6.8 Track status and recovery in Recovery Unit # 8.

11.4 Conduct population viability analyses for California red-legged frog metapopulations throughout the range as appropriate.

Population viability analyses are tools that can identify populations in need of recovery actions, as opposed to those that may be viable over the long-term without intervention. Population viability analyses also may help identify the best sites for reestablishment (i.e., identify metapopulations that may require additional subpopulations for long-term viability), determine the effectiveness of recovery actions (i.e., determine whether population growth rates are sufficient to ensure long term viability), determine whether recovery criteria are appropriate or need revision (i.e., whether the recovery goals are adequate to ensure long-term viability of the subspecies), determine minimum population sizes required for long-term viability, determine the anticipated time when recovery goals can be reached, and provide many other answers related to population trends.

11.5 Study metapopulation dynamics, particularly the California red-legged frog movements, among subpopulations.

This information will be used to determine whether active reestablishment efforts are necessary following habitat restoration. Information on metapopulation dynamics, in conjunction with frog monitoring data, will also help define isolated populations that are at risk of local extirpation, and identify source and sink subpopulations.

11.6 Conduct research to better understand the ecology of the California red-legged frog including the use of uplands, dispersal habits, and overland movements.

Environmental factors and habitat characteristics that hinder or facilitate movement of various life stages should be determined. This will assist in the development of best management practices, appropriate buffers from disturbances, and optimum preserve design and size.

11.7 Investigate the effects of contaminants issues including ozone, pesticides, herbicides, heavy metals, salinity, selenium, agricultural chemicals, hydrocarbons, chlorine, ultraviolet radiation, estrogen mimics, airborne contaminants, methoprene and other chemicals used to control mosquitoes, and others as appropriate (e.g., detergents).

The effects of contaminants on the California red-legged frog have not been widely studied and this is an area where research is needed. As noted above, toxicity tests are needed to determine the effects of contaminants, the levels at which detrimental effects occur, and measures required to minimize the effects of chemicals. Further, the transport of contaminants from primary sources (e.g., Central Valley) to distant areas (e.g., the Sierran foothills) should be investigated. Research on the effects and transport of contaminants will provide information necessary for establishing sound air and water quality standards. In addition, risk assessments of pesticides typically fail to evaluate the breakdown by-products. Recent research suggests these by-products may pose a threat to amphibians (La Clair 1998) although these experiments used 15,000 times the label rate and still found low levels of deformity or mortality (P. Bindings *in litt.* 2000). Therefore, the effects of breakdown by-products of pesticidal chemicals should also be evaluated

11.8 Conduct research on the effects of mosquitofish including the development of alternatives to mosquitofish use.

Mosquitofish are considered to be a predator of the California red-legged frog although there are some sites where the species coexist. Additional research is needed to better understand how these two species interact. Alternatives to the use of mosquitofish as a means of mosquito abatement should be investigated to decrease this practice if it does indeed pose a threat to the frog. Alternatives include other biological control methods such as the application of several species of bacteria (*Bacillus* sp.) and a fungus (*Lagenidium giganteum)* which attacks and kills only mosquitoes. The implications of introductions of these other control agents, however, may require extensive research. To implement this task, we should work with mosquito and vector control districts to minimize conflicts between public health and the California red-legged frog, and look for sources of funding for necessary research.

11.9 Conduct research on the ecology of non-native species.

To better understand the interactions with and effects on the California red-legged frog and gain an understanding on the best management of habitats (i.e, management that favors red-legged frogs over non-native predators), more information on the distribution, life histories, and habitat needs of non-native predators is needed. An important component of this task is to gather such information on bullfrogs. Bullfrogs should be studied at a minimum of three northern coastal sites, three northern non-coastal sites, three southern coastal sites, and three southern non-coastal sites, to consider variations in the bullfrog's life history within the range of the California red-legged frog. Another research need is to determine effects of non-native species including crayfish, non-native fish, and African clawed frogs.

11.10 Determine the genetic and ecological relationships between *Rana aurora draytonii* and *R. a. aurora*.

Red-legged frogs in the intergrade zone from northern Marin County to southern Del Norte County have not been assigned to either subspecies (northern red-legged frog or California red-legged frog). Based on morphological and behavioral differences, researchers have suggested that the two subspecies may actually be distinct species and that the frogs in the intergrade zone may represent a zone of hybridization between the two species (G. Fellers pers. comm. 1999). Genetic research is needed to clarify systematic relationships and allow a more precise identification of the northern limits of the geographic distribution of the California red-legged frog.

11.11 Determine whether distinct vertebrate population segments are identifiable for the California red-legged frog.

Portions of the range of the California red-legged frog may be delisted incrementally, provided the delisted portions qualify as distinct population segments (defined in U.S. Fish and Wildlife Service 1996e). Research is needed to determine whether particular recovery units, combinations of recovery units, or other portions of the range of the frog meet the definition of distinct population segments. Such research would address whether portions of the range are 'discrete' and 'significant' in relation to the remainder of the species (as described in Section II-c and in U.S. Fish and Wildlife Service 1996e).

11.12 Conduct experimental manipulations of habitat to determine habitat requirements of the frog, and subsequently, develop habitat creation and restoration.

One of the most fruitful ways to investigate the habitat requirements of California red-legged frogs is through creation and manipulation of habitats. These investigations will serve two needs: to better understand habitat requirements of the frog, and refine the methods for creation, improvement, and management of habitat (natural and artificial). Experiments could include examination of the optimum structure (i.e., depth, size) of artificial ponds and the optimum hydroperiod for maintaining suitability for the California red-legged frog, while decreasing the chances of non-native predator proliferation. Responses of the red-legged frog to habitat experiments need to be carefully monitored over a period of 5 years minimum.

11.13 Conduct studies on the interactions of cattle grazing and California red-legged frogs.

Experimental manipulations with habitat controls will best assist land managers in the development of appropriate grazing regimes. In particular, to determine the effects of various grazing regimes, it will be extremely beneficial to experimentally fence portions of riparian zones, ponds, springs, and other aquatic bodies to exclude livestock to varying degrees and over differing time periods.

11.13.1 Determine the effects of livestock waste on frogs, particularly larval development.

Congregation of livestock and horses (i.e., watering troughs, corrals) may be a source of concentrated waste. Research is necessary to fully understand the effects on all life stages of the California red-legged frog and to determine the appropriate avoidance buffer needed to minimize impacts to the frog.

11.13.2 Determine grazing thresholds, on a site by site basis, that ensure optimum habitat suitability for the California red-legged frog.

Areas that need further research include determination of appropriate stocking densities, seasonality of grazing, and residual dry matter levels for California red-legged frog habitat suitability.

11.14 Develop and/or refine a protocol for a captive rearing and propagation program.

California red-legged frogs from captive rearing and propagation efforts may be required for reestablishment efforts or as an insurance measure to forestall extinction of wild populations in the event of catastrophic population declines. Propagation techniques should be designed to minimize both the loss of genetic diversity and the introduction and spread of non-native diseases. Laboratory experiments should only use frogs from captive propagation efforts.

11.15 Investigate the effects of eucalyptus on water quality and habitat suitability for California red-legged frogs.

Stream reaches which are dominated by eucalyptus may not be suitable for the California red-legged frog. The relationship of eucalyptus and habitat suitability for the frog should be examined.

12.0 Increase public awareness and involvement in the protection of the California red-legged frog and native, co-occurring species.

Implementation of recovery actions may depend on the level of awareness of public landowners, private landowners, conservation groups, planning interests, and stakeholders. Outreach plans and educational programs explaining the life history and habitat needs of the species and the goals of recovery will be an important part of implementation.

12.1 Develop and implement outreach plans.

Plans should focus on providing information to interested and affected landowners about: (1) the California red-legged frog, (2) what is meant by recovery, and (3) how recovery can be achieved. Private landowners should become familiar with the frog and/or frog habitat that occur on their land, with the significance of the populations, and with available conservation measures, including incentive programs. For private lands with potential occurrences of the California red-legged frog (i.e., lands with historic occurrences or otherwise within the range of the subspecies), permission should be sought from landowners to conduct surveys (task 11.2). If populations of the California red-legged frog are identified, landowners should be informed of their significance and should be encouraged to follow land uses guidelines that protect the species and its habitat.

We should offer periodic updates to the press and general public regarding the status of the California red-legged frog and recovery efforts. Creation of exhibits containing live frogs in natural frog habitat should be encouraged if exhibits are also used to gather pertinent research information such as captive propagation techniques. The National Wildlife refuges, Point Reyes National Seashore, Golden Gate National Recreation Area, Año Nuevo and/or other State parks, National Forests, and regional park districts should be excellent locations for providing such educational opportunities to the public.

12.2 Develop and implement participation plans.

Participation plans will assist in the realization of recovery goals by getting commitments from participating agencies and stakeholders to implement recovery actions where feasible. Implementation of recovery tasks will require cooperative efforts on the part of resource and regulatory agencies, regional, county, and city park districts, local landowners, conservation groups, and planning interests. Development and implementation of separate participation plans in each recovery unit is necessary.

12.2.1 Develop a participation plan for Recovery Unit # 1.

12.2.2 Develop a participation plan for Recovery Unit # 2.

12.2.3 Develop a participation plan for Recovery Unit # 3.

12.2.4 Develop a participation plan for Recovery Unit # 4.

12.2.5 Develop a participation plan for Recovery Unit # 5.

12.2.6 Develop a participation plan for Recovery Unit # 6.

12.2.7 Develop a participation plan for Recovery Unit # 7.

12.2.8 Develop a participation plan for Recovery Unit # 8.

12.3. Provide technical assistance to private landowners who wish to voluntarily improve conditions for the California red-legged frog.

A significant portion of recovery can be achieved through landowners who may voluntarily improve habitat conditions for the California red-legged frog. Landowners should be provided technical guidance such as guidelines for wetland/pond management when requested (see Appendix D).

13.0 Assess effects of various conservation efforts on co-occurring, native species.

Population data on listed and non-listed sensitive, co-occurring native species (Table 2) will aid in their preservation. Improved habitat conditions may lead to increased populations of species of concern and thus may forestall the need to list these species in the future. Although it is assumed that enhancement of habitat conditions for the California red-legged frog will benefit other native species, the impacts of enhancement efforts on co-occurring, native species should be assessed.

13.1 Monitor co-occurring, native species.

There must be sufficient monitoring of populations and reproduction to detect any detrimental effects that may arise from habitat improvements directed at improving conditions for the California red-legged frog. Species-specific habitat information should be collected on an as needed basis. This task can be achieved through coordination with ongoing recovery efforts for associated listed species.

13.2 Implement remediation, where appropriate.

If conservation efforts cause declines in populations of listed or non-listed co-occurring species, remediation efforts should be developed and implemented.

IV. Implementation Schedule

This implementation schedule outlines actions and estimated costs for this recovery plan. It is a guide for meeting the objectives discussed in this recovery plan. This schedule describes and prioritizes tasks, provides an estimated time table for performance of tasks, indicates responsible agencies, and estimates costs of performing tasks. These actions, when accomplished, should recover the California red-legged frog and co-occurring species.

KEY TO ACRONYMS USED IN THE IMPLEMENTATION SCHEDULE

Definition of task priorities:

Priority 1	An action that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.
Priority 2	An action that must be taken to prevent a significant decline in the species' population or habitat quality, or some other significant negative impact short of extinction.
Priority 3	All other actions necessary to meet recovery or conservation objectives.

Definition of task durations and costs:

Continual	A task that will be implemented on a routine basis once begun.
Ongoing	A task that is currently being implemented and will continue until action is no longer necessary.
TBD	To be determined.
*	Continued implementation of task expected to be necessary after delisting.
†	Task expected to be necessary until delisting of species (possible by 2025).

Responsible parties are those agencies who may voluntarily participate in any aspect of implementation of particular tasks listed within this recovery plan. Responsible parties may willingly participate in project planning, funding, provide technical assistance, staff time, or any other means of implementation.

Costs of some recovery tasks cannot be estimated at this time. Costs of developing and implementing watershed management and protection plans will vary with local circumstances and details of individual plans. Sites for reestablishment of California red-legged frogs have not yet been determined, so costs of assessment and restoration cannot be estimated. The scope of necessary contaminants studies depends on results of ongoing research.

Responsible parties:

ACE	Army Corps of Engineers
ADC	Animal Damage Control
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BRD	Biological Resources Division, U.S. Geological Survey
CDFG	California Department of Fish and Game
CDPR	California Department of Parks and Recreation
CDF	California Department of Forestry and Fire Protection
COUN	County
DOD	Department of Defense
DWR	California Department of Water Resources
EBRPD	East Bay Regional Park District
EPA	Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
FS	U.S. Forest Service
MUD	Municipal Utility District
MULTI	Multiple public land agencies
MVCD	Mosquito Vector Control District
NPS	National Park Service
TNC	The Nature Conservancy
Tribe	Local Native American tribe(s)
UCNRS	University of California Natural Reserve System
UNIV	University or academic researchers
WMD	Local Water Management Districts

Potential lead responsible parties are designatd in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
1	1.1	Develop and implement a management and protection plan for Core Area #1 (Feather River).	continual*	**Plumas National Forest**, Lassen National Forest, FWS	TBD					
1	1.2	Develop and implement a watershed management and protection plan for Core Area #2 (Yuba River-South Fork Feather)	continual*	**Plumas National Forest**, FWS, private	TBD					
1	1.3	Develop and implement a management and protection plan for Core Area #3 (Middle Fork American River)	continual*	**Eldorado National Forest**, FWS, private	TBD					
1	1.4	Develop and implement a management and protection plan for Core Area #4 (Cosumnes River-South Fork American River)	continual*	**Plumas National Forest**, FWS, BLM, DWR, USFS, FWS, El Dorado County, El Dorado Irrigation District, American River Conservancy private	TBD					
1	1.5	Develop and implement a management and protection plan for Core Area #5 (South Fork Calaveras River)	continual*	FWS, **USFS–Calaveras Ranger District**, private	TBD					
1	1.6	Develop and implement a watershed management and protection plan for Core Area #6 (Tuolumne River)	continual*	**Yosemite National Park**, FWS	TBD					
1	1.7	Develop and implement a watershed management and protection plan for Core Area #7 (Piney Creek)	continual*	**Stanislaus National Forest**, FWS	TBD					

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units)					
					Total Costs	FY1	FY2	FY3	FY4	FY5
1	1.8	Develop and implement a watershed management and protection plan for Core Area #8 (Cottonwood Creek)	continual*	MULTI	TBD					
1	1.9	Develop and implement a management and protection plan for Core Area #9 (Putah Creek-Cache Creek)	continual*	**BLM**, FWS, private	TBD					
1	1.10	Develop and implement a management plan for Core Area #10 (Tributaries to Lake Berryessa)	continual*	FWS, **BLM**, USBR, CDFG, UCNRS, Quail Ridge Wilderness Conservancy	TBD					
1	1.11	Develop and implement a watershed management and protection plan for Core Area #11 (Upper Sonoma Creek)	continual*	**CDPR**, FWS	TBD					
1	1.12	Develop and implement a watershed management and protection plan for Core Area #12 (Petaluma Creek-Sonoma Creek)	continual*	**FWS**, Sonoma Land Trust, private	TBD					
1	1.13	Develop and implement a watershed management and protection plan for Core Area #13 (Point Reyes Peninsula)	continual*	**NPS**, CDPR, Marin Municipal Water District, FWS	TBD					
1	1.14	Develop and implement a watershed management and protection plan for Core Area #14 (Belvedere Lagoon)	continual*	**FWS**, private	TBD					
1	1.15	Develop and implement a management and protection plan for Core Area #15 (Fagan-Jameson Canyon-Lower Napa River)	continual*	FWS, **Land Trust of Napa County**, City of American Canyon	TBD					

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
1	1.16	Develop and implement a management and protection plan for Core Area #16 (East San Francisco Bay)	continual*	**EBRPD**, FWS, CDFG, CDPR, EBMUD, Lawrence Livermore Laboratory, DWR, USBR, TNC, private	TBD					
1	1.17	Develop and implement a watershed management and protection plan for Core Area #17 (Santa Clara Valley)	continual*	MULTI	TBD					
1	1.18	Develop and implement a management and protection plan for Core Area #18 (South San Francisco Bay)	continual*	**CDPR**, CDFG, FWS. private	TBD					
1	1.19	Develop and implement a management and protection plan for Core Area #19 (Watsonville Slough–Elkhorn Slough)	continual*	Elkhorn Slough National Estuarine Research Institute, **CDPR**, FWS, private	TBD					
1	1.20	Develop and implement a management and protection plan for Core Area #20 (Carmel River-Santa Lucia)	continual*	**CDPR**, **Los Padres National Forest**, FWS, private	TBD					
1	1.21	Develop and implement a management and protection plan for the Core Area #21 (Gablan Range)	continual*	FWS, **Pinnacles National Monument**, private	TBD					
1	1.22	Develop and implement a management and protection plan for the Core Area #22 (Estero Bay)	continual*	**CDPR**, FWS, private	TBD					

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units)					
					Total Costs	FY1	FY2	FY3	FY4	FY5
1	1.23	Develop and implement a management and protection plan for Core Area #23 (Arroyo Grande)	continual*	**CDPR**, FWS, private	TBD					
1	1.24	Develop and implement a management and protection plan for Core Area #24 (Santa Maria-Santa Ynez River)	continual*	Los Padres National Forest, **Vandenberg Air Force Base (DOD)**, CDPR, FWS, private	TBD					
1	1.25	Develop a management and protection plan for Core Area #25 (Sisquoc River)	continual*	FWS, **Los Padres National Forest**	TBD					
1	1.26	Develop a watershed management and protection plan for Core Area #26 (Ventura River-Santa Clara River)	continual*	**Los Padres National Forest**, FWS, private	TBD					
1	1.27	Develop and implement a watershed management and protection plan for Core Area #27 (Santa Monica Bay-Ventura Coastal Streams)	continual*	**CDPR**, **Santa Monica National Recreation Area**, Las Virgenes Institute, FWS, private	TBD					
1	1.28	Develop a watershed management and protection plan for Core Area #28 (Estrella River)	continual*	**FWS**, private	TBD					
1	1.29	Develop a watershed management and protection plan for Core Area #29 (San Gabriel Mountains)	continual*	**Angeles National Forest**, FWS	TBD					
1	1.30	Develop and implement a management and plan for Core Area #30 (Mojave River)	continual*	**San Bernadino National Forest**, FWS	TBD					

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
1	1.31	Develop and implement a watershed management and protection plan for Core Area #31 (Santa Ana Mountain)	continual*	**Cleveland National Forest**, FWS	TBD					
1	1.32	Develop and implement a watershed management and protection plan for Core Area #32 (Santa Rosa Plateau)	continual*	**TNC**, CDFG, FWS, Cleveland National Forest, private	TBD					
1	1.33	Develop and implement a watershed management plan for Core Area #33 (San Luis Rey)	continual*	Tribe, **FWS**, WMD, private,	TBD					
1	1.34	Develop and implement a watershed management plan for Core Area #34 (Sweetwater River)	continual*	FWS, **CDFG**, Sweetwater Authority (WMD)	TBD					
1	1.35	Develop and implement a watershed management and protection plan for Core Area #35 (Laguna Mountain)	continual*	**Cleveland National Forest**, FWS, private	TBD					
1	4	Develop and implement conservation plans for the California red-legged frog for all State and regional parks and water/utility districts within the historic and current range	continual*	**CDPR**, **Regional Parks**, MUDs, FWS	TBD					
1	5	Work with county planners and local water districts to minimize effects of urban and suburban development by creating regional plans or habitat conservation plans	ongoing*	**FWS**, local governments and water districts	12	0.5	0.5	0.5	0.5	0.5
1	6.1	Emphasize connectivity of affected habitat areas or populations by analyzing impacts and developing mitigation recommendations at the metapopulation and regional level	ongoing*	**FWS**	18	0.75	0.75	0.75	0.75	0.75

Potential lead agencies are designated in bold.

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Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
1	6.2	Design mitigation plans to enhance the viability of an entire metapopulation	ongoing†	**FWS**	12	0.5	0.5	0.5	0.5	0.5
1	6.3	Analyze project impacts by considering the variable breeding status of frogs in response to varying weather conditions	ongoing†	**FWS**	12	0.5	0.5	0.5	0.5	0.5
1	6.4	Implement off-site mitigation when on-site conditions are not likely to be beneficial for the frog	ongoing†	**FWS**	18	0.75	0.75	0.75	0.75	0.75
1	6.5	Include management and monitoring plans for mitigation measures that rely on habitat construction, enhancement or preservation	ongoing†	**FWS**	18	0.75	0.75	0.75	0.75	0.75
1	7	Develop and implement guidelines for improving water quality within the range of the California red-legged frog	continual*	**EPA**, DWR, FWS	180	40	30	5	5	5
1	8	Implement air quality standards where poor quality is contributing to degraded conditions	ongoing*	**EPA**, FWS	270	80	80	5	5	5
1	9.1	Refine guidelines to minimize the spread of disease and parasites	1 year	**BRD**, FWS	1.5	1.5				
1	9.2	Minimize chances of spread of disease when conducting field surveys and research	ongoing*	MULTI	12	0.5	0.5	0.5	0.5	0.5
1	10.1	Implement site assessments and restoration programs prior to reestablishment of the frog	2 years	Los Angeles Zoo, **BRD**, **Univ**, FWS	TBD					
1	10.2	Conduct pilot captive rearing and reestablishment programs to test methods	2 years	Los Angeles Zoo, **BRD**, **Univ**, FWS, Las Virgenes Institute	500	250	250			

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units)					
					Total Costs	FY1	FY2	FY3	FY4	FY5
1	10.3.1	Reestablish the frog in unoccupied core areas in Recovery unit # 1	5 years	FWS, **BRD**, **Univ**	500	100	100	100	100	100
1	10.3.2	Reestablish the frog in unoccupied core areas in Recovery Unit # 2	5 years	FWS, **BRD**, **Univ**	500	100	100	100	100	100
1	10.3.3	Reestablish the frog in unoccupied core areas in Recovery Unit # 8	5 years	Los Angeles Zoo, **FWS**, Univ, Las Virgenes Institute	500	100	100	100	100	100
2	2	Develop and implement management and protection plans for all Priority 2 watersheds	continual*	MULTI	TBD					
2	6.6	Analyze past and future mitigation measures against clearly defined success criteria to determine effectiveness	ongoing†	**FWS**	18	0.75	0.75	0.75	0.75	0.75
2	6.7	Establish and maintain a database that tracks the amount of incidental take authorized and the effectiveness of mitigation measures	ongoing†	**FWS**	3.6	0.15	0.15	0.15	0.15	0.15
2	6.8	Summarize extent of incidental take previously authorized	ongoing†	**FWS**	2.4	0.1	0.1	0.1	0.1	0.1
2	6.9	Cease the use of frog barriers as a mitigation measure	continual†	MULTI	2	2				
2	11.1	Develop a California red-legged frog survey and monitoring protocol	1 year	MULTI	40	40				
2	11.2.1	Conduct surveys in the Tehachapi Mountains	5 years	MULTI	25	5	5	5	5	5
2	11.2.2	Conduct surveys in the Santa Monica Mountains	5 years	MULTI	25	5	5	5	5	5

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
2	11.2.3	Conduct surveys in the Sisquoc River Watershed	5 years	MULTI	25	5	5	5	5	5
2	11.2.4	Conduct surveys in the upper Salinas River Drainage	5 years	MULTI	25	5	5	5	5	5
2	11.2.5	Conduct surveys in the Carrizo Plain vicinity	5 years	MULTI	25	5	5	5	5	5
2	11.2.6	Conduct surveys on Bureau of Land Management lands	5 years	**BLM**, FWS	50	10	10	10	10	10
2	11.2.7	Conduct surveys within the historic and current range in the Sierra Nevada.	5 years	MULTI	50	10	10	10	10	10
2	11.2.8	Conduct surveys on all other lands identified as unsurveyed	20 years	MULTI	1790					
2	11.3.1	Develop a population monitoring program	1 year	BRD, **FWS**, Univ	40	40				
2	11.3.2	Conduct qualitative assessments of known populations	4 years	**FWS**, **BRD**, CDPR	320	80	80	80	80	
2	11.3.3	Conduct quantitative assessments of representative populations	10 years	MULTI	1500	150	150	150	150	150
2	11.3.4	Researchers should provide survey data to California Department of Fish and Game and FWS	ongoing†	MULTI	12	0.5	0.5	0.5	0.5	0.5
2	11.3.5	Utilize monitoring results to determine where recovery should be focused	25 years	**FWS**	120		10		10	
2	11.3.6.1	Track status and recovery in Recovery Unit # 1	ongoing†	**FWS**	120	5	5	5	5	5

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
2	11.3.6.2	Track status and recovery in Recovery Unit # 2	ongoing†	**FWS**	120	5	5	5	5	5
2	11.3.6.3	Track status and recovery in Recovery Unit # 3	ongoing†	**FWS**	120	5	5	5	5	5
2	11.3.6.4	Track status and recovery in Recovery Unit # 4	ongoing†	**FWS**	120	5	5	5	5	5
2	11.3.6.5	Track status and recovery in Recovery Unit # 5	ongoing†	**FWS**	120	5	5	5	5	5
2	11.3.6.6	Track status and recovery in Recovery Unit # 6	ongoing†	**FWS**	120	5	5	5	5	5
2	11.3.6.7	Track status and recovery in Recovery Unit # 7	ongoing†	**FWS**	120	5	5	5	5	5
2	11.3.6.8	Track status and recovery in Recovery Unit # 8	ongoing†	**FWS**	120	5	5	5	5	5
2	11.4	Conduct population viability analyses for metapopulations	5 years	**BRD**, **Univ**, FWS	25			5	5	5
2	11.5	Research metapopulation dynamics	10 years	**BRD**, **Univ**, FWS	250			25	25	25
2	11.6	Conduct research to better understand the ecology of this species including use of uplands, dispersal habits, and overland movements	10 years	**BRD**, **Univ**, Los Angeles Zoo, EBRPD, EBMUD, FWS	400	40	40	40	40	40
2	11.7	Investigate contaminants issues	ongoing†	FWS, **EPA**, **BRD**	TBD					
2	11.8	Conduct research on the effects of mosquitofish and determine alternatives to mosquitofish use	5 years	BRD, **Univ**, **MVCD**, FWS	400	80	80	80	80	80
2	11.9	Conduct research on the ecology of exotic species	5 years	**BRD**, **Univ**, FWS	100	20	20	20	20	20

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
2	11.10	Determine genetic and ecological relationships between *R. aurora draytonii* and *R.a.aurora*	3 years	**Univ**, BRD, FWS	90	30	30	30		
2	11.11	Determine whether distinct vertebrate population segments are identifiable for the California red-legged frog	5 years	**BRD**, **FWS**, **Univ**	150	30	30	30	30	30
2	11.12	Conduct experimental manipulations of habitat to determine requirements for creation and restoration	5 years	**BRD**, Los Angeles Zoo, **Univ**, FWS, Las Virgnes Institute, TNC	100	20	20	20	20	20
2	11.13.1	Determine the effects of livestock waste	2 years	BRD, **NPS**, FWS	40	20	20			
2	11.13.2	Determine grazing thresholds that ensure optimum habitat suitability	5 years	MULTI	100	20	20	20	20	20
2	11.14	Develop a protocol for a captive propagation program	2 years	Los Angeles Zoo, BRD, **Univ**, **FWS**, Las Virgenes Institute	50	25	25			
2	12.1	Develop and implement outreach plans	1 year	**FWS**	40	40				
2	12.2.1	Develop and implement participation plan for Recovery Unit # 1	1 year	**FWS**	40	40				
2	12.2.2	Develop and implement participation plan for Recovery Unit # 2	1 year	**FWS**	40	40				
2	12.2.3	Develop and implement participation plan for Recovery Unit # 3	1 year	**FWS**	40	40				
2	12.2.4	Develop and implement participation plan for Recovery Unit # 4	1 year	**FWS**	40	40				
2	12.2.5	Develop and implement participation plan for Recovery Unit # 5	1 year	**FWS**	40	40				

Potential lead agencies are designated in bold.

Implementation Schedule for the California Red-legged Frog Recovery Plan

Task Priority	Task Number	Task Description	Task Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total Costs	FY1	FY2	FY3	FY4	FY5
2	12.2.6	Develop and implement participation plan for Recovery Unit # 6	1 year	**FWS**	40	40				
2	12.2.7	Develop and implement participation plan for Recovery Unit # 7	1 year	**FWS**	40	40				
2	12.2.8	Develop and implement participation plan for Recovery Unit #8	1 year	**FWS**	40	40				
2	12.3	Provide technical assistance to landowners	continual†	**FWS**	120	5	5	5	5	5
3	3	Develop and implement a watershed management and protection plan for Priority 3 watersheds	continual*	MULTI	TBD					
3	11.15	Investigate the effects of eucalyptus on water quality	1 year	NPS, GGNRA, **EBRPD**, BRD, FWS	20	20				
3	13.1	Monitor cohabiting, native species	continual†	MULTI	240	10	10	10	10	10
3	13.2	Implement remediation, where appropriate	continual†	MULTI	TBD					
		Total estimated cost			**10,031.5+ TBD costs**					

Potential lead agencies are designated in bold.

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V. Appendices

APPENDIX A. GLOSSARY OF TECHNICAL TERMS

amplexus — from Latin, an embracing; the breeding position of frogs, where the male is on the female’s back and clasping her directly behind the front legs or directly in front of the hind legs.

anadromous — describes fish that are born in fresh water, migrate to sea, and return to fresh water to spawn (e.g., salmon, sturgeon).

Anura — the Order of tailless amphibians; frogs and toads.

aquatic — of or in water; streams, lakes, rivers, ponds, and marshes are aquatic habitats.

candidate — species for which the U.S. Fish and Wildlife Service believes there is enough information on status and threats to support a proposal for listing.

colonization — the act or process of establishing a new colony or population.

contour — a practice of leaving felled trees parallel to the contour line felling of a hillside to stabilize soils and prevent erosion.

core areas — watersheds, or portions thereof, that have been determined to be essential to the recovery of the California red-legged frog.

dispersers — individual frogs, usually juveniles or subadults, that move away from the site where they hatched and metamorphosed and settle at another site.

diurnal — active during the day.

dorsal — of or pertaining to the upper surface; top or back.

dorsolateral folds — ridge of skin along the region between the center of the back and the sides.

ecotone — a zone where vegetation types (such as riparian and upland) adjoin each other and often mix.

effluent — an outflow, such as waste from a sewer, or water off of agricultural fields or streets and other developed areas.

ephemeral — lasting only a short time, temporary; for aquatic habitats, water present only part of the year.

exotic — not native to the area, introduced from another region or country.

extinct	no longer existing. Can refer to a species in its entirety, or in a particular part of the range.
extirpated	extinct in a particular area.
habitat	the environment in which a species or population lives and grows. Different types of habitats may be used for different life stages.
habitat fragmentation	breaking up continuous habitat into smaller, isolated pieces.
intergrade	having representative characteristics of two or more distinct groups, such as hybrid frogs with characteristics of two subspecies or species.
interstitial	the spaces between sand grains or gravel.
juvenile	a newly metamorphosed frog; sometimes called froglets up to sexual maturity at 2 to 3 years.
listed	species recognized by Federal or State governments as endangered or threatened.
maritime	adjacent to the ocean, influenced by the ocean.
metamorph	immature life stage with characteristics of both tadpoles and adult frogs.
metamorphosis	the process of changing from a larvae (tadpole) to an adult (frog).
metapopulation	several to many subpopulations of frogs that are close enough to one another that dispersing individuals could be exchanged.
microhabitat	the smallest unit of a habitat, such as a clump of reeds that provides cover for tadpoles, or the vegetation to which eggs are attached, or a basking site for a frog.
morphological	pertaining to body shape or structure.
nocturnal	active during the night.
oviposition	the act of egg-laying and/or the location where eggs are laid.
perennial	for aquatic habitats, persisting all year; for plants, living more than 1 year.
point bar	the inside portion of a bend in a stream or river where sand and gravel accumulate.
population	in the wider sense, all California red-legged frogs throughout their range. In the narrower sense, used to refer to the frogs in one particular locality or watershed; a collection of individuals that share a common gene pool.

posterior toward the rear or tail.

proposed species for which a proposal to list the species as threatened or endangered has been published in the Federal Register.

Ranidae the Family of true frogs.

recovery units regions of the species' distribution that are distinct from one another based on ecological characteristics, status of the species, threats to the continued existence of the species, or recovery actions needed within the area.

riparian terrestrial areas adjacent to aquatic habitats; on the bank of a stream, river, pond, marsh, or lake.

sink population a population whose average reproductive rate is less than its average rate of mortality.

snout-urostyle "nose-to-tail", the length measured from the anterior tip of the nose to the **length** posterior end of the urostyle.

source population an actively breeding population that has an average birth rate that exceeds its average death rate, and thus produces an excess of juveniles that may disperse to other areas.

spatial of or relating to space or distribution in space, such as how ponds and streams are distributed in a landscape.

subpopulation a group of frogs using a particular breeding site or area; several to many subpopulations constitute a metapopulation.

taxon a level in the classification system, such as species, genus, family, or order.

temporal of or relating to time; can be on a daily, seasonal, annual, or longer basis.

upland terrestrial habitats not included in riparian zones, the higher elevations.

urostyle a rodlike bone composed of fused tail vertebrae present in frogs and toads.

viability capability or capacity to survive; for populations, the ability to survive into the foreseeable future.

vocal sac an inflatable pouch on the throat or at the sides of the neck in male frogs.

APPENDIX B. POTENTIAL CONTAMINANTS ASSOCIATED WITH CALIFORNIA RED-LEGGED FROG HABITAT

The chemicals of greatest concern for which data on amphibians, fish, or their food supply could be found are:

acephate
azinphos-methyl
carbaryl
chlorpyrifos
diazinon
dicofol
disulfoton
endosulfan
esfenvalerate
fenamiphos
glyphosate
malathion
mancozeb
methamidophos
methoprene
naled
paraquat
permethrin
phosmet
polycyclic aromatic hydrocarbons
pyrethrins
rotenone
strychnine
triclopyr
trifluralin

Units Glossary

LC50-lethal concentration to 50 percent of test organisms
mg/kg-milligrams per kilograms
mg/L-milligrams per liter
ng/L-nanongrams per liter
µg/L-micrograms per liter
PAH-Polycyclic Aromatic Hydrocarbons

Toxicity Analysis for These Chemicals

The information below, unless cited specifically, was obtained from Briggs (1992) and Moses (1997).

Acephate is an organophosphate insecticide (classified in some sources as a carbamate) that generally is applied as a foliar spray to control aphids. It is used on broccoli, cabbage, brussels sprouts, cauliflower, celery, kale, leeks, lettuce, and greenhouse plants. Studies on the toxicity of acephate to amphibians have shown effects to occur at relatively high concentrations when compared to other organophosphates. Studies by Geen *et al*. (1984) determined a lethal concentration to 50 percent of test organisms (LC50) of 8,816,000 micrograms/liter (µg/L) during a 4 day exposure period for the northwestern salamander (*Ambystoma gracile*). Studies on the green frog (*Rana clamitans*) reported a LC50 of 6,433 milligrams per liter (mg)/L (U.S. Environmental Protection Agency (1995)). Most other toxicity information on amphibians report LC50 values above 40,000 µg/L. However, accidental spills of acephate into habitat of the California red-legged frog could expose this species or its food base to lethal doses.

Azinphos-methyl (AZM) is an organophosphate insecticide and miticide used on fruits, nuts, vegetables, field crops, ornamentals, and forest and shade trees. The U.S. Environmental Protection Agency (1995) classifies this pesticide as class I, indicating high toxicity. Harris *et al*. (1998) reported a green frog (*Rana clamitans*) 16-day LC50 of >5.0 mg/L for Guthion WP, a preparation of 50 percent AZM. Dolah *et al.* (1997) reported that, in South Carolina streams, measured concentrations of AZM at greater than 17 µg/L have coincided with documented fish kills. They reported that at a concentration of 20 µg/L, 100 percent mortality occurs within a short time. The use of AZM in the vicinity of the California red-legged frog could affect recruitment and survival directly, or by affecting the food supply.

Carbaryl is a wide-spectrum carbamate insecticide, acaricide, and molluscicide used on citrus, fruit, cotton, forests, forage crops, rangelands, lawns, nuts, ornamentals, shade trees, and other crops, as well as on poultry, livestock, and pets. Studies on the toxicity of carbaryl to bullfrogs have shown effects to occur at relatively high concentrations (LC50 greater than 4,000 mg/kg) (Hudson 1984). Bioaccumulation of carbaryl can occur in catfish, crawfish, and snails, as well as in algae and duckweed. Residue levels in fish were 140-fold greater than the concentration of carbaryl in water. In general, due to its rapid metabolism and rapid degradation, carbaryl should not pose a significant bioaccumulation risk in alkaline waters. However, under conditions below neutrality, bioaccumulation may be significant (Baron 1991).

Chlorpyrifos, an organophosphate pesticide, is used in the vicinity of California red-legged frog populations and habitats on oats, greenhouse plants, broccoli, cabbage, brussels sprouts, cucumbers, cauliflower, kale, leeks, lettuce, parsley, radish, and berries. It is primarily a contact poison and is available as granules, wettable powder, dustable powder, and emulsifiable concentrate. There is insufficient information on the toxicity of chlorpyrifos to amphibians to fully evaluate the potential effects to the species. However, studies on the toxicity of chlorpyrifos to invertebrates have shown that relatively minor applications of the pesticide can have dramatic lethal and sublethal effects (Delpuech *et al.* 1998, Odenkirchen and Eisler 1988). Direct toxic effects to the California red-legged frog or its prey base from the application of this pesticide are possible with standard application rates and agricultural runoff.

Diazinon is a phosphorothioate used on fruits, vegetables, forage, field crops, pasture, rangelands, turf, and ornamentals to control soil insects and nematodes. It is also used for household insects and fly control. Harris *et al*. (1998) reported a diazinon 16-day LC50 for green frogs of 0.005±0.0001 mg/L active ingredient (a.i.). Harris also reported that Basudin® 500EC, a diazinon based pesticide, had a similar 16-day LC50 of 0.0028±0.0003 mg/L a.i. It is apparent that diazinon is extremely toxic to amphibians, and its use should be restricted in the vicinity of the California red-legged frog.

Dicofol is an organochlorine miticide manufactured from DDT and used on a wide variety of fruit crops, cotton, and ornamentals. In 1986, use of dicofol was temporarily canceled by the U.S. Environmental Protection Agency because of concerns raised by high levels of DDT contamination. However, it was reinstated when it was shown that modern manufacturing processes could produce technical grade dicofol containing less than 0.1 percent DDT. Dicofol is highly toxic to fish, aquatic invertebrates, and algae (Rohm and Haas Company 1991). It could pose a significant risk to the California red-legged frog and its prey base.

Disulfoton is a phosphorothioate insecticide and acaricide used on cotton, sugar beets, cabbage family crops, corn, wheat, ornamentals, cereal grains, and potatoes. It is a selective, systemic pesticide that is especially effective against sucking insects. Disulfoton is considered highly toxic to cold- and warm-water fish, crab, and shrimp. The LC50 values for the compound are 0.038 mg/L in bluegill sunfish, 0.25 mg/L in guppies, 1.85 mg/L in rainbow trout, and 6.5 mg/L in goldfish. According to the U.S. Environmental Protection Agency, the use of disulfoton on certain crops may pose a risk to some aquatic and terrestrial endangered species (U.S. Environmental Protection Agency 1984).

Endosulfan is a sulfur-containing organochlorine used for the control of aphids, thrips, beetles, mites, borers, cutworms, bollworms, bugs, whiteflies, and leafhoppers on citrus, small fruits, fiber crops, forage crops, forests, grains, nuts, oil crops, ornamentals, and vegetables. Studies by Berrill *et al*. (1998) reported severe toxicity to amphibians from exposure to endosulfan, including extensive paralysis to three different species of anuran tadpoles and high post-exposure mortality. Two-week old tadpoles suffered greater than 50 percent mortality 4 to 19 days after exposure to a range of 0.041-0.364 mg/L endosulfan. At an exposure of 0.307 mg/L, American toad (*Bufo americanus*) tadpoles exhibited discoloration, swelling, and death within 24 hours, or experienced delayed metamorphosis. Harris *et al*. (1998) reported that green frogs exposed to Thiodan ® (a 47 percent mixture of endosulfan) had a 16-d LC50 of greater than 5.0 mg/L. It is apparent that endosulfan is extremely toxic at low concentrations to amphibians, and its use should be restricted in the vicinity of the California red-legged frog.

Esfenvalerate, a class of isomers of fenvalerate, a synthetic pyrethroid (see **pyrethrin**), is used as a broad spectrum insecticide on fruits, nuts, artichokes, cabbage family crops, many other vegetables, forests, Christmas tree farms, and recreational areas. Eisler (1992) reported that at 4 degrees Celsius all northern leopard frogs exposed to a dose of 3 μg/L were dead within 72 hours. These isomers of fenvalerate are reported to be the most toxic technical mixtures, and their use in the vicinity of the California red-legged frog could have serious negative effects.

Fenamiphos, a phosphorothioate, is used on a variety of plants including turf, citrus and other fruit crops, some vegetables, and grains to control a wide variety of nematodes (roundworms). The compound is absorbed by roots and is then translocated throughout the plant. The toxicity of fenamiphos to aquatic species varies from moderate to high. Bluegill are extremely sensitive to fenamiphos; the LC50 is 9.6 mg/L in this species. Other species tested include the rainbow trout (LC50 is 0.11 mg/L) and goldfish (LC50 is 3.2 mg/L) (University of California at Davis 1997a). Fenamiphos has been linked to fish and bird kills and is known to have a high potential of leaching into the groundwater. The compound is not expected to bioaccumulate appreciably in aquatic organisms (Smith 1993).

Glyphosate is used for control of annual and perennial plants including grasses, sedges, broad-leaved weeds, and woody plants. It is used on range and pasture, as well as on over 150 crops. Glyphosate is also used for control of exotic species such as giant cane (*Arundo donax*), and thus has a role in the rehabilitation of habitat for several native species, including the California red-legged frog. Glyphosate does have the potential to contaminate surface waters due to its use patterns and through erosion, as it adsorbs to soil particles suspended in runoff. If glyphosate reached surface water, it would not be broken down readily by water or sunlight. Toxicity tests performed under standard conditions at the Columbia National Fisheries Laboratory indicated that this compound is “moderately toxic” to rainbow trout (U.S. Environmental Protection Agency 1993). Some formulations may be more toxic to aquatic species due to the different surfactants used in formulation. Although the herbicide glyphosate appears to have limited effects on amphibians, other components of the most commonly used formulations (e.g., Roundup®), particularly the surfactants, have severe negative effects on amphibians. Formulations of glyphosate must be used carefully in and near California red-legged frog habitat.

Malathion is a nonsystemic, wide-spectrum organophosphate insecticide used for the control of mosquitos, sucking and chewing insects on fruits and vegetables, flies, household insects, animal parasites (ectoparasites), and head and body lice. Malathion is used in formulations with many other pesticides. It is highly toxic to aquatic invertebrates with EC50 values from 1 μg/L to 1 mg/L (Johnson and Finley 1980), and to the aquatic stages of amphibians (U.S. Environmental Protection Agency 1992). Malathion has a wide range of toxicities in fish, from very highly toxic in walleye (96-hour LC50 of 0.06 mg/L) to slightly toxic in goldfish (10.7 mg/L) (Johnson and Finley 1980). Malathion could affect California red-legged frog populations through direct mortality and by reducing the prey base.

Mancozeb is a carbamate fungicide used on field crops, fruits, vegetables, nuts, and commercial sod farms. Harris *et al.* (1998) reported that green frog embryos exposed to Dithane DG® (76 to 80 percent mancozeb) had zero percent hatching success at approximately 1.0 to 20 mg/L. Adult frogs exhibited a 16-day LC50 of 0.20±0.04 mg(a.i.)/L. Mancozeb appears to be quite toxic to amphibians. Its use should be restricted in the vicinity of the California red-legged frog.

Methamidophos is a highly active, systemic, residual, organophosphate insecticide and acaricide used to control aphids, flea beetles, whiteflies, thrips, cabbage loopers, Colorado potato beetles, potato tubeworms, armyworms, mites, leafhoppers, and many others. Crop uses include broccoli, brussels sprouts, cauliflower, grapes, celery, sugar beets, cotton, and potatoes. This compound is considered to be highly toxic to mammals, birds, and bees (U.S. Environmental Protection Agency 1997a) and is also toxic to aquatic organisms. The LC50 ranges from 25 to 100 mg/l in 96-hour tests with rainbow trout, guppies, carp, and goldfish. Freshwater, estuarine, and marine crustaceans are extremely sensitive to methamidophos. Concentrations as low as 0.22 ng/L (nanograms/liter) (0.00000022 mg/l) were lethal to larval crustaceans in 96-hour toxicity tests.

Methoprene is an insect growth regulator. It is considered a biochemical pesticide because, rather than controlling target pests through direct toxicity, methoprene interferes with an insect’s life cycle and prevents it from reaching maturity or reproducing. Methoprene is used in the production of a number of foods including meat, milk, eggs, mushrooms, peanuts, rice, and cereals. It is also used in aquatic areas to control mosquitos and several types of flies, moths, beetles, and fleas. Studies on other amphibians suggest that use of this chemical may pose a threat. Although methoprene did not cause increased mortality of gray treefrog tadpoles (*Hyla versicolor*), it has been implicated in reduced survival rates and malformations in the development of northern leopard frogs (*Rana pipiens*) (Ankley *et al.* 1998). According to the U.S. Environmental Protection Agency (1991), methoprene is highly and acutely toxic to estuarine invertebrates, and ecological effects studies suggest that use of the briquette or slow-release formulation in estuarine areas may cause disruption of normal ecological processes. In addition, the U.S. Environmental Protection Agency states in their fact sheets that methoprene is moderately toxic to warm water, freshwater fish, and is slightly toxic to cold water, freshwater fish. Mosquito and Vector Control Districts typically use dosages far below those found to cause developmental problems and mortality (P. Bindings *in litt.* 2000).

Naled, an organophosphate pesticide, is used on greenhouse plants, broccoli, cabbage, brussels sprouts, kale, leeks, lettuce, and radishes. It is used to control aphids, mites, mosquitos, and flies. As an organophosphate pesticide it is assumed naled is toxic to aquatic organisms and caution should be exercised when using it in the vicinity of California red-legged frog habitats.

Paraquat is a herbicide widely used for broadleaf weed control. It has been employed for killing marijuana in the U.S. and in Mexico. It is also used as a crop desiccant and defoliant, and as an aquatic herbicide. Paraquat is considered to be slightly to moderately toxic to many species of aquatic life, including rainbow trout, bluegill, and channel catfish (U.S. Environmental Protection Agency 1997b). Eisler (1990) reported that concentrations as low as 0.5 mg/kg had an adverse effect on northern leopard frog tadpoles. These effects included a high number of tail abnormalities, reduced growth rate, abnormal swimming behavior, and increased mortality. In 15-day old northern leopard frog tadpoles, 95 percent of the test organisms were dead after 6 days when exposed to 2 mg/kg paraquat. In addition to potential adverse effects on tadpoles, there may be an adverse effect on the California red-legged frog by reduction of plant cover.

Permethrin, a pyrethroid pesticide, is used on berries, broccoli, cabbage, brussels sprouts, greenhouse plants, kale, leeks, lettuce, and radishes. It is also used to control animal ectoparasites, biting flies, and cockroaches. It is available in dusts, emulsifiable concentrates, smokes, ultra-low volume sprays, and wettable powder formulations. There is insufficient information on toxicity of permethrin to amphibians. Toxicity studies on invertebrates have shown that permethrin contaminated sediments are toxic to chironomid larvae (Fleming *et al*. 1998). Studies conducted on adult desert pupfish (*Cyprinodon macularius)* have shown a 48-hour LC50 of 0.005 mg/L of permethrin (Mulla *et al*. 1978). Standard applications of permethrin and agricultural runoff may cause direct acute effects to the California red-legged frog or its prey base.

Phosmet is a non-systemic, organophosphate insecticide used on both plants and animals. It is mainly used on apple trees for control of codling moths; it is also used on a wide range of fruit crops, ornamentals, and vines for the control of aphids, mites, and fruit flies. The reported 96-hour LC50 values for phosmet are less than 1 mg/L in bluegill, small- and largemouth bass, rainbow trout, and chinook salmon, and are less than 10 mg/L in fathead minnow and channel catfish (Johnson and Finley 1980). The compound is also very highly toxic to aquatic invertebrates (Johnson and Finley 1980). Phosmet has little potential for accumulation in aquatic organisms. Phosmet could have direct toxic effects on the California red-legged frog and indirect effects through reduction of the prey base.

Polycyclic Aromatic Hydrocarbons, or PAHs, are among the most potent carcinogens known to exist. However, amphibians are considered to be quite resistant to PAH carcinogens when compared to mammals. PAHs are widely distributed in the environment and have been detected in plant and animal tissues, sediments, soils, air, surface water, and groundwater (Eisler 1987). PAHs may enter the aquatic environment through industrial and domestic discharge, surface runoff, and releases of petroleum products into water bodies. PAHs can cause a wide variety of adverse biological effects, including effects on survival, growth, metabolism, and tumor formation (Eisler 1987). Eisler (1987) reports that 85 percent of adult African clawed frogs exposed to 1.5 mg benzo(a)pyrene, a PAH, developed lymphosarcomas (cancer of connective tissues associated with the lymphatic system) in 85 to 288 days. When leopard frogs were exposed to a single dose of 3-methylcholanthrene, another PAH, at 40 mg/kg body weight, cellular function and blood and tissue oxygen levels were abnormal for several weeks. Hatch and Burton (1998) suggested that low levels of PAHs may act with other environmental factors to cause adverse effects to larval amphibians.

Pyrethrins are natural insecticides produced by certain species of chrysanthemums; synthetic pyrethrins also are manufactured. The compounds may be used in grain storage and in poultry pens, and on dogs and cats to control lice and fleas. Both natural and synthetic compounds are extremely toxic to aquatic life, such as bluegill and lake trout, and slightly toxic to bird species, such as mallards. Toxicity increases with higher water temperatures and acidity.

Natural pyrethrins are highly fat soluble, but are easily degraded and thus do not accumulate in the body. Although no information regarding the toxicity of natural pyrethrins to amphibians was found, effects may be similar (see **esfenvalerate**).

Rotenone is the dried and ground root of various plants, or extracts thereof. It is used for fish eradications as part of water body management, in home gardens for insect control, and for lice and tick control on pets. Rotenone interferes with normal cell functions and nerve transmission and is highly toxic to fish and amphibians. Reported 96-hour LC50s were 0.031 mg/L in rainbow trout, 0.0026 mg/L in channel catfish, and 0.023 mg/L in bluegill for the 44 percent pure formulation (Johnson and Finley 1980). Aquatic invertebrates have a wide range of sensitivity to rotenone with 48-hour EC50 values ranging from 0.002 to 100 mg/L (Johnson and Finley 1980). The compound is not expected to accumulate appreciably in aquatic organisms as its highly toxic nature allows little survival of the organisms in which it would accumulate. Contamination of breeding ponds with rotenone could cause the loss of an entire year's production of California red-legged frog larvae.

Strychnine is currently registered for use only below-ground as a bait application to control pocket gophers, but was used in the U.S. to control vertebrate animals for many years before 1947. Strychnine ranges from moderately to highly toxic to freshwater fish and is moderately toxic to aquatic invertebrates (Environmental Protection Agency 1998). The U.S. Environmental Protection Agency believes that the risks to non-target terrestrial animals are minimal when strychnine is used below-ground and that below-ground use of strychnine does not constitute a risk to non-target or endangered species. However, this does not take into account any burrowing species or those that may use small mammal burrows as temporary refuges.

Triclopyr, a pyridine, is a selective systemic herbicide used for control of woody and broadleaf plants along rights-of-way, in forests, on industrial lands, and on grasslands and parklands. Studies on the toxicity of triclopyr to aquatic organisms have shown that the parent compound of this pesticide is practically nontoxic to fish, with a LC50 (96-hour) of 117 mg/L in rainbow trout and 148 mg/L in bluegill sunfish (University of California at Davis 1997b). The compound has little if any potential to accumulate in aquatic organisms. In addition to the potential direct effects of the ester formulation of this herbicide on amphibians, there may be an adverse effect on the California red-legged frog by reduction of plant cover.

Trifluralin is a selective, pre-emergence dinitroaniline herbicide used to control many annual grasses and broadleaf weeds in lawns and in a large variety of fruit, nut, vegetable, and grain crops, including soybeans, sunflowers, cotton, and alfalfa. Trifluralin is highly toxic to fish, amphibians, and other aquatic organisms. The 96-hour LC50 is 0.02 to 0.07 mg/L in rainbow trout and bluegill (Johnson *et al*. 1980). Variables such as temperature, pH, life stage, and size may affect the toxicity of the compound. Trifluralin is highly toxic to *Daphnia*, with a 48-hour LC50 of 0.5 to 0.6 mg/L. The compound shows a moderate tendency to accumulate in aquatic organisms (U.S. Environmental Protection Agency 1996).

Other contaminants

Ammonia: Harris *et al*. (1998) reported that elevated levels of ammonia could act as an environmental stressor to amphibians and could lead to decreased hatching success, survival, or growth rates.

CONTAMINANTS GLOSSARY

acaricide compound used to kill ticks and mites.

acute toxicity the ability to cause a poisonous effect or death as a result of a short-term or single exposure. Common acute effects are skin or eye irritation, vomiting, tremors.

bioaccumulate increase in concentration in living organisms as they breathe contaminated air, drink contaminated water, or eat contaminated food.

carbamate organic compounds based on carbamic acid (CO_2NH_3); cholinesterase inhibitors, they interfere with nerve function, cause malformations in developing embryos, and are suspected carcinogens.

carcinogen cancer-causing agent.

cholinesterase a neurotransmitter; cholinesterase inhibitors interfere with the transmission of nerve impulses. Symptoms of cholinesterase inhibition include nausea, vomiting, cramps, increased heart rate, and death.

chronic toxicity the ability to cause a poisonous effect or death as a result of long-term exposure. Liver or kidney damage, impaired reproduction, and cancers are common chronic effects.

dinitroaniline herbicides; in animals, they interfere with cell function, cause skin and eye irritation, and are carcinogenic and teratogenic.

fungicide compound used to kill fungi.

herbicide compound used to kill plants.

insecticide compound used to kill insects.

miticide compound used to kill mites.

molluscicide a compound used to kill molluscs (snails, slugs, clams, etc.).

organochlorine chlorinated hydrocarbons; compounds that contain, carbon, hydrogen, and chlorine, such as DDT; interfere with transmission of nerve impulses primarily in the central nervous system (brain and spinal cord); bioaccumulate, carcinogens, suspected teratogens and mutagens; can travel long distances through air and groundwater.

organophosphate compounds that contain, carbon, hydrogen, and phosphorus; cholinesterase inhibitors, they interfere with nerve function, cause malformations in developing embryos, and are suspected carcinogens.

pesticide a general term for compounds used to kill organisms considered pests, including slugs, nematodes, insects, mites, rodents, birds, and plants.

phosphorothioate a class of organophosphates that also contain sulfur.

pyrethroids	natural compounds derived from chrysanthemums, or synthetic compounds that mimic their structure and function. Pyrethroids block nerve impulse transmission, affect hormone metabolism, and affect the immune system. They are suspected carcinogens, mutagens, and teratogens.
pyridine	herbicide; limited information available.
systemic	absorbed by the leaves or roots and then translocated throughout the plant. Systemic pesticides are particularly effective against sucking insects and mites.
teratogen	a substance that causes malformations in developing embryos.

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Appendix C. Maps of Core Areas Per County

APPENDIX C. MAPS OF CORE AREAS PER COUNTY

The following core are maps were developed using the California Watershed Map (Calwater Version 2.2). This is a set of standardized watershed boundaries meeting standardized delineation critera. The hierachy of watershed designations consists of six levels of increasing specificity: Hydrologic Region, Hydrologic Unit, Hydrologic Area, Hydrologic Sub-Area, Super Planning Watershed, and Planning Watershed. Core area maps were delineated at the Hydrologic Sub-Area level. Following each core area map is a list of Hydrologic Sub-Areas that are included in each map per core area.

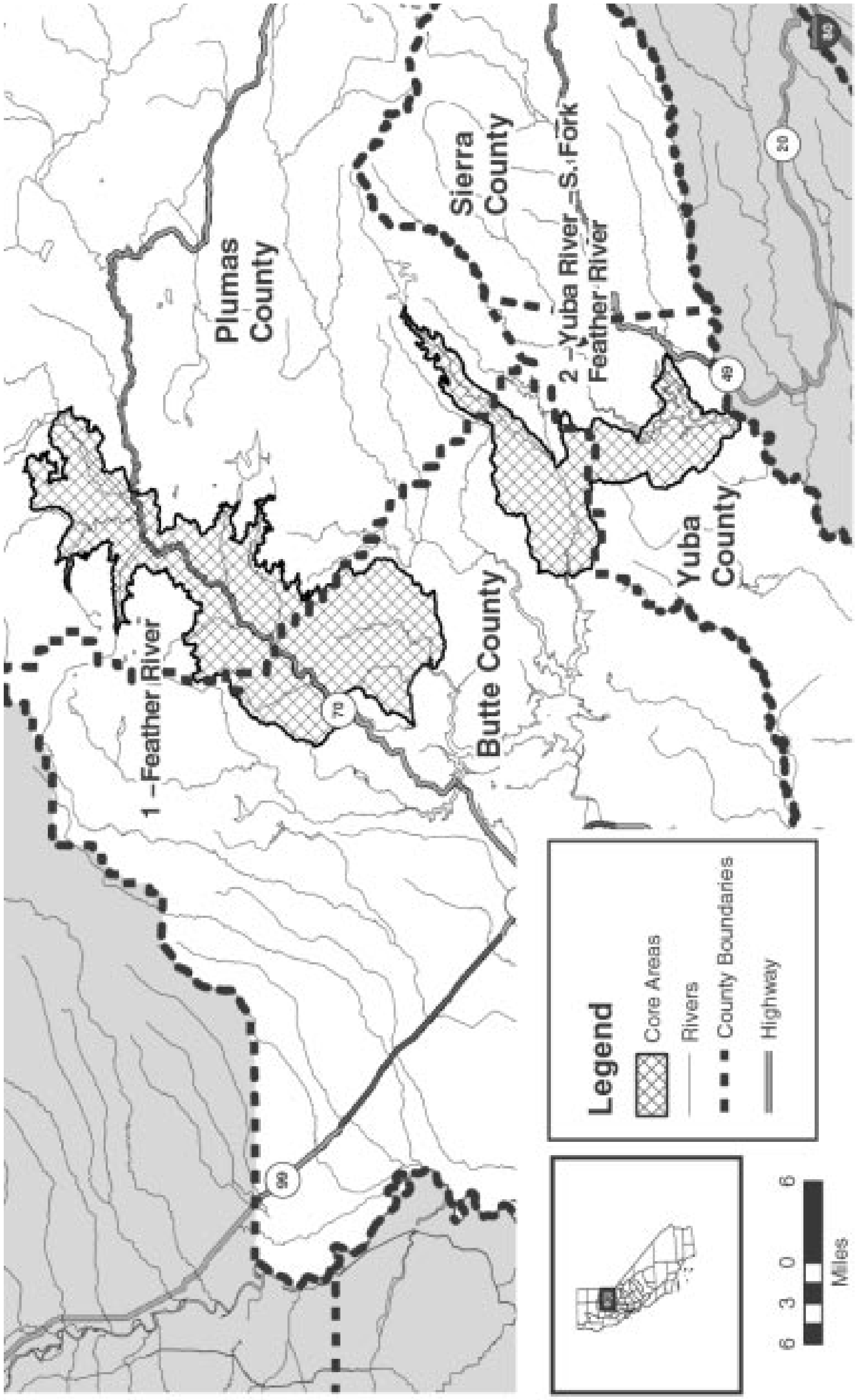


Figure 13. Map of core areas in Butte, Plumas, and Yuba Counties.

Butte County

Core Area:
Feather River
Hydrologic Sub-Area:
Bucks Lake
Reservoir Drain

Core Area:
Yuba River–S. Fork Feather River
Hydrologic Sub-Area:
Bullards Bar
Lumpkin

Plumas County

Core Area:
Feather River
Hydrologic Sub-Area:
Bucks Lake
Butt Valley
Reservoir Drain

Core Area:
Yuba River–S. Fork Feather River
Hydrologic Sub-Area:
Lumpkin

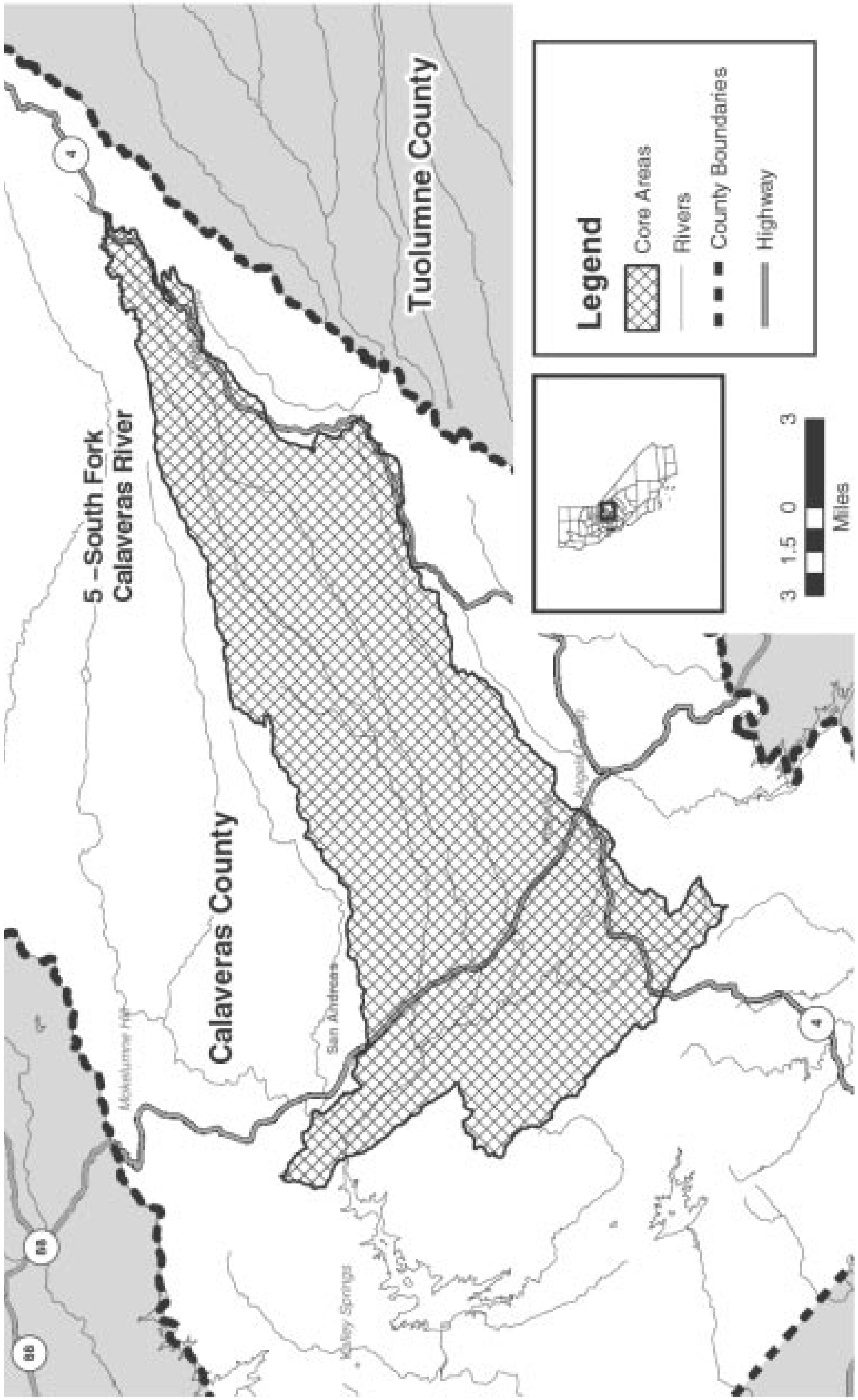
Yuba County

Core Area:
Yuba River–S. Fork Feather River
Hydrologic Sub-Area:
Bullards Bar
Lumpkin

Figure 14. Map of core areas in Calaveras County

Calaveras County

Core Area:
South Fork Calaveras River
HSA:
South Fork Calaveras



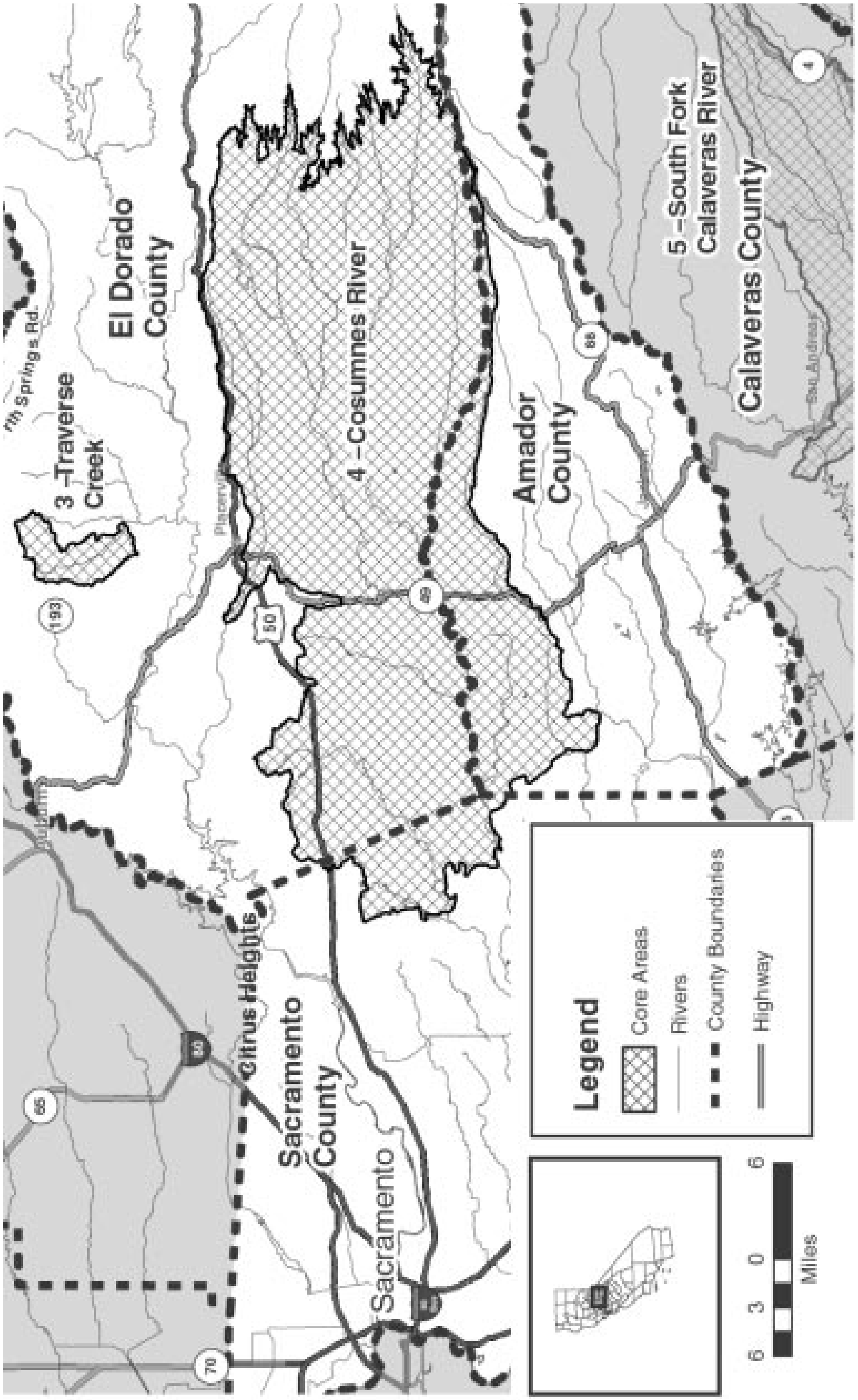


Figure 15. Map of core areas in Sacramento, El Dorado, and Amador Counties

Sacramento County

Core Area:
Cosumnes River
Hydrologic Sub-Area:
Big Canyon Creek
Upper Deer Creek

El Dorado County

Core Area:
Cosumnes River
Hydrologic Sub-Area:
Big Canyon Creek
North Fork Cosumnes
Omo Ranch
Upper Deer Creek
Weber Creek

Core Area:
Traverse Crek
HSA:
Coloma

Amador County

Core Area:
Cosumnes River
Hydrologic Sub-Area:
Big Canyon Creek
North Fork Cosumnes
Omo Ranch

Figure 16. Map of core areas in Tuolumne and Mariposa Counties

Tuolumne County

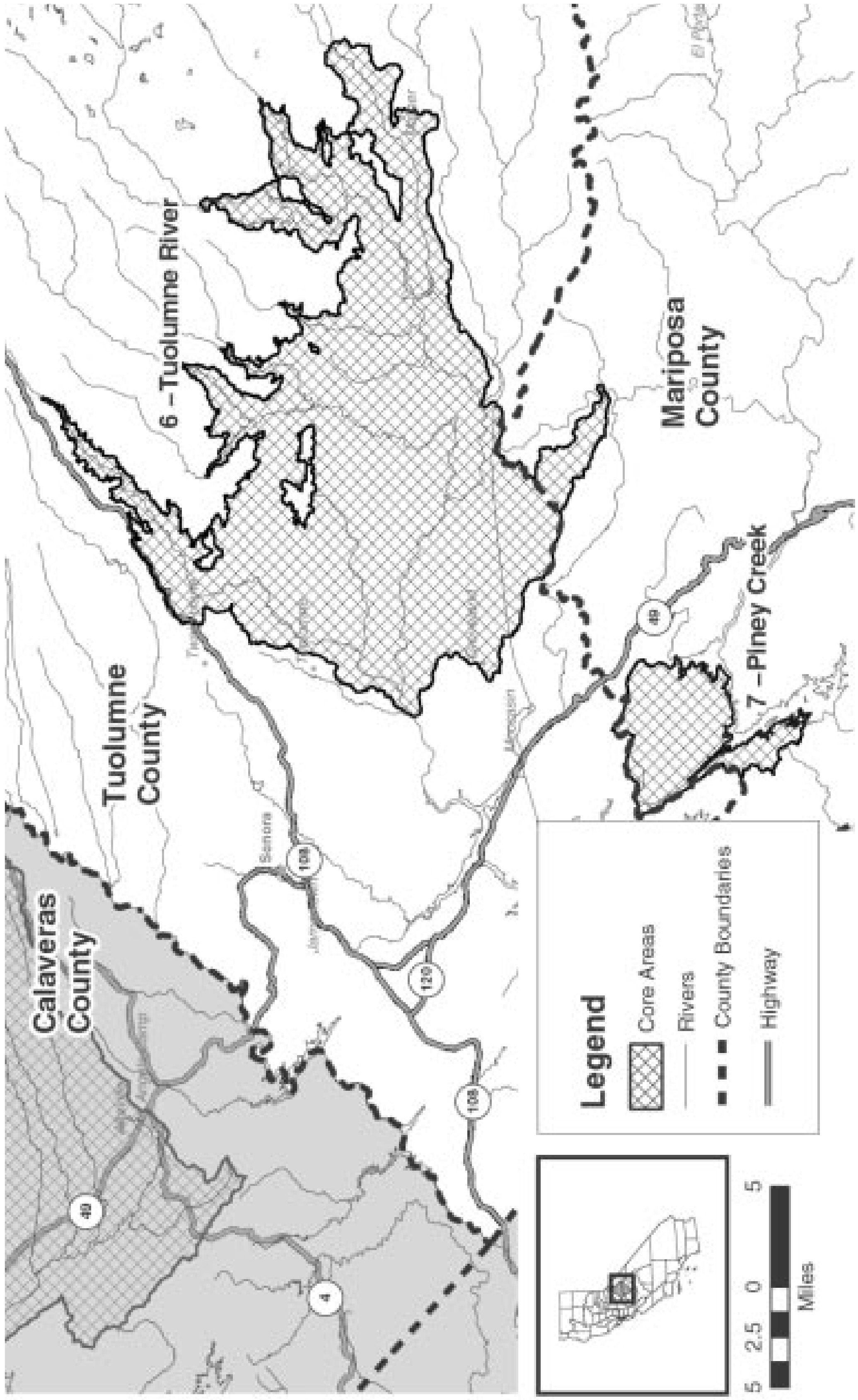
Core Area:
Piney Creek
HSA:
Coulterville

Core Area:
Tuolumne River
Hydrologic Sub-Area:
Cherry Lake
Clavey River
Hetch Hetchy
Lake Eleanor
Mercut Peak
North Fork Merced

Mariposa County

Core Area:
Piney Creek
HSA:
Coulterville

Core Area:
Tuolumne River
Hydrologic Sub-Area:
Clavey River
North Fork MErced



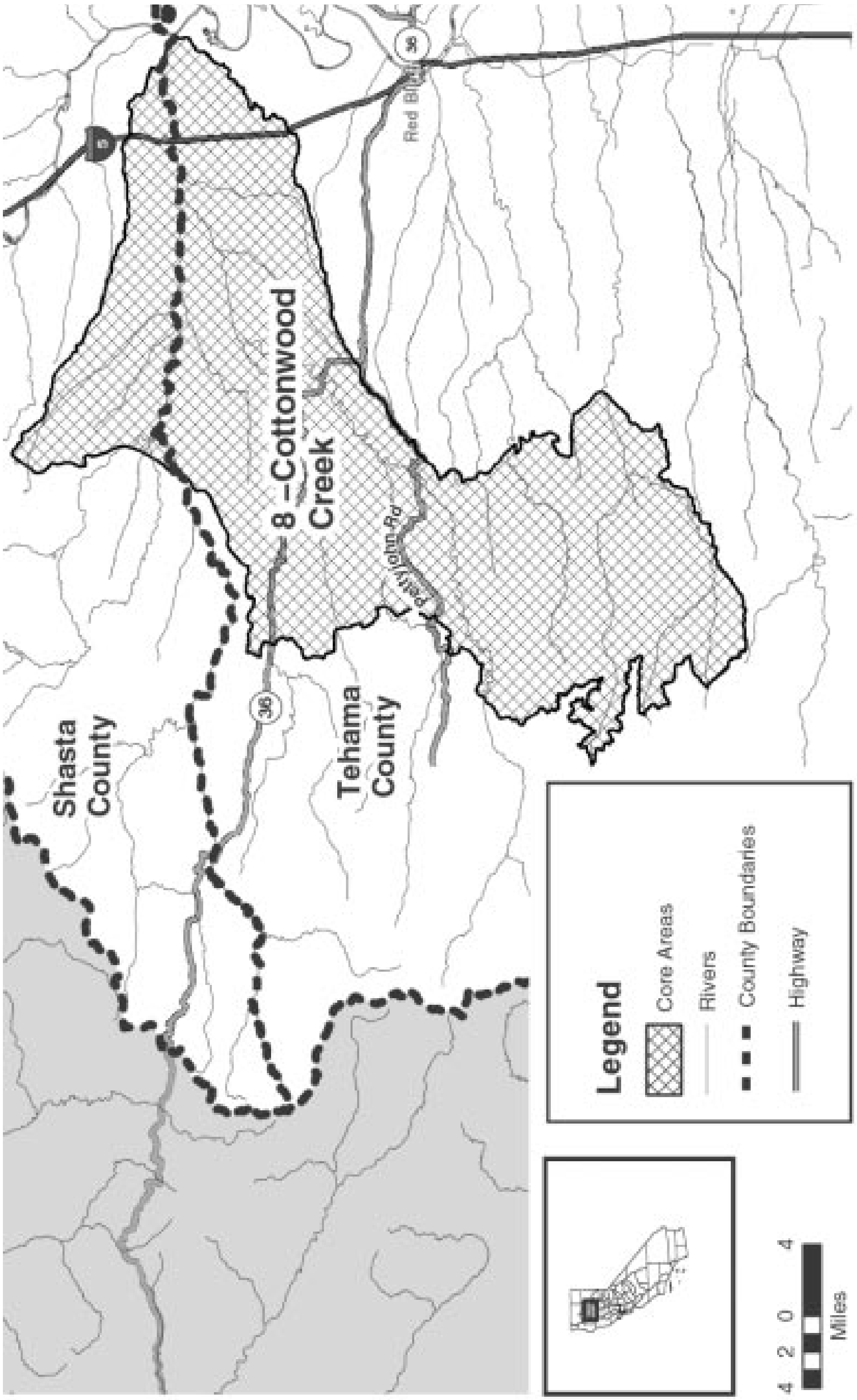


Figure 17. Map of core areas in Shasta and Tehama Counties

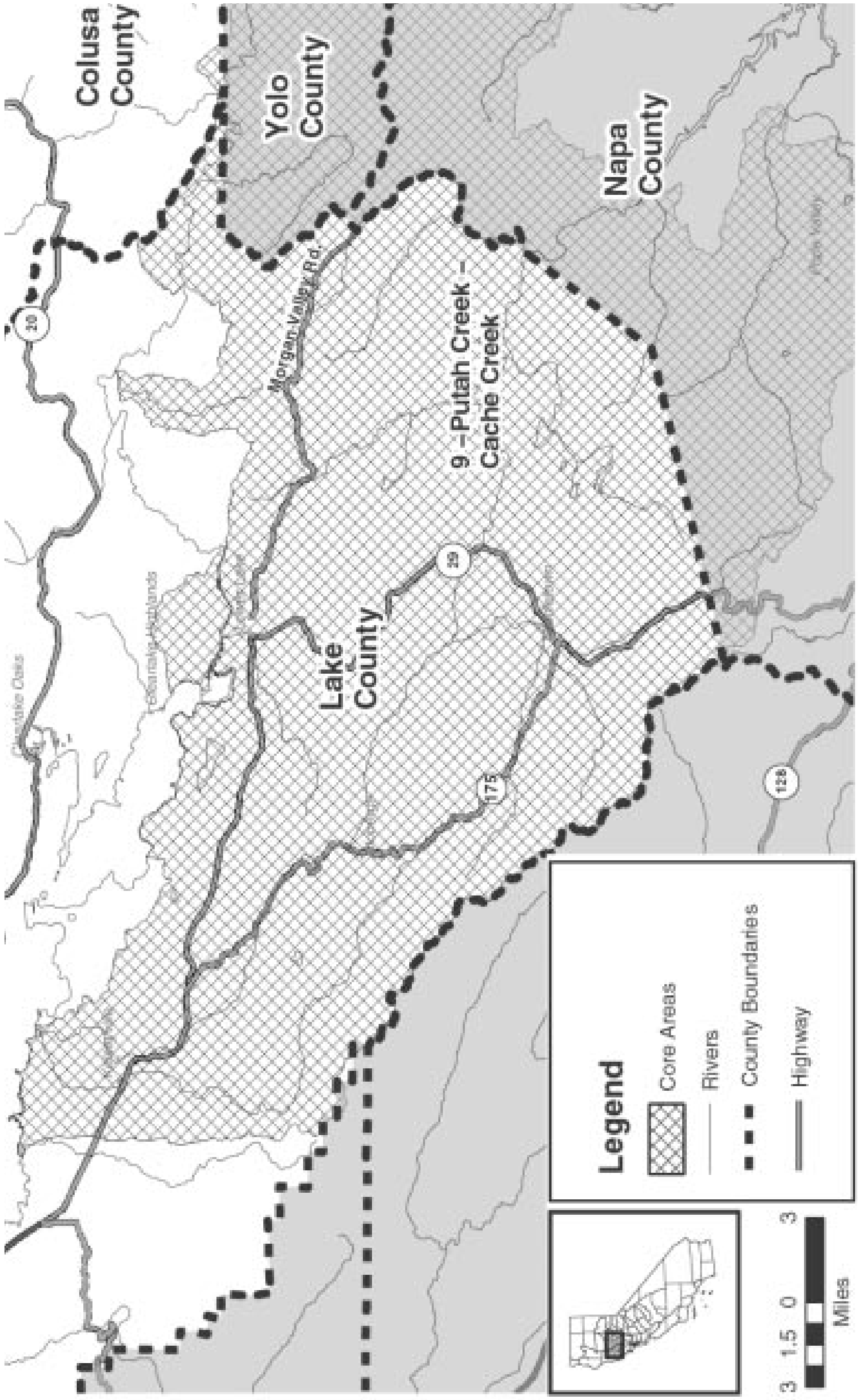
Shasta County

Core Area:
Cottonwood Creek
HSA:
Lower Cottonwood

Tehama County

Core Area:
Cottonwood Creek
Hydrologic Sub-Area:
Elder Creek
Lower Cottonwood
Red Bank Creek
South Fork
Wells Creek

Figure 18. Map of core areas in Lake and Colusa Counties



Lake County

Core Area:
Putah Creek–Cache Creek
HSAs
Lakeport
Lower Lake
Pope Creek
Upper Putah Creek
Wilson Valley

Colusa County

Core Area:
Putah Creek–Cache Creek
Hydrologic Sub-Area:
East Blue Ridge
Rumsey
Wilson Valley

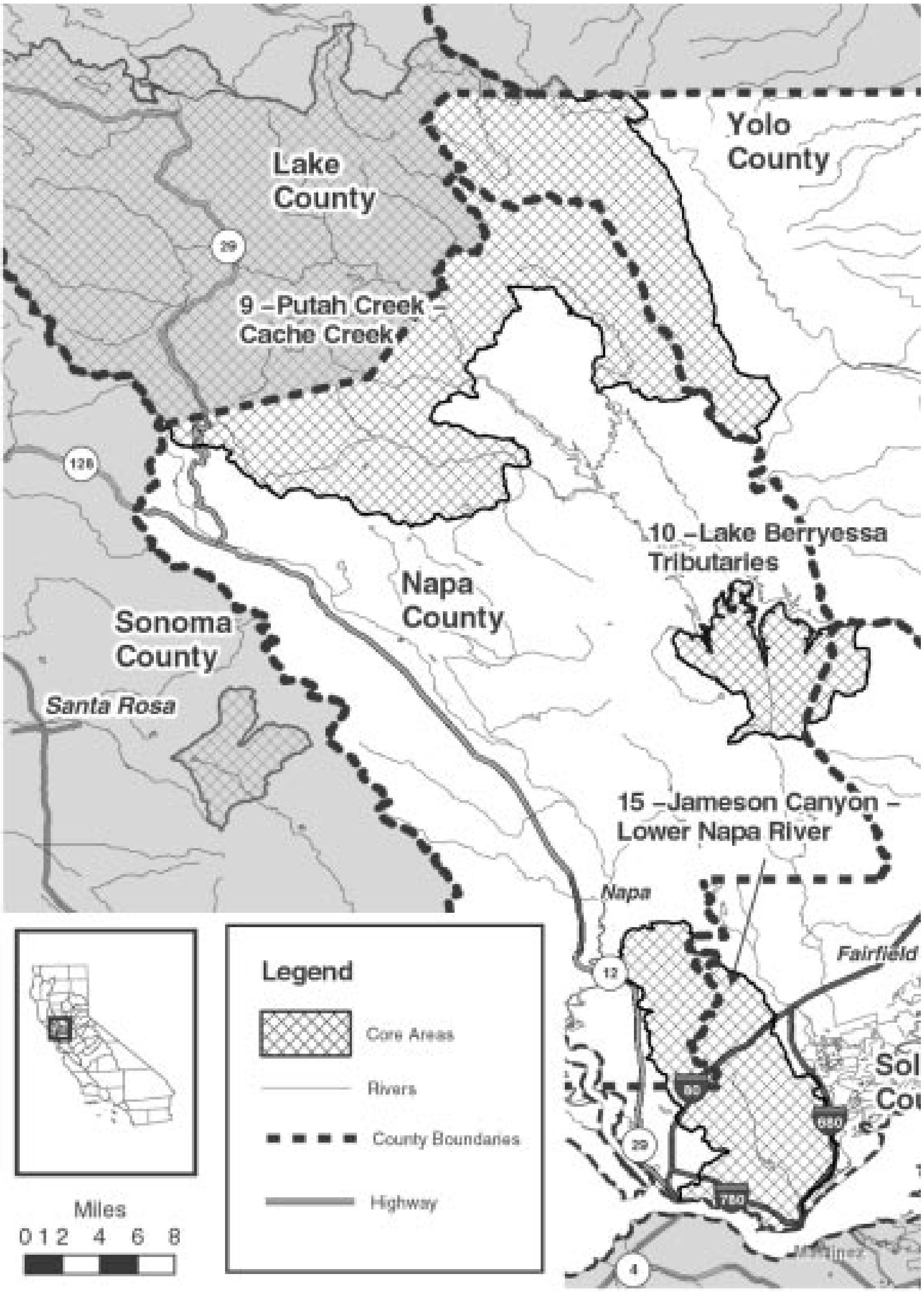


Figure 19. Map of core areas in Napa, Solano, and Yolo Counties

Napa County

Core Area:
Jameson Canyon–Lower Napa River
Hydrologic Sub-Area:
Benicia
Napa River

Core Area:
Lake Berryessa Tributaries
Hydrologic Sub-Area:
Capell Creek
East Rocky Ridge

Core Area:
Putah Creek–Cache Creek
Hydrologic Sub-Area:
East Blue Ridge
Eticuera Creek
Pope Creek
Rumsey
Upper Puah Creek
Wilson Valley

Solano County

Core Area:
Jameson Canyon–Lower Napa River
Hydrologic Sub-Area:
Benicia
Napa River

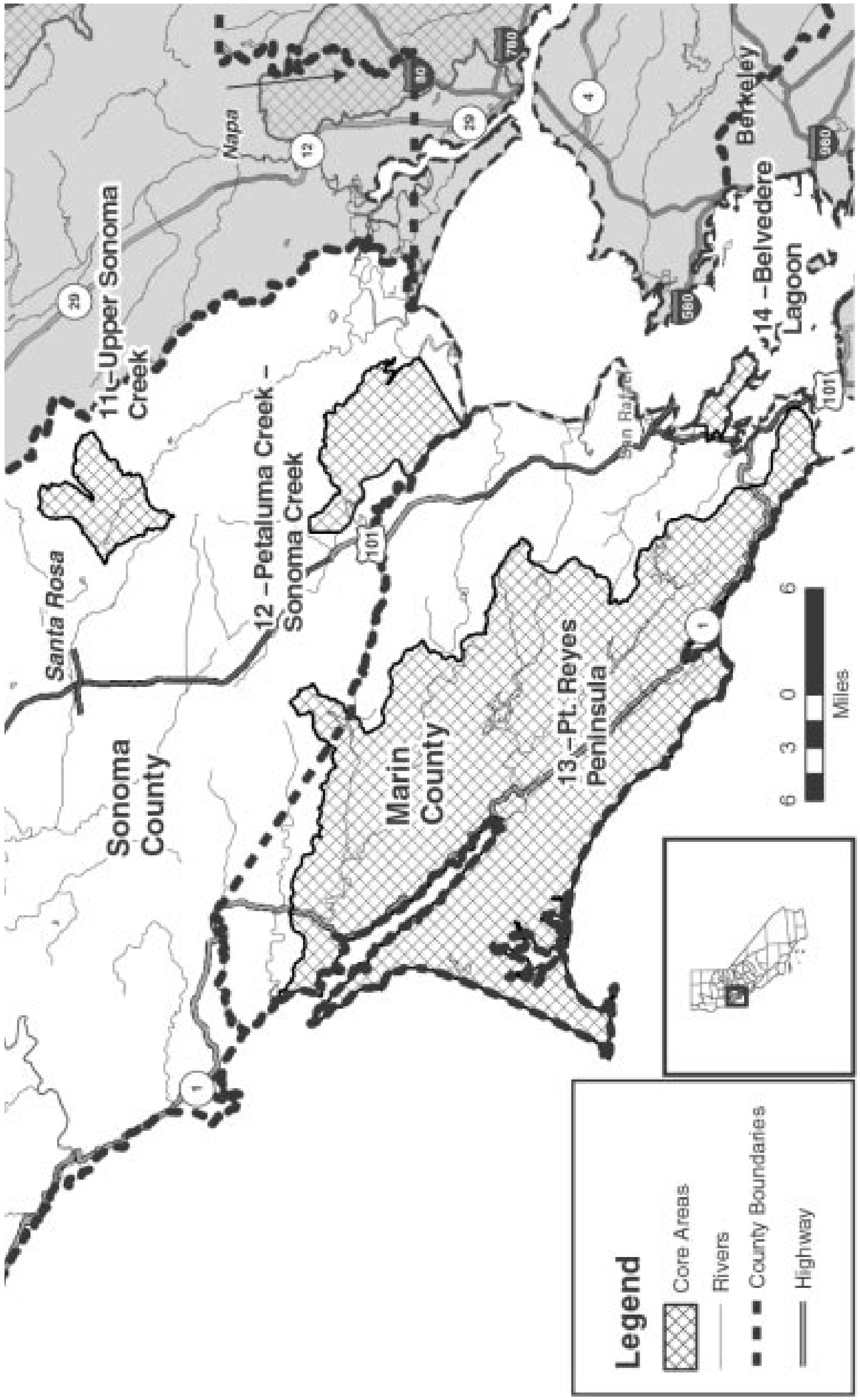
Core Area:
Lake Berryessa Tributaries
Hydrologic Sub-Area:
Capell Creek
East Rocky Ridge

Yolo County

Core Area:
Lake Berryessa Tributaries
HSA:
East Rocky Ridge

Core Area:
Putah Creek–Cache Creek
Hydrologic Sub-Area:
East Blue Ridge
Eticuera Creek
Rumsey
Upper Putah Crek
Wilson Valley

Figure 20. Map of core areas in Marin and Sonoma Counties



Marin County

Core Area:
Belvedere Lagoon
HSA:
San Rafael

Core Area:
Petaluma Creek–Sonoma Creek
HSA:
Petaluma River

Core Area:
Pt. Reyes Peninsula
Hydrologic Sub-Area:
Bolinas
Inverness
Lagunitas Creek
Point Reyes
Walker Creek

Sonoma County

Core Area:
Petaluma Creek–Sonoma Creek
Hydrologic Sub-Area:
Petaluma River
Sonoma Creek

Core Area:
Pt. Reyes Peninsula
HSA:
Walker Creek

Core Area:
Putah Creek–Cache Creek
Hydrologic Sub-Area:
Lakeport
Upper Putah Creek

Core Area:
Upper Sonoma Creek
HSA:
Sonoma Creek

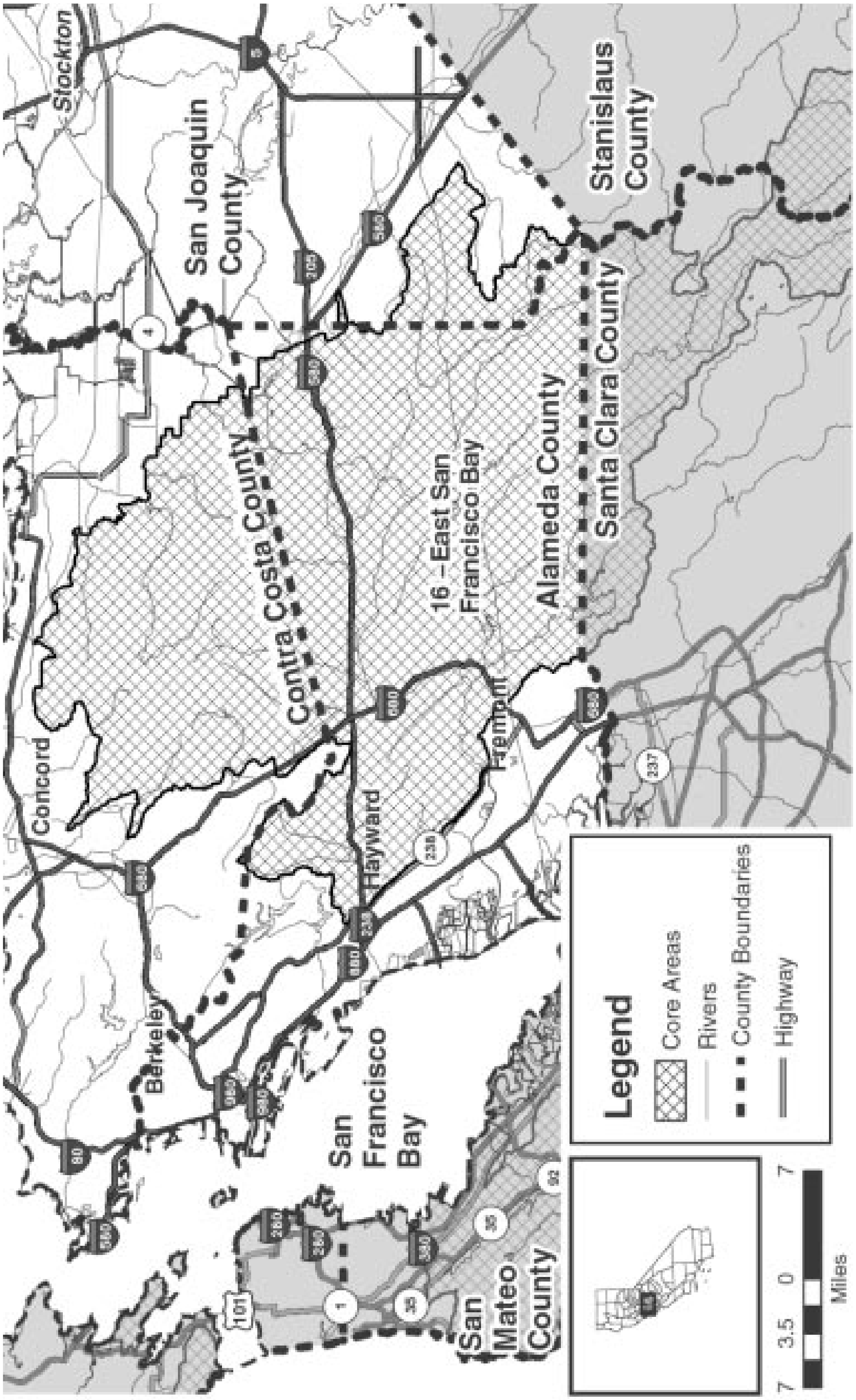


Figure 21. Map of core areas in Alameda, San Joaquin and Contra Costa Counties

Alameda County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Alameda Creek
East Bay Cities
North Diablo Range

Contra Costa County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Alameda Creek
East Bay Cities
North Diablo Range
Pittsburg
Walnut Creek

Figure 22. Map of core areas in Santa Clara and Stanislaus Counties

Santa Clara County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Alameda Creek
Coyote Creek
Orestimba Creek
Pacheco-Santa Ana Creek
Romero Creek

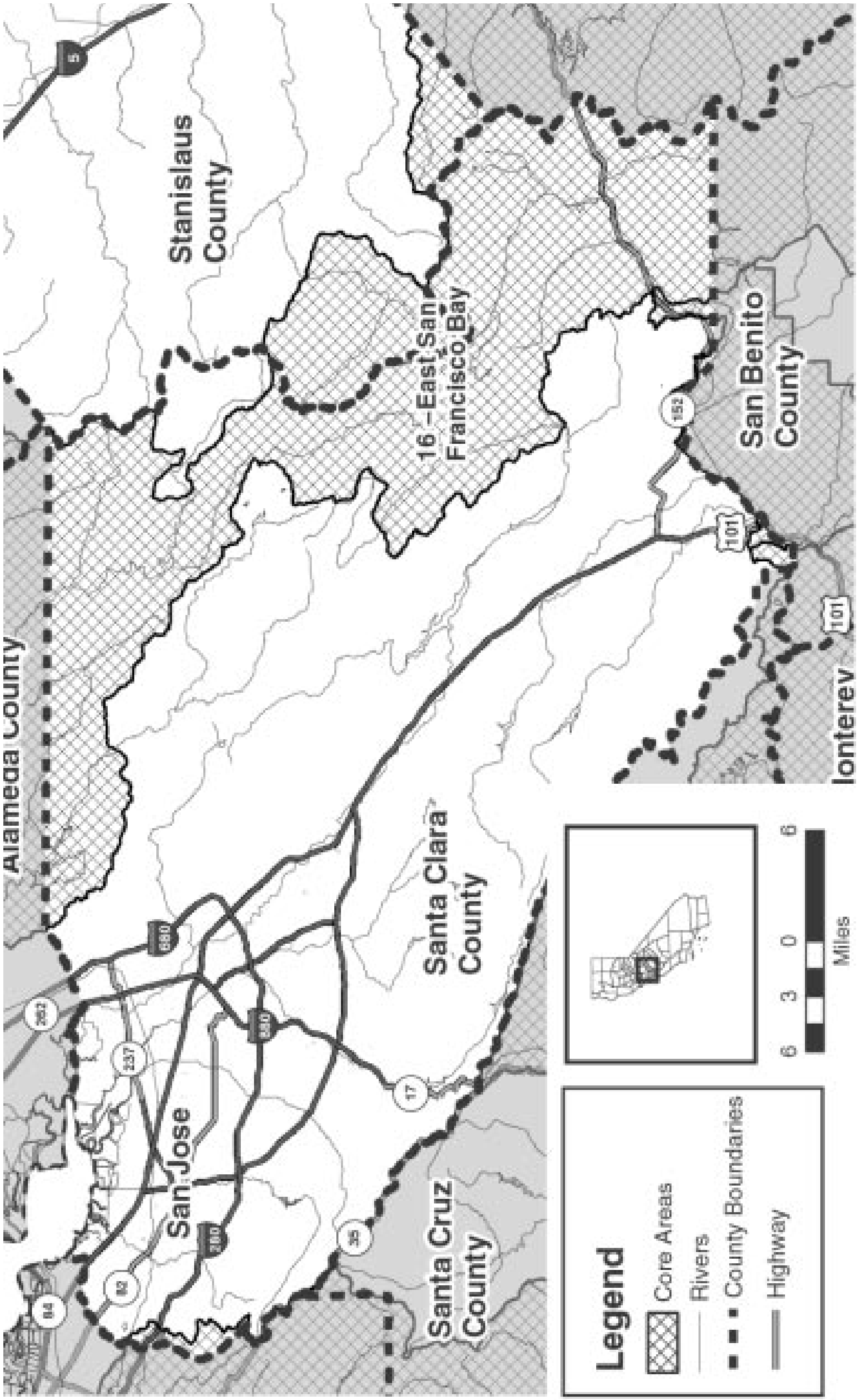
Core Area:
Salinas River–Pajaro River
Hydrologic Sub-Area:
Aptos–Soquel
Santa Cruz Mountains

Core Area:
Santa Clara Valley
Hydrologic Sub-Area:
Santa Cruz Mountains
South Santa Clara Valley

Core Area:
South San Francisco Bay
Hydrologic Sub-Area:
Palo Alto
Pescadero Creek

Stanislaus County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Alameda Creek
Coyote Creek
Orestimba Creek
Pacheco–Santa Ana Creek
Romero Creek



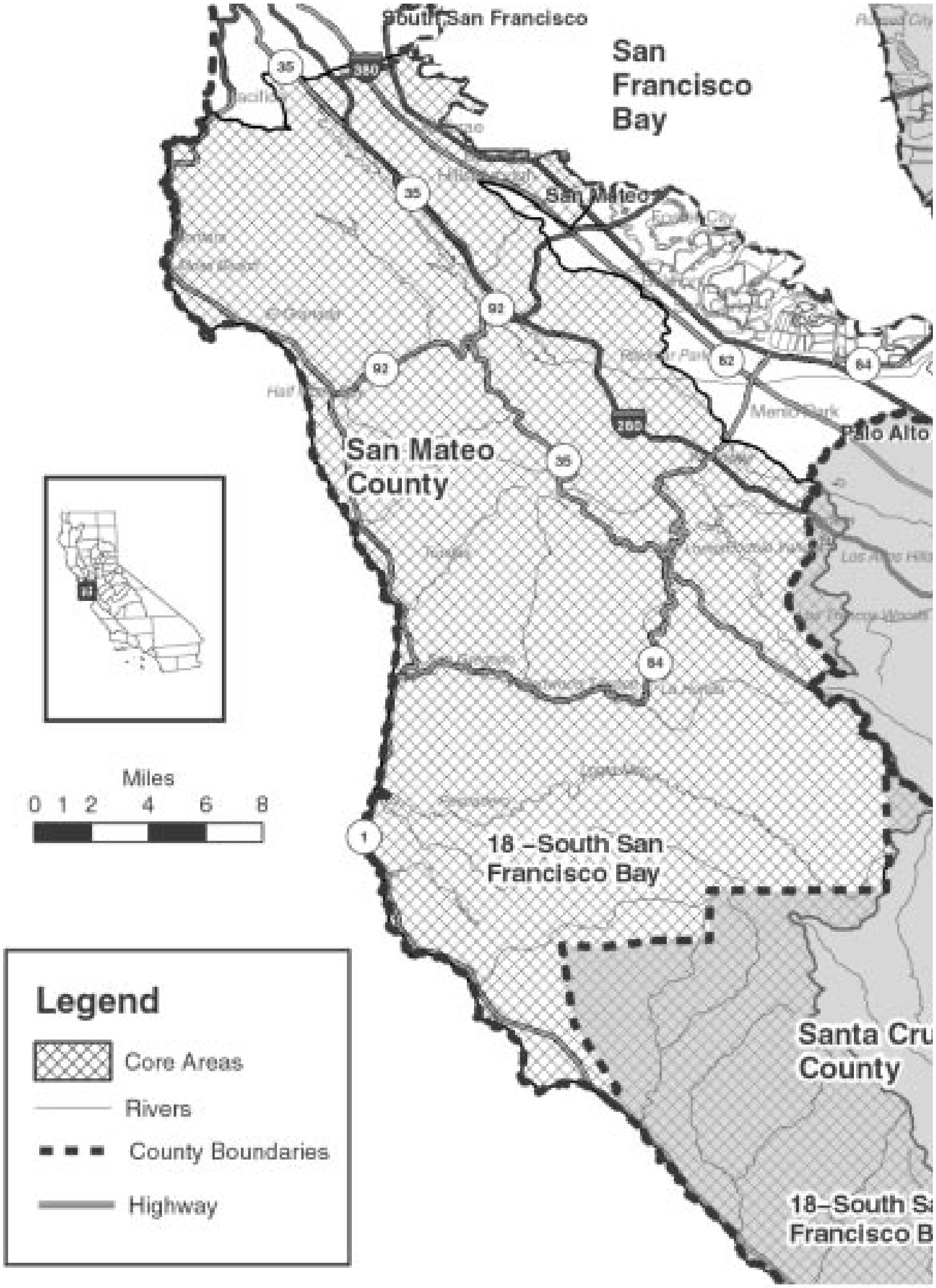


Figure 23. Map of core areas in San Mateo County

San Mateo County

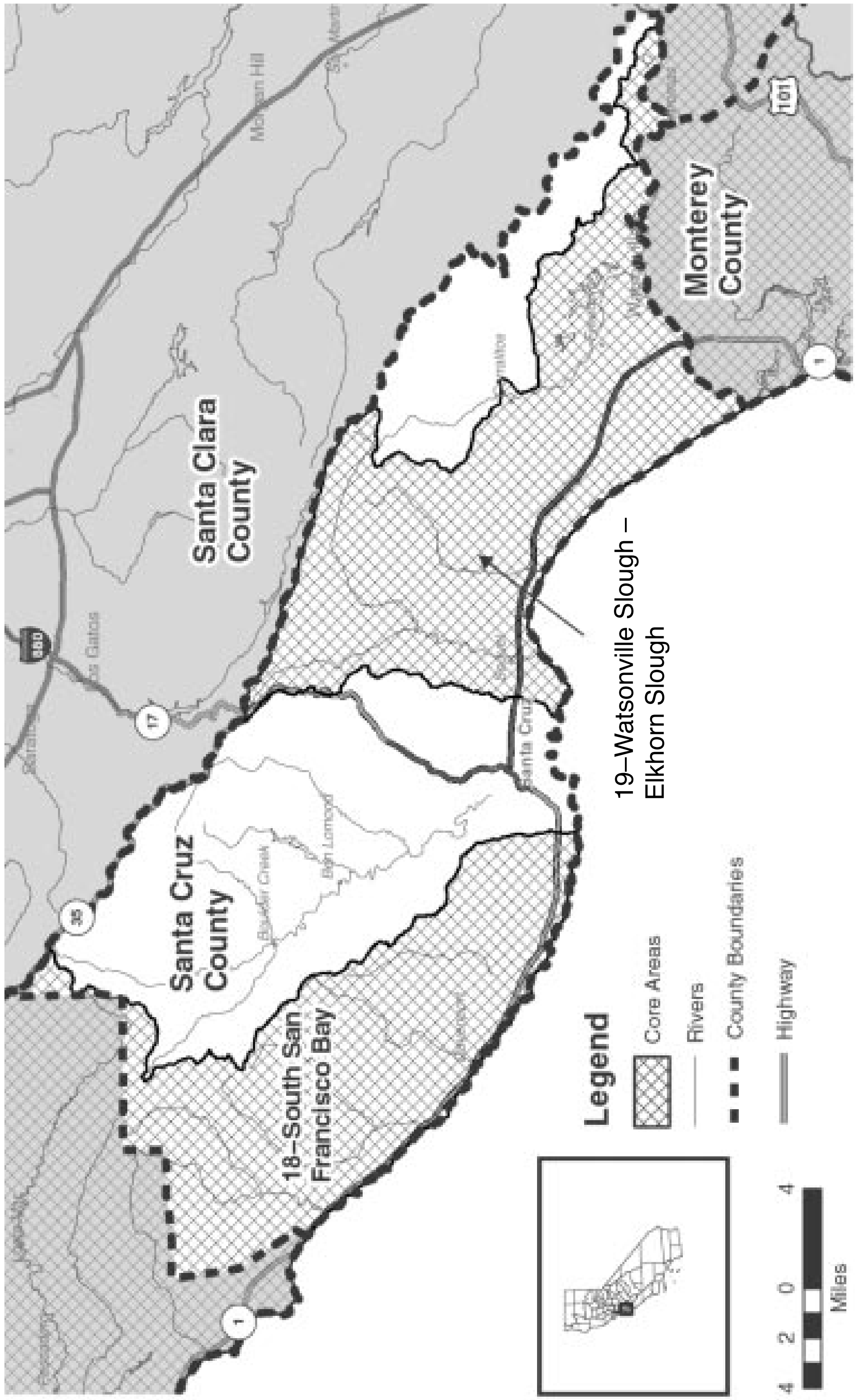
Core Area:
South San Francisco Bay
Hydrologic Sub-Area:
Ano Nuevo
Davenport
Half Moon Bay
Pacfica
Palo Alto
Pescadero Creek
San Gregorio Creek
San Mateo Bayside
Tunitas Crek

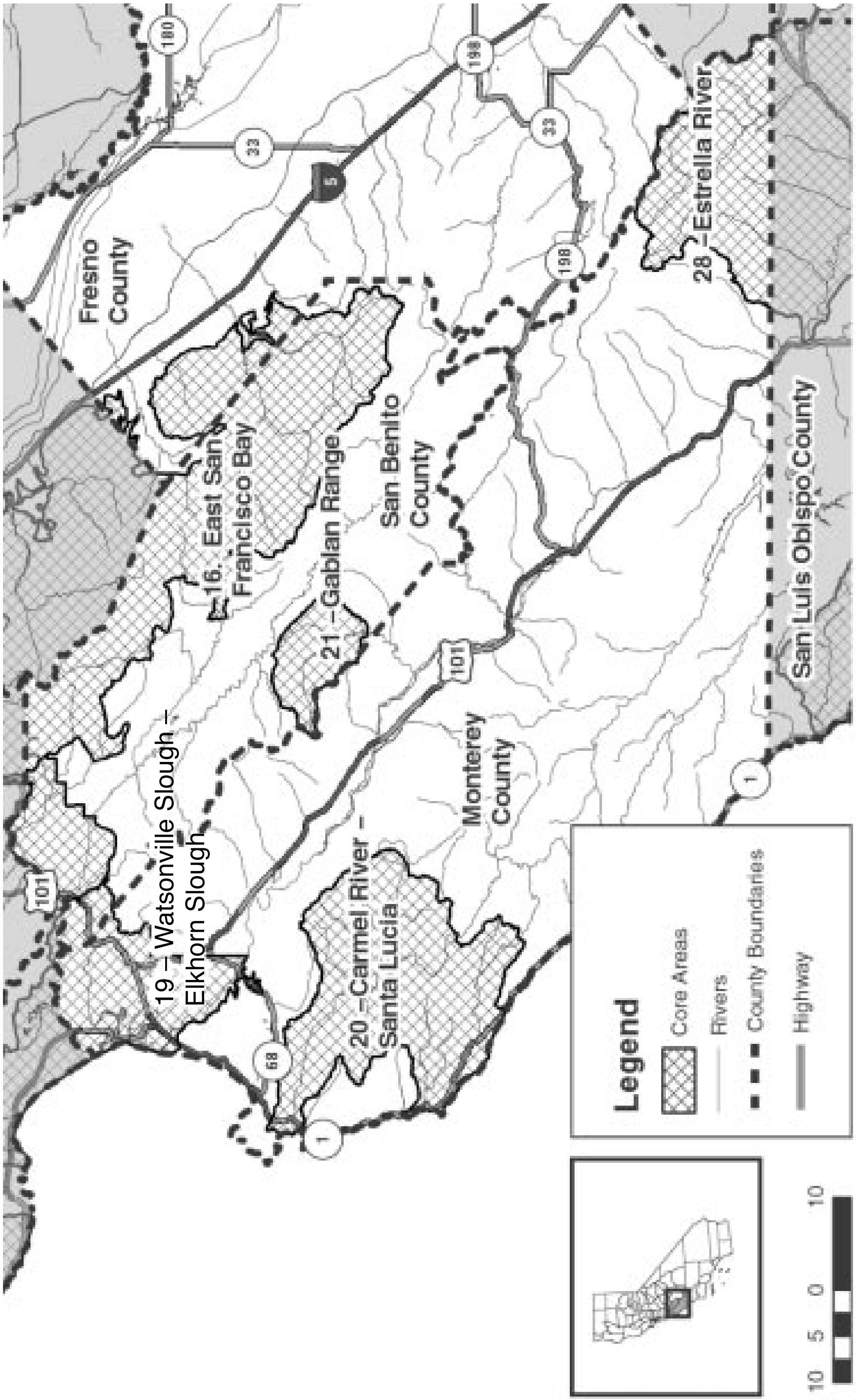
Figure 24. Map of core areas in Santa Cruz County

Santa Cruz County

Core Area:
Watsonville Slough–Elkhorn Slough
Hydrologic Sub-Area:
Aptos–Soquel
Santa Cruz Mountains
Watsonville

Core Area:
South San Francisco Bay
Hydrologic Sub-Area:
Ano Nuevo
Davenport
Pescadero Creek





and Fresno Counties

Monterey County

Core Area:
Carmel River–Santa Lucia
Hydrologic Sub-Area:
Carmel River
Santa Lucia

Core Area:
Estrella River
HSA: Estrella River

Core Area:
Gabilan Range
Hydrologic Sub-Area:
Gabilan Range

Core Area:
Watsonville Slough–Elkhorn Slough
Hydrologic Sub-Area:
Bolsa Neuva
Chualar
Moro Cojo
Neponset
Watsonville

San Benito County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Pacheco–Santa Ana Creek
Panoche
San Benito River

Core Area:
Gabilan Range
Hydrologic Sub-Area:
Gabilan Range

Core Area:
Salinas River–Pajaro River
Hydrologic Sub-Area:
Bolsa Neuva
Santa Cruz Mountains
Watsonville

Core Area:
Santa Clara Valley
Hydrologic Sub-Area:
Santa Cruz Mountains
S. Santa Clara Valley

Fresno County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Panoche

Core Area:
Estrella River
HSA: Estrella River

Figure 26. Map of core areas in San Luis Obispo and Kern Counties

San Luis Obispo County

Core Area:
Arroyo Grande Creek
HSA:
Oceano
Core Area:
Estero Bay
Hydrologic Sub-Area:
Arroyo De La Cruz
Cayucos
Chorro
Los Osos
Morro
Old
San Luis Obispo Creek
San Simeon
Santa Rosa
Toro
Villa

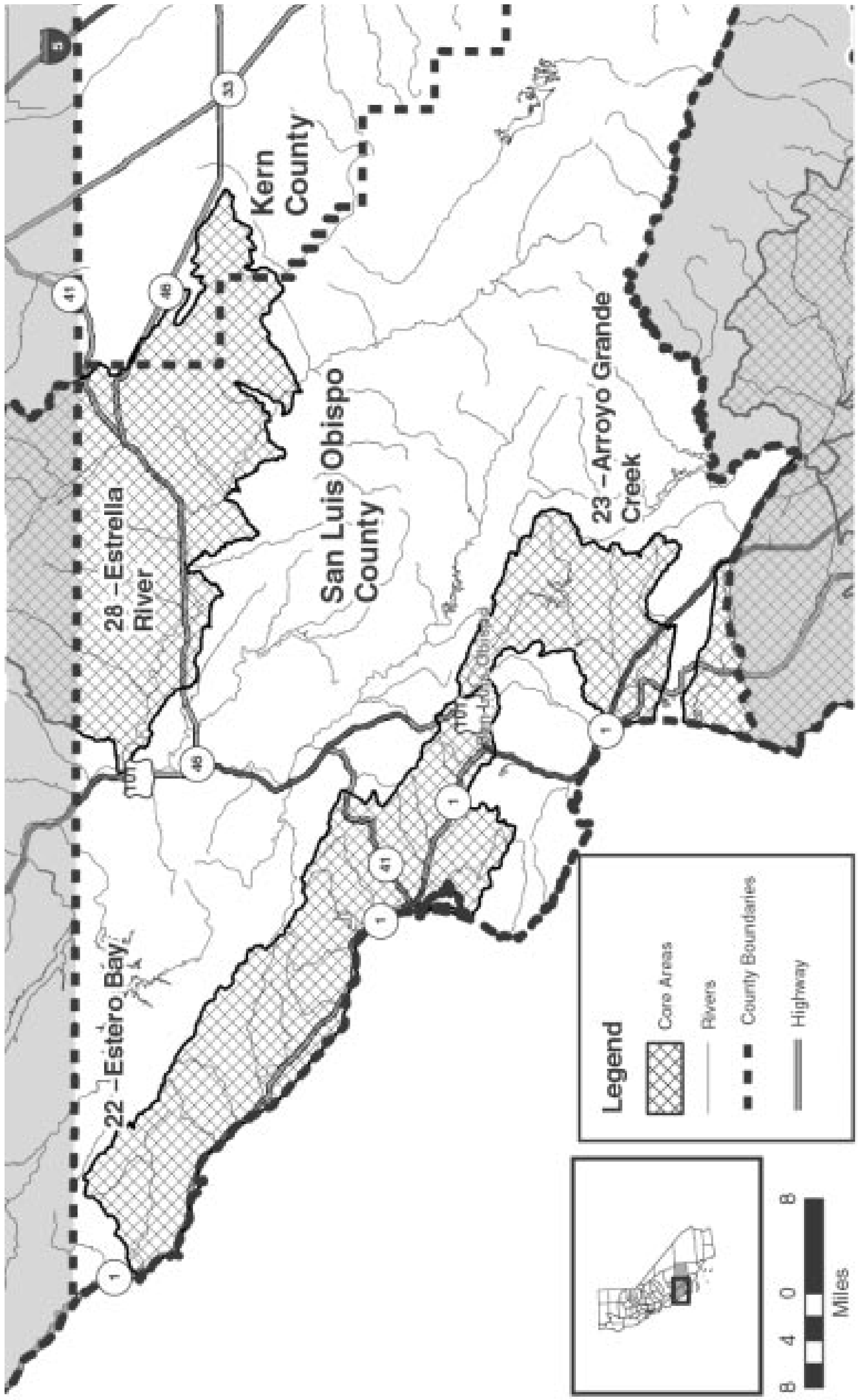
Core Area:
Estrella River
Hydrologic Sub-Area:
Estrella River
Temblor

Core Area:
Santa Maria River–
Santa Ynez River
HSA:
Guadalupe

Core Area:
Sisquoc River
HSA:
Sisquoc

Kern County

Core Area:
Estrella River
Hydrologic Sub-Area:
Estrella River
Temblor



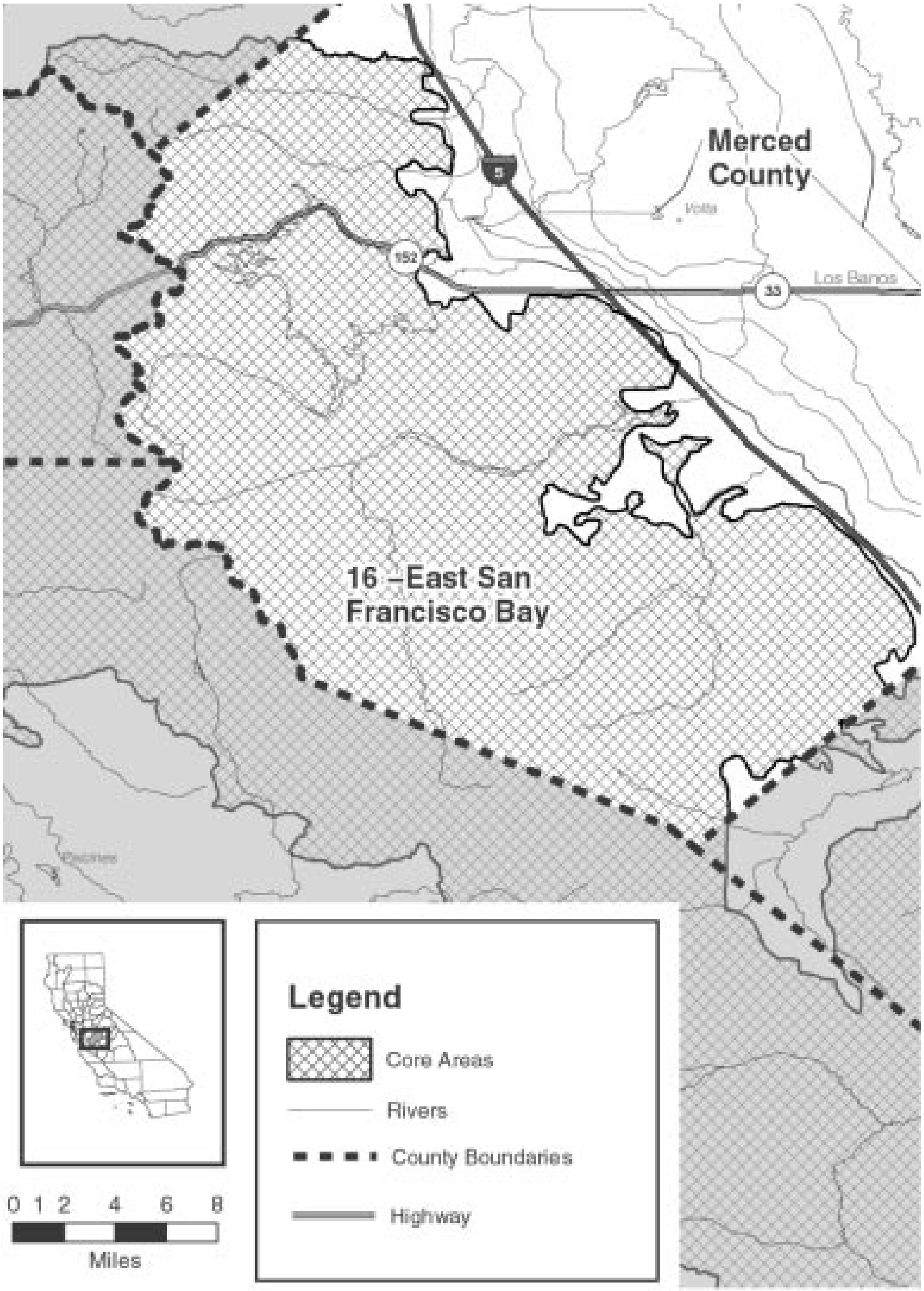


Figure 27. Map of core areas in Merced County

Merced County

Core Area:
East San Francisco Bay
Hydrologic Sub-Area:
Pacheco–Santa Ana Creek
Romero Creek
San Benito River
San Luis Reservoir

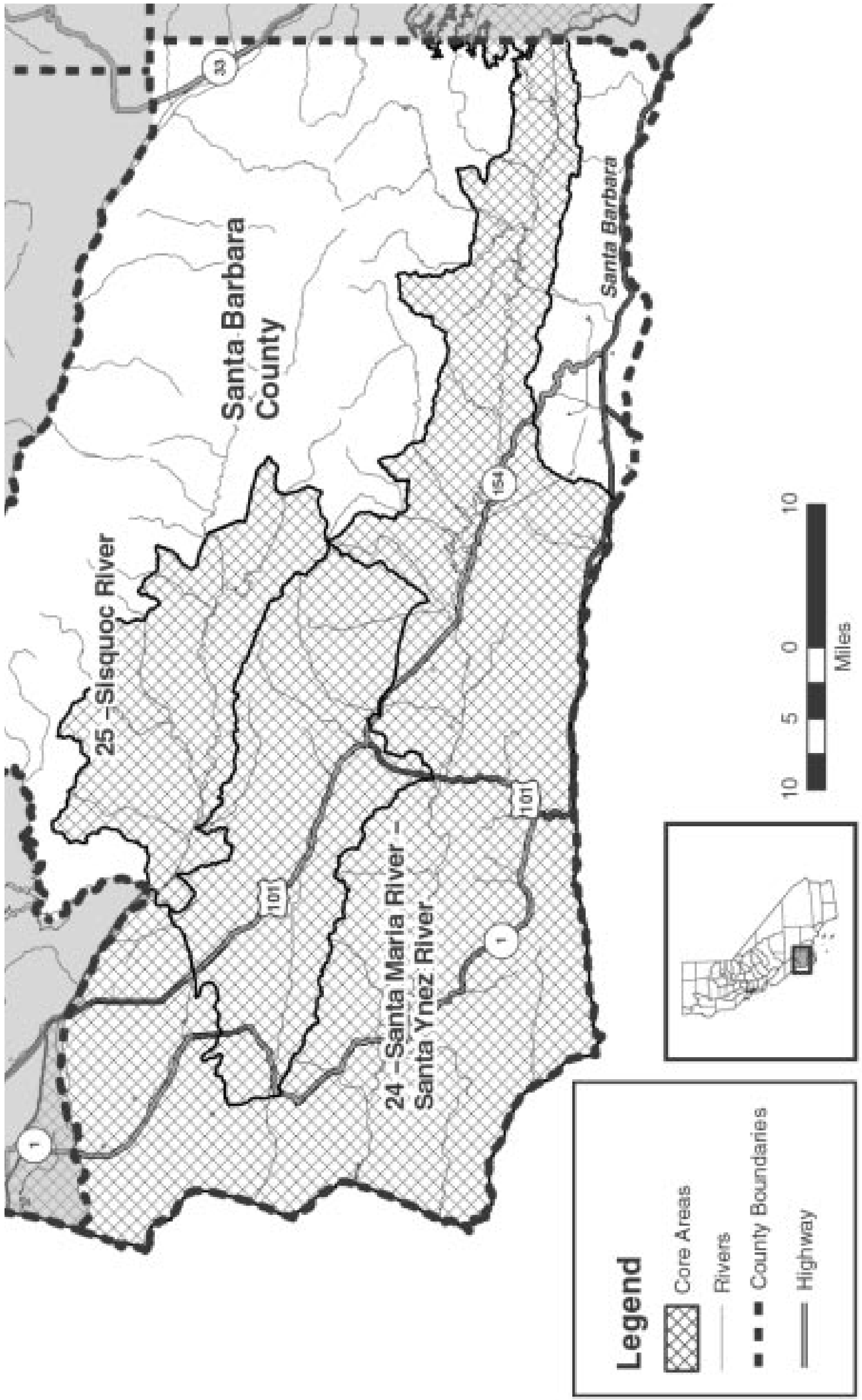
Figure 28. Map of core areas in Santa Barbara County

Santa Barbara County

Core Area:
Santa Maria River–Santa Ynez River
Hydrologic Sub-Area:
Arguello
Buellton
Guadalupe
Lake Cachuma
Lompoc
Los Olivos
San Antonio
Santa Cruz Creek
Santa Rita

Core Area:
Sisquoc River
HSA:
Sisquoc

Core Area:
Ventura River–Santa Clara River
Hydrologic Sub-Area:
Topa Topa
Upper Ventura River



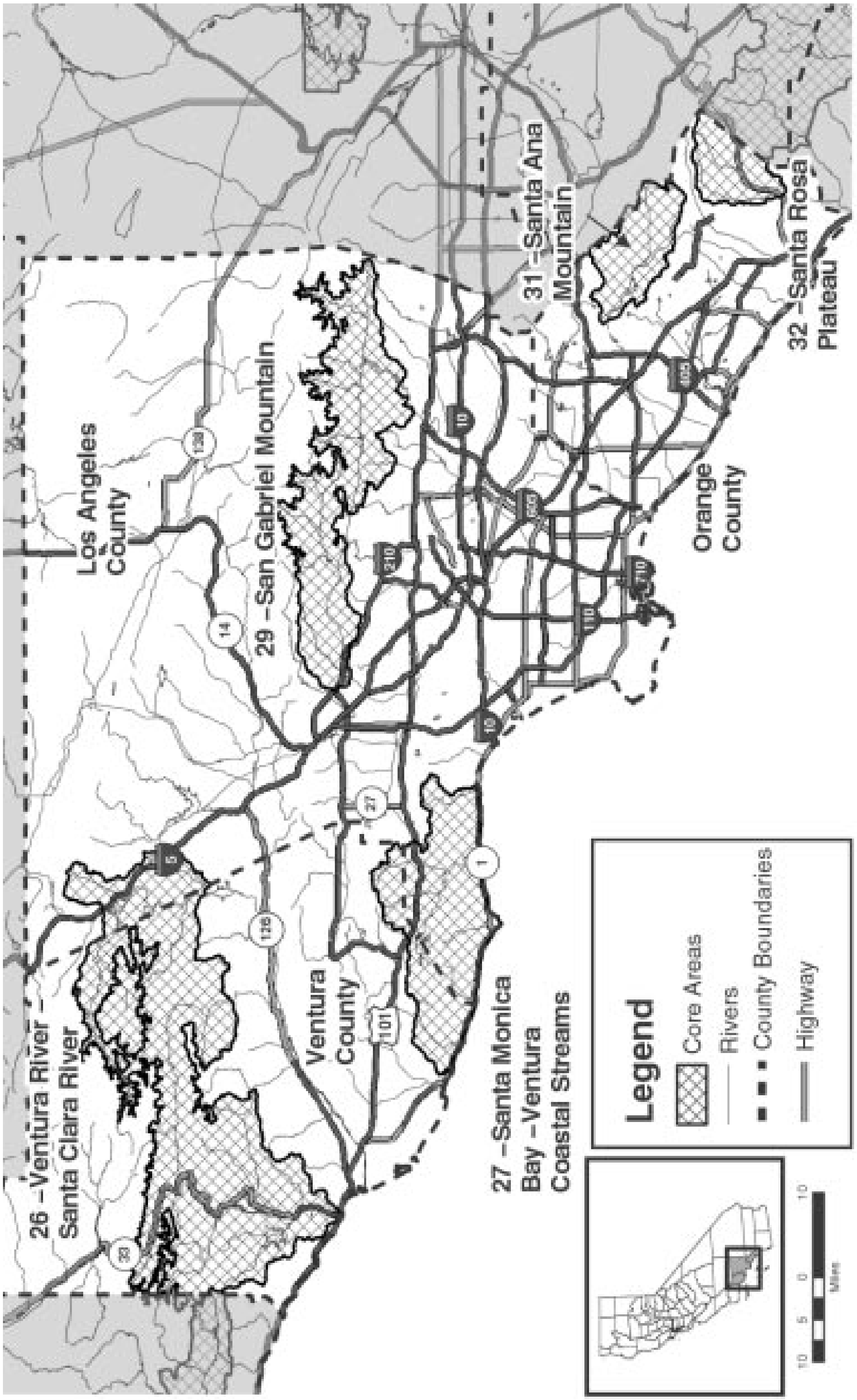


Figure 29 . Map of core areas in Los Angeles, Ventura, and Orange Counties

(see next page for Core Areas and HSAs)

Los Angeles County

Core Area:
San Gabriel Mountain
Hydrologic Sub-Area:
Santa Anita
Tujunga
Upper Canyon

Core Area:
Santa Monica Boy–
Ventura Coastal
Hydrologic Sub-Area:
Arroyo Senuit
Carbon Canyon
CorralCanyon
Encinal Canyon
Escondido Canyon
La Virgenes Canyon
Las Flores Canyon
Latigo Canyon
Lindero Canon
Little Sycamore Canyon
Los Alisos Canyon
Monte Nido
Nicholas Canyon
Pena Canyon
Piedra Gorda Canyon
Ramera Canyon
Russell Valley
Sherwood
Solstice Canyon
Topanga Canyon
Trancas Canyon
Triunfo Canyon
Tuna Canyon
Zuma Canyon

Core Area:
Ventura River–Santa
Clara River
HSA:
Upper Piru

Ventura County

Core Area:
Santa Maria River–
Santa Ynez River
HSA:
Santa Cruz Creek

Core Area:
Santa Monica Bay–
Ventura Coastal
Hydrologic Sub-Area:
Arroyo Senuit
Big Sycamore Canyon
Deer Canyon
La Jolla Valley
La Virgenes Canyon
Lindero Canyon
Little Sycamore Canyon
Russell Valley
Sherwood

Core Area:
Ventura River–Santa
Clara River
Hydrologic Sub-Area:
Lower Ventura River
Ojai Valley
Sisar Topa Topa
Upper Ojai
Upper Piru
Upper Ventura River

Orange County

Core Area:
Santa Ana Mountain
HSA:
Santiago

Core Area:
Santa Rosa Plateau
HSA:
Upper San Juan

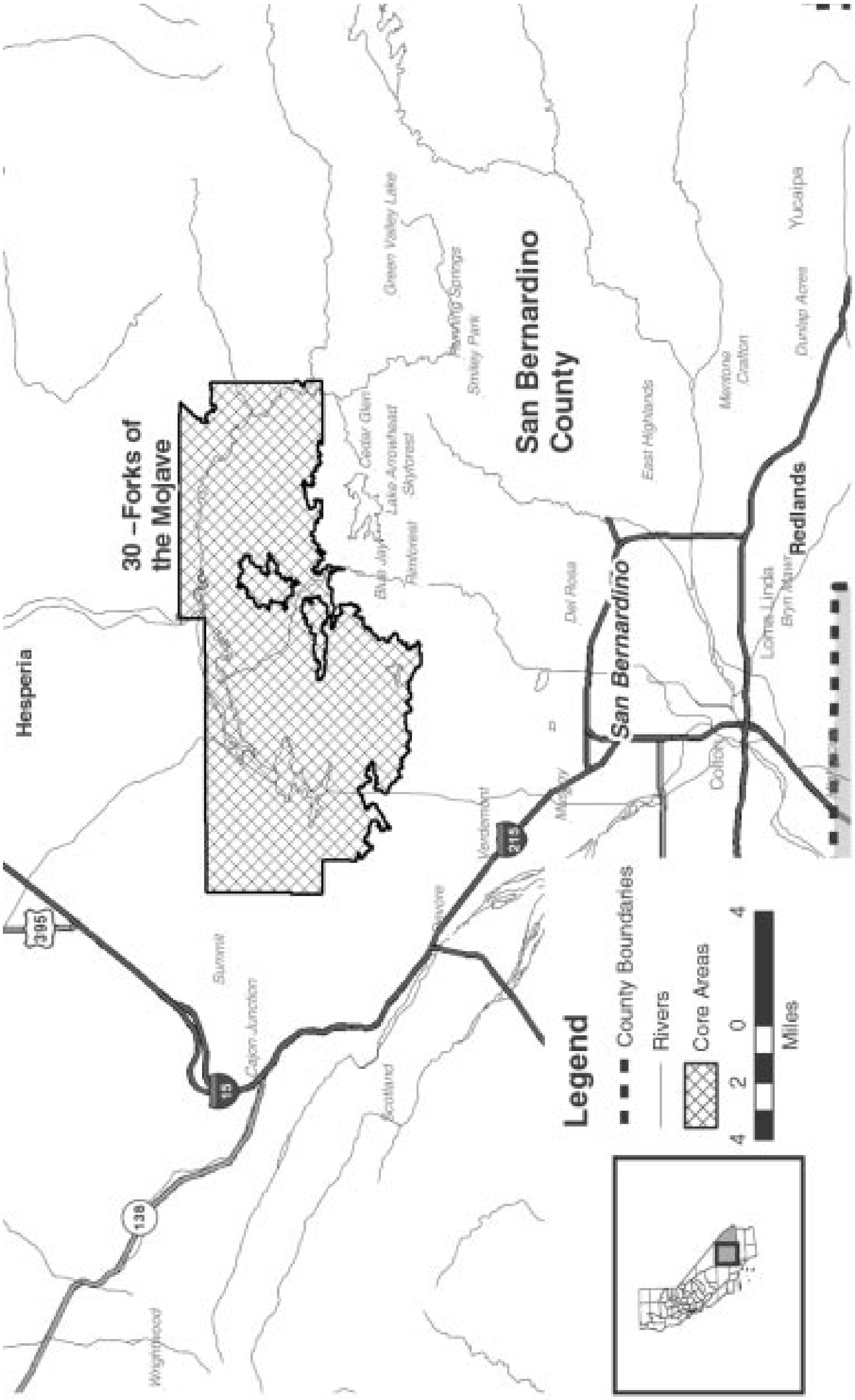


Figure 30. Map of core areas in San Bernardino County

San Bernardino County

Core Area:
Forks of the Mojave
HSA:
Upper Mojave

Figure 31. Map of core areas in San Diego and Riverside Counties

San Diego County

Core Area:
Laguna Mountain
Hydrologic Sub-Area:
Cottonwood
Pine

Core Area:
San Luis Rey
Hydrologic Sub-Area:
Guejito
Pala
Pauma

Core Area:
Santa Rosa Plateau
Hydrologic Sub-Area:
Deluz Creek
Gavilan
San Mateo Canyon

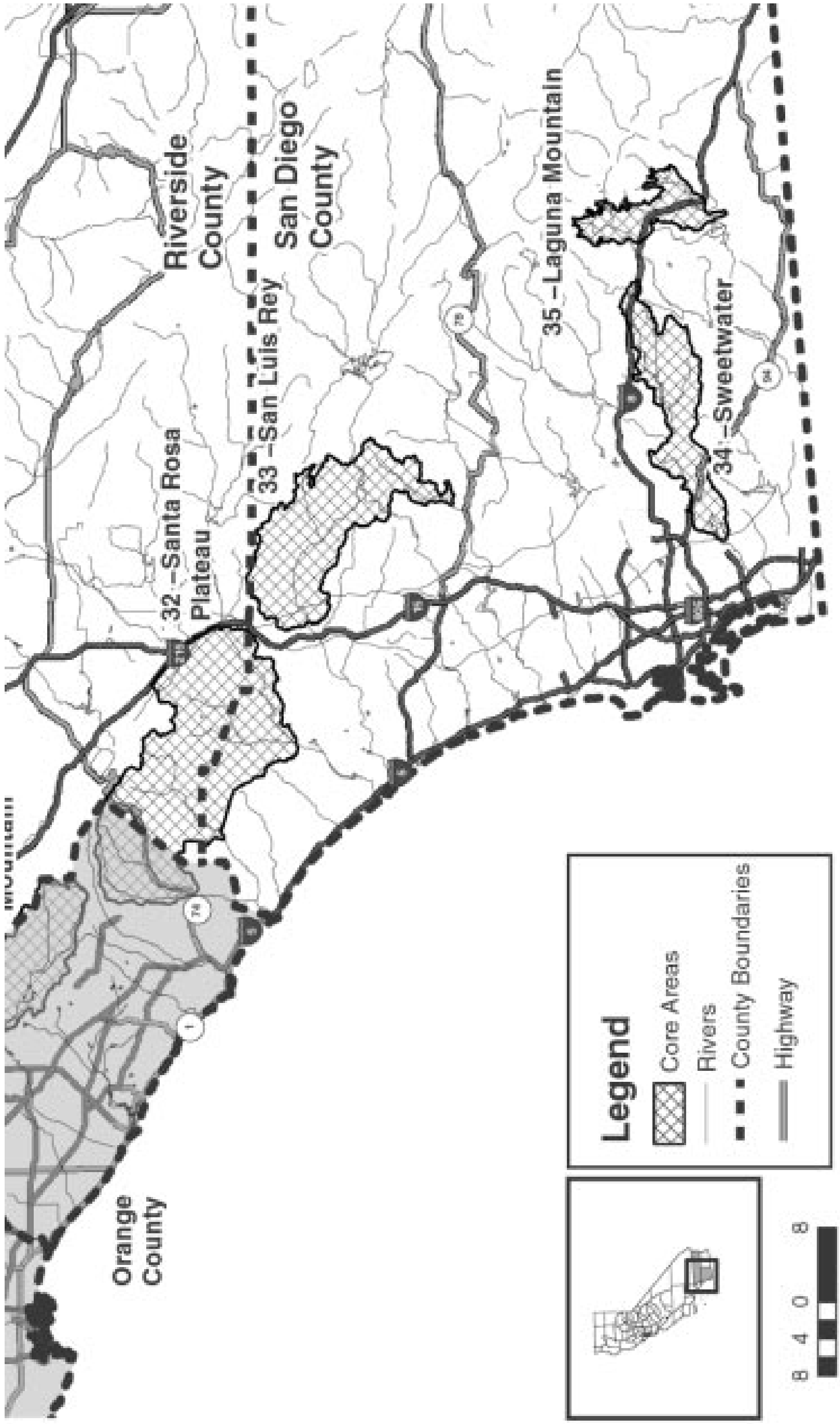
Core Area:
Sweetwater
Hydrologic Sub-Area:
Jamacha
Loveland

Riverside County

Core Area:
San Luis Rey
HSA:
Pala

Core Area:
Santa Ana Mountain
HSA:
Santiago

Core Area:
Santa rosa Plateau
Hydrologic Sub-Area:
Deluz Creek
Gavilan
Murrieta
San Mateo Canyon
Upper San Juan



APPENDIX D. GUIDELINES FOR VOLUNTARY POND MANAGEMENT FOR THE BENEFIT OF THE CALIFORNIA RED-LEGGED FROG

In many California red-legged frog metapopulations, artificial ponds maintained for watering livestock are the principal sources of the young frogs that annually repopulate the system. In dry areas, a pond can represent a longer-lasting water source, providing for complete tadpole development and adult escape cover. At wetter sites, ponds are often the only quiet water refuges for egg-laying and tadpole development outside of the swiftly flowing streams. In both cases, ponds can give a stability and predictability to the habitats that would not otherwise be present.

However, in some cases, ponds can be extremely detrimental to the California red-legged frog. Perhaps the most common nuisance pond is one that attracts and provides habitat for bullfrogs and predatory fish. In many instances, these predators eliminate the California red-legged frog. Another type of detrimental pond is one that fills and is attractive breeding habitat in late winter and early spring, but dries up before tadpoles can undergo metamorphosis. These ponds can trap many California red-legged frog egg masses and larvae and eliminate reproductive output.

California red-legged frogs have evolved in California's Mediterranean climate with wet winters and springs and dry summers and falls, but most of their introduced predators have not. In most cases, pond management that mimics the natural water cycle will be most beneficial for the California red-legged frog.

Red-legged Frog Biology

Ponds that successfully enhance California red-legged frog populations must complement their biology. The frogs breed from December to April in ponds and streams. They seem to choose the sites that have the warmest water available, as long as it is at least 20 centimeters (8 inches) deep. Tadpoles hatch in a few days, depending on temperature, and develop through the spring. They start to transform into froglets in June or July, and by late August most have completed the process.

Outside of the breeding season, adult frogs seek out water greater than 1 meter (3 feet) deep for escape from predators. In some areas, late summer water can be very scarce, and frogs will travel to congregate in old dug wells, in deep holes in drying streams, or in and around springs. With the first soaking rains of fall, frogs tend to move away from their summer refuges. During a rainy winter, they may establish a temporary residence quite a distance from any body of water. At this time they often gradually move towards the late winter breeding site.

Choosing a Site

At the present time, stock ponds are useful for rehabilitation and enhancement of California red-legged frog populations only if the frogs can get to them. We must approve the transport and reestablishment of the California red-legged frog into areas where they do not now occur. Reestablishment is only considered after intensive studies of both the donor and recipient sites, with guarantees that the donor population will not be damaged. Given this, ponds for the benefit of California red-legged frogs should be limited to areas that already contain at least a remnant population. In such areas, if the ponds are suitable, the frogs will find them on their own and will not need to be moved.

Ponds should be located as far as possible from predator source-areas. Bullfrogs from a pond with a large population will quickly invade a new pond up to a few hundred meters (about

1,000 feet) away, but it should take them longer to build up to damaging population levels if the ponds are separated by a kilometer (0.6 mile) or more. Raccoons are also a serious California red-legged frog predator in many places. They build up to many times the normal population density in urban areas and campgrounds with a plentiful supply of garbage, and dog and cat food.

Pond Design

Suggestions for pond design are based on observations of frogs in many habitats, but they have not been experimentally tested for efficacy. Further research will surely modify or eliminate some of these suggestions. The final design depends on a number of considerations such as the terrain, the use of the pond, and the adequacy and timing of the water supply. From a biological point of view, pond design is most tightly restricted when bullfrogs are present in the area.

The ideal pond probably has two main components: a deep-water escape portion and a shallow tadpole- and juvenile-rearing section. The former should have areas that are deeper than 1 meter (3 feet). It may not matter if this part is clogged with aquatic vegetation. Mats of floating submerged vegetation in deep water seem to be ideal for the adult frog in the non-breeding season. Predators such as raccoons and herons, and even large bullfrogs, probably find it difficult to reach California red-legged frogs on floating mats.

The tadpole-rearing portion should be unshaded and shallow enough to warm quickly in the winter sun. Submerged aquatic vegetation seems to be tolerated, but emergents such as willows (*Salix*), cattails (*Typha*), or bulrushes (*Scirpus*) shade the water and keep it cool. The pond must contain water for tadpole development during the entire rearing season (minimally March through July in most areas), but it can be allowed to dry at other times of the year.

If the main pond dries regularly, adult frogs will use a restricted summer refuge. In places with a high water table, these can be dug wells if they have deep, perennial water and protecting vegetation and are designed so frogs can get out (i.e., not too deep and steep sided). Springs can also be easily modified as summer refuges.

Discouraging Predators

Perhaps the most important factor in discouraging aquatic vertebrate predators of the California red-legged frog is the installation of a pond drain. If the pond can be regularly and completely drained, even once every 3 or 4 years, bullfrog and fish populations will be greatly reduced or eliminated. Bullfrog eggs are laid in the early summer (April through July), and the majority of tadpoles do not transform until the following year. If the pond is completely drained in the fall or winter, bullfrog (and fish) life cycles will be broken.

Bullfrog tadpoles and adults are usually associated with deep water, and extensive shallow, marshy areas may favor the California red-legged frog. Also, small isolated ponds a few meters (several yards) across, such as dug out spring heads, may harbor the California red-legged frog, but may not be attractive to bullfrogs.

Chemical means of bullfrog tadpole and fish control are possible (e.g., use of rotenone), but their use requires the permission of the California Department of Fish and Game and the U.S. Fish and Wildlife Service to ensure that the California red-legged frog and other native wildlife will not be harmed.

The Role of Grazing

Pond management usually needs to be integrated with the local livestock grazing program. Grazing can be an important tool to help keep the shallower, tadpole-rearing portions of the pond free of emergent vegetation that shades the water. The shallows should be deep enough so that livestock do not churn them into a mucky mire, but shallow enough so that the animals can graze comfortably. Ponds with fluctuating levels where the shallow portions dry each year, facilitate this type of grazing management.

Many ponds used by cattle gradually become shallow mud holes as cattle trample the banks. To prevent this, the deepest portion of the pond should be fenced so that cattle cannot enter. This can be done so that the primary function of the pond, which is to provide livestock water, is not compromised, but deep escape water is preserved for frogs.

The critical periods for livestock water on many California ranges is late summer and early fall. Draining of ponds for bullfrog and fish control can usually be postponed until after the first fall rains, when livestock water is less critical. Alternatively, a temporary catch basin below the drained pond could provide livestock water. Water in the catch basin could be maintained until the main pond refills, then the catch basin could be drained. A catch basin should also be used if there is danger of releasing unwanted predators into a downstream body of water.

APPENDIX E. PRIVATE LANDOWNER INCENTIVES FOR IMPLEMENTATION OF CONSERVATION MEASURES

A. NATIONAL RESOURCE CONSERVATION SERVICE PROGRAMS

The 1996 Farm Bill authorized $2.2 billion nationally in funding for conservation programs, extended the Conservation Reserve Program and Wetland Reserve Program, and created new initiatives to improve natural resources on America's private lands. To qualify for market transition payments under basic commodity programs which replace traditional farm subsidies, farm operators must agree to abide by Conservation Compliance and Wetlands Conservation (Swampbuster) provisions in the 1996 Farm Bill. As of October 2001, some of these programs have ceased to be funded but due to the overwhelming support for Farm Bill programs, future reauthorization and funding is expected.

1. **Conservation Reserve Program**

   The Conservation Reserve Program encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as non-native and native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices. This program allows up to 34.4 million acres, nationally, to be enrolled at any one time. New enrollments can replace expired or terminated contracts.

2. **Wetland Reserve Program**

   The Wetland Reserve Program is a voluntary easement program that offers financial incentives to help landowners restore and protect wetlands. The program targets farmed wetlands and farmland that once was wetland. A priority is given to areas offering the most wetland benefits (lands adjacent to restorable wetlands that contribute significantly to wetland functions and values, previously restored wetlands that need long-term protections, upland areas needed to provide an adequate ecological buffer or otherwise contribute to defining a management boundary, existing or restorable riparian habitat corridors that connect protected wetlands and lands substantially altered by flooding where there is a likelihood of successful wetland restoration at a reasonable cost). The program offers three options to protect, restore, and enhance wetlands and associated uplands: permanent easements, 30-year easements, or 10-year restoration cost share agreements.

3. **Wetland Conservation (Swampbuster)**

   The Wetland Conservation provision allows landowners to comply with wetland conservation requirements while protecting natural resources under the 1996 Farm Bill. It provides more options for mitigation by including restoration, enhancement, or creation as long as wetland functions and values are maintained. The program stipulates that wetland conservation activities, authorized by permits issued under section 404 of the Clean Water Act, which make agriculture production possible, will be accepted for Farm Bill purposes if they were adequately mitigated. It requires wetland determinations to be certified by the National Resource Conservation Service. It also establishes a pilot program for wetland mitigation to allow the U.S. Department of Agriculture to assess how well mitigation banking works for agriculture.

4. Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program was established in the 1996 Farm Bill to provide a single, voluntary conservation program for farmers and ranchers to address significant natural resource needs and objectives. Nationally, this program provides technical, financial, and educational assistance, half of it targeted to livestock-related natural resource problems and the other half to more general conservation priorities.

The program works in priority areas where there are serious and critical environmental needs and concerns. These critical needs areas are determined and prioritized by the National Resource Conservation Service, other U.S. Department of Agriculture agencies, and local work groups. High priority is given to areas where State or other local governments offer financial or technical assistance and where agricultural improvements will help meet water quality and other environmental objectives. All Environmental Quality Incentives Program activities must be carried out according to a conservation plan.

The program offers 5 to 10-year contracts that provide incentive payments and cost sharing for conservation practices needed at the site. Cost sharing may pay up to 75 percent of the costs of certain practices important to improving and maintaining the health of the natural resources of the area. Incentive payments can be made to encourage producers to perform land management practices including wildlife habitat management. Incentive payments can be up to 100 percent of the producer’s cost.

The program funding comes from commodity credit corporations. The budget is $200 million per year, nationally, through the year 2002. Conservation practices for natural resource concerns related to livestock production will receive 50 percent of the funding. Total cost share and incentive payments are limited to $10,000 per person per year and $50,000 over the length of the contract.

5. Wildlife Habitat Incentives Program

The Wildlife Habitat Incentives Program is a voluntary program for people who want to develop or improve fish and wildlife habitat primarily on private lands. It provides both technical assistance and cost share payments to help establish and improve fish and wildlife habitat. The National Resource Conservation Service helps participants prepare a wildlife habitat development plan in consultation with the local conservation district. The plan describes the landowner’s goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement. This plan may or may not be part of a larger conservation plan that addresses other resource needs, such as water quality and erosion. Cost share assistance includes an agreement for wildlife habitat development and usually lasts 5 to 10 years.

Under the agreement:

1. The landowner agrees to install and maintain the program practices and allow the National Resource Conservation Service or its agent access to monitor the effectiveness of the practices.

2. The U.S. Department of Agriculture agrees to provide technical assistance and pay up to 75 percent of the costs of installing the wildlife habitat practices.

Wildlife Habitat Incentives Program funds are distributed to States based on state wildlife habitat priorities which may include: a) wildlife habitat areas; b) targeted species and their habitats; and c) specific practices.

The program may be implemented in cooperation with other Federal, State, or local agencies; conservation districts; or private conservation groups. State priorities in California for the Wildlife Habitat Incentives Program are the following:

1. Riparian area and stream habitat restoration or enhancement.

2. Federal or State threatened or endangered species habitat restoration or enhancement.

3. Treatment or improvement of habitats in uplands (rangeland, woodland, and forest land).

4. Wetland area creation, restoration, enhancement, and management.

5. "Farmland compatible" habitat development (odd areas, ditches, field borders, rights-of-way, and other areas in or adjacent to farmland fields).

6. Cold water fisheries habitat restoration and enhancement (including salmon, steelhead, and trout).

7. Restoration or enhancement of critical habitat related to endangered species.

8. Habitat restoration and enhancement for game species and other species.

6. Forestry Incentives Program (FIP)

The Forestry Incentives Program supports good forest management practices on privately owned, nonindustrial forest lands. This program is intended to assure the Nation's ability to meet future demand for saw timber, pulp wood, and quality hardwoods by planting more trees and placing more forest land under good forest management. The program provides 65 percent of the cost of tree planting, timber stand improvements, and related practices on nonindustrial private forest land. The Federal cost share limit is $10,000 per person per year. The Forest Incentives Program's forest maintenance and reforestation provide numerous natural resource benefits, including reduced wind and soil erosion and enhanced water quality and wildlife habitat. The program is administered by the Natural Resource Conservation Service and the U.S. Forest Service.

7. California Stewardship Incentives Program

The California Stewardship Incentives Program is similar to the Forest Incentives Program. Whereas the Forest Incentives Program requires that the total private acreage be timbered acreage potentially suitable for timber production, the Stewardship Incentives Program only requires that 10 percent of the land have tree canopy or be planted to trees. Cost share rates and benefits to natural resources are the same as the Forest Incentives Program.

8. Emergency Conservation Program

The Emergency Conservation Program provides emergency funds for sharing with farmers and ranchers the cost of restoring to productive use farmland seriously damaged by natural disasters. This program is available ***only*** to solve new conservation problems caused by natural disasters that impair and endanger the land or materially affect the productive capacity of the land. The damage must be unusual (except for wind erosion) and not likely to recur frequently in the same area. Conservation problems existing prior to the disaster are not eligible for program assistance. Emergency practices to rehabilitate damaged farmland may include: 1) rehabilitating stream banks, channels, levees, and dikes affected by the natural disaster; 2) removing debris deposited by a natural disaster (e.g. flood debris) that interfere with normal farming operations; and 3) restoring land between any levee and the stream.

9. Emergency Watershed Protection Program

The Emergency Watershed Protection Program, administered by the Natural Resource Conservation Service, provides technical and financial assistance to communities for restoring watersheds ravaged by natural disasters such as, floods, fires, wind storms, earthquakes, and drought. Through the Emergency Watershed Protection Program, the Natural Resource Conservation Service provides assistance to prevent damage from flooding, runoff, and erosion, reducing the threat to life and property. The Natural Resource Conservation Service helps repair over-topped levees, dikes, and other flood retarding structures. Assistance is also available to help clear water courses clogged by sediment and debris to prevent future flooding. Other available measures include establishing vegetative cover, controlling gullies, and protecting stream banks.

This assistance protects homes, businesses, and other properties from further damage in the event of subsequent storms. The Natural Resource Conservation Service also provides financial assistance covering up to 75 percent of construction costs of eligible emergency treatments. Local sponsors of program projects are responsible for obtaining the necessary permits, providing 25 percent cost share, and providing for the operation and maintenance of completed emergency measures.

10. Resource Conservation and Development Program

The Resource Conservation and Development Program was initiated in 1962 to help people care for and protect their natural resources and to improve an area’s economy, environment, and living standards. The program provides a way for local residents to work together and plan how they can actively solve environmental, economic, and social problems facing their communities. Assistance is available from the Natural Resource Conservation Service for planning and installation of approved projects specified in Resource Conservation and Development area plans, for land conservation, water management, community development, and environmental enhancement. The program provides for multi-county planning coordination. Groups of landowners, communities, nonprofit organizations, and local government agencies are eligible to participate in this program, as well as Native American landowners and Tribal trust lands meeting the requirement that land is located in a Resources Conservation and Development area.

Land must be in a United States Department of Agriculture-recognized Resource Conservation and Development area. Currently these areas are: OreCal Resource Conservation and Development area in Siskiyou and western Modoc Counties in California, and Klamath/Lake Counties in Oregon; North Cal Neva Resource Conservation and Development area in Lassen, Plumas, and western Modoc Counties in California and Washoe County, Nevada; Trinity County Resource Conservation and Development area in Trinity County, California; High Sierra Resource Conservation and Development area in Nevada, Placer, El Dorado, Sierra, and Amador Counties in California; Central Coast Resource Conservation and Development area in Santa Cruz, Monterey, San Benito, and San Luis Obispo Counties in California.

Assistance is provided in the form of: 1) technical assistance and 2) grants (as funding allows) up to 25 percent of the total cost, not to exceed $50,000. Local or State governments must provide 10 percent of the total cost and they are responsible for the operation and maintenance.

11. Other Programs

Several other programs administered by the Natural Resource Conservation Service are designed to protect natural resources on a watershed basis. These include River Basin Studies and Water Project Plans. River Basin Studies identify water and land resource problems, and analyze the economic base and environmental setting. Alternative plans for solving problems and improving the economy and the environment are offered. Watershed Project Plans and Environmental Impact Statements provide plans that assist urban and rural communities to protect, improve, and develop water and land resources in watersheds up to 92,000 hectares (250,000 acres). The Natural Resource Conservation Service may provide both technical and financial assistance in the planning and implementation of watershed projects. The local sponsors may have major obligations in these projects, including obtaining 25 percent of the funding to implement the projects and the responsibility for insuring the operation and maintenance of the installed practices which make up the project. Wetland restoration, creation, or enhancement is often used to mitigate wildlife habitat losses caused by project actions.

B. U.S. FISH AND WILDLIFE SERVICE PROGRAMS

1. Partners for Fish and Wildlife

Partners for Fish and Wildlife is our habitat restoration cost-sharing program for private landowners. The program was established to offer technical and financial assistance to landowners who wish to restore wildlife habitat on their property. On-the-ground habitat improvement projects that benefit Federal trust species include restoration of wildlife habitat on degraded or converted wetlands, riparian areas, native grasslands, and streams. The assistance we provide can range from giving informal advice on the design and location of a potential restoration project, to designing a project and funding up to 50 percent of the implementation costs under a formal cooperative agreement with the landowner. Projects with the highest priorities are those that reestablish the natural historical communities and provide benefits to migratory birds, anadromous fish, and threatened and endangered species. Projects include efforts such as, but not limited to: creating shallow water areas, revegetating native plants, erecting fences along riparian areas to exclude livestock, grazing plans to benefit livestock and wildlife, pesticide use reduction, water level management, and soil and water quality improvements.

The process is as follows:

We meet with the landowner and any representative from other cooperating agencies or organizations on the property to discuss the landowner's goals and objectives. We provide technical advice on project design, material, and engineering as appropriate. Cost sharing is proposed. A habitat restoration proposal, developed by the landowner and our staff, is submitted to one of our State offices to compete for funds. After funding is approved, the Wildlife Extension Agreement is signed. Upon project completion, we will reimburse the landowner after receipts and other documents are submitted according to the agreement.

2. Safe Harbor Programs

Many public and private interests have suggested that there be an incentive for private landowners and/or public land managers to voluntarily enhance habitat for California red-legged frogs or to participate in reestablishment efforts for this species in historically occupied areas. Many have concerns that doing so, without proper incentive programs in place, will pose a long-term regulatory threat. This is particularly a concern for those landowners who may be situated adjacent to areas undergoing reestablishment. For this reason, a safe harbor program may be the best vehicle to encourage voluntary reestablishment programs and alleviate the concerns of neighboring landowners. A Safe Harbor Agreement is a voluntary agreement between us and one or more private or non-Federal landowners to restore, enhance, or maintain habitats for listed species, candidates, or other species of concern. Under the Agreement, we provide the landowner with assurances that additional land use actions would not be imposed. If the Agreement provides a net conservation benefit to the covered species and the landowner meets all the terms of the Agreement, we would authorize the incidental taking of covered species to enable the landowner to return the enrolled lands to agreed upon conditions.

The California red-legged frog appears to be a good candidate for application of a safe harbor program. Because recovery planning emphasizes the importance of maintaining viable metapopulations and protecting a network of connected habitats, it is reasonable to assume that any conservation measure that is enacted (albeit with the understanding that it is implemented under a potentially limited time frame via a safe harbor agreement) will provide potential short term benefits to an individual population but lasting benefits to the overall metapopulation. For example, if habitat is created via enhancements of a stockpond such that the stockpond is colonized by California red-legged frogs or if a stockpond is stocked with translocated individuals, this restoration action will presumably provide some number of years of suitable habitat for successful breeding. This will in turn, provide dispersers into adjacent habitats. If a landowner decides to remove this habitat at some future point in time, the overall metapopulation will still have gained by the potential increase in subpopulations. Provided that adjacent landowners are party to the agreement, all colonized habitats could be covered under the agreement, perhaps with staggered time periods/endpoints. Opportunities for enhancement of habitat exist rangewide and the use of safe harbor programs may substantially facilitate implementation of recovery actions.

There are several steps to develop a Safe Harbor Agreement and obtain the appropriate permits. An interested landowner should contact the nearest Fish and Wildlife Service Field Office and speak to someone about the program. The landowner, with our the aid, must provide some background information including the location and of the property, the proposed management actions, and the species that will benefit. We (or appropriate cooperators as approved by the landowner) will describe the baseline conditions for the enrolled property in terms appropriate for the listed species. Baseline conditions include the number and location of individuals, if it can be determined, and also includes an assessment of habitat extent and quality. Both parties will discuss land use objectives, assess habitat quality, and identify any other information needed to develop an Agreement. After this, a Safe Harbor Agreement is developed; it should include a monitoring program to assess the success of the management practices. Assurances are provided through a “enhancement of survival” permit once the Agreement is developed. We complete an internal section 7 review and a public comment period, issue a 10(a)(1)(A) permit, and finalize the agreement. This permit allows the landowner to return the property to the baseline conditions at the end of the Agreement. Safe Harbor Agreements will be honored after the sale of the enrolled property if the new owner willingly signs the original Agreement; agreements can also be renewed.

C. STATE OF CALIFORNIA PROGRAMS

1. California Resource Conservation Districts

Conservation Districts emerged during the 1930s as a way to prevent the soil erosion problems of the Dust Bowl from recurring. Formed as independent local liaisons between the Federal government and landowners, conservation districts have always worked closely with the USDA Natural Resources Conservation Service. Resource Conservation Districts address a wide variety of conservation issues such as forest fuel management, water and air quality, wildlife habitat restoration, soil erosion control, conservation education, and much more.

Resource Conservation Districts render assistance to private landowners wishing to conserve soil and water and manage their resources on a sustainable basis. But Resource Conservation Districts also act as a focal point for local conservation efforts, and Resource Conservation Districts throughout the State now function as leaders in the conservation community, including a large number of watershed groups such as Coordinated Resource Management Planning (CRMP) groups throughout the State. Resource Conservation Districts continue to sponsor educational efforts to teach children and adults alike of the importance of conserving resources.

California now has 103 Resource Conservation Districts, most of which are funded largely through grants. A few receive limited funds through county property tax revenues. The Department of Conservation and the Natural Resources Conservation Service provide training and in-kind support, as well as a watershed grant program for districts.

2. California Forestry Incentives Program (CFIP)

The purpose of the California Forest Improvement Program is to encourage private and public investment in, and improved management of, California forest lands and resources. This focus is to ensure adequate high quality timber supplies, related employment and other economic benefits, and the protection, maintenance, and enhancement of a productive and stable forest resource system for the benefit of present and future generations.

The program scope includes the improvement of all forest resources, including fish and wildlife habitat, soil, and water quality. The program provides technical assistance to private forest landowners, forest operators, wood processors, and public agencies. Cost share assistance is provided to private forest landowners, Resource Conservation Districts, and non-profit watershed groups. Cost-shared activities include management planning, site preparation, tree purchase and planting, timber stand improvement, fish and wildlife habitat improvement, and land conservation practices for ownerships containing up to 5,000 acres of forest land.

D. GREEN CERTIFICATION PROGRAMS

Green Certification programs have recently been developed to bring environmental concerns to the marketplace. Products that are generated using environmentally sensitive methods are offered as alternatives to traditionally produced items. There is a double incentive for these types of programs that leads to reduced environmental effects. Producers are encouraged by the potential for higher income, and consumers are stimulated by the prospect of owning higher-valued specialty items. Both are motivated by personal desires to contribute to good land stewardship and sustainable environments. These programs typically involve certification of the producer by an independent party using criteria generated through ecological and economic research. Certification can be done to verify lowered impacts to a species or group of species (e.g., Dolphin-Safe Tuna) or to verify that land management practices in general meet sustainability criteria (e.g., the Smart Wood Program).

There are a number of programs that could be considered as models for setting up criteria and a labeling program for the California red-legged frog. "Dolphin-Safe Tuna" labeling was one of the first such programs. This program uses independent monitors that have unrestricted access to fishing boats and manufacturing facilities to document the minimal effects of tuna fishing on dolphins. There are numerous large companies that now use the Dolphin-Safe label. Another species-specific program is "Bird-Friendly Coffee." Recent changes in the way coffee is grown (from under forest canopies that provide shade to open-field, sun grown) have had significant negative impacts to native birds in the tropics and neotropical migrants. This program uses criteria developed by the Smithsonian Migratory Bird Center, as applied by independent evaluators, to certify coffee as shade-grown and "Bird Friendly." There is at least one coffee company now that produces and sells this certified coffee.

Several other programs provide certification to landowners that use ecologically sustainable land management practices. Two examples of these types of programs are "Smart Wood" and "Salmon Safe." Both are overseen by independent non-profit entities that have developed specific criteria for their local area. In the case of "Salmon Safe," small agricultural landowners in California and Oregon are currently the main focus. Expert evaluators use criteria and scoring guidelines developed by the Pacific Rivers Council (Eugene, Oregon) to certify that farmland management uses with best management practices to avoid harm to stream ecosystems. These practices may result in restoration of currently degraded areas. The following four criteria guide this process: 1) quality of management of riparian and wetland areas; 2) quality of management of water use and irrigation; 3) approaches to uses of pesticides, herbicides, and fertilizers; and 4) erosion and sediment control measures. More specific sub-criteria are used to do actual scoring. The "Smart Wood" program, developed by the Rainforest Alliance (New York City, New York) is probably the largest wood products certification program. The program certifies wood products, resource managers, and manufacturing companies that produce and handle wood that has been generated using ecologically sustainable practices. Local organizations typically develop region-specific criteria that are then approved by the "Smart Wood" program. An example are the certification criteria used by the Institute for Sustainable Forestry in Redway, California. Their approach includes evaluation of: 1) the overall forest and watershed management plan, 2) silvicultural techniques, 3) the monitoring plan, 4) road management and sediment production, 5) stream and riparian management, 6) wildlife and biodiversity management, 7) fire and fuels management, 8) wildlife habitat, 9) roads and trails, 10) yarding, 11) special resources, 12) restoration, 13) community and economic stewardship, 14) use of local workforce, and 15) documentation of the "chain of custody" (how the wood is tracked through to a final product).

Developing a program to encourage private landowners and businesses to practice land management activities that are sensitive to the needs of the California red-legged frog could be based on a combination of the approaches used by the "Salmon Safe" and "Smart Wood" programs. These two programs cover the main impacts to the California red-legged frog in many areas of its current range. Agriculture, livestock grazing, and forestry practices could be certified as "frog friendly" by independent evaluators based on criteria developed by the recovery plan technical team or another science-based group. These criteria might include: 1) management of ponds, wetlands, and streams; 2) management of adjacent upland areas; 3) lack of exotic vertebrate species and/or a program for reduction of exotic species on the property; and/or 4) minimal use of chemical pesticides, herbicides, and fertilizers.

APPENDIX F. CODE OF PRACTICE TO REDUCE SPREAD OF DISEASE AND PARASITES

A Code of Practice was prepared by a group of scientists within the Declining Amphibian Populations Task Force to provide guidelines for use by anyone conducting fieldwork at amphibian breeding sites or in other aquatic habitats. While this protocol has not been reviewed and endorsed by the task force at large, the Code of Practice serves as a starting point for the development and adoption of measures that reduce the spread of disease and parasites (see task 7 in the Stepdown Narrative Outline).

Observations of diseased and parasite-infected amphibians are now being frequently reported from sites all over the world. This has given rise to concerns that releasing amphibians following a period of captivity, during which time they can pick up infections of novel disease agents, may cause an increased risk of mortality in wild populations. Amphibian pathogens and parasites can also be carried in a variety of ways between habitats on the hands, footwear, or equipment of fieldworkers, which can spread them to novel localities containing species which have had little or no prior contact with such pathogens or parasites. Such occurrences may be implicated in some instances where amphibian populations have declined. Therefore, it is extremely important for those involved in amphibian research and other types of wetland/pond studies (such as those on fish, invertebrates, and plants) to take steps to minimize the spread of disease agents and parasites between study sites.

The Declining Amphibian Populations Task Force Fieldwork Code of Practice:

1. Remove mud, snails, algae, and other debris from nets, traps, boots, vehicle tires, and all other surfaces. Rinse cleaned items with sterilized (eg., boiled or treated) water before leaving each study site.

2. Boots, nets, traps, etc. should then be scrubbed with 70 percent ethanol solution and rinsed clean with sterilized water between study sites. Avoid cleaning equipment in the immediate vicinity of a pond or wetland.

3. In remote locations, clean all equipment with 70 percent ethanol or a bleach solution, and rinse with sterile water upon return to the lab or a “base camp.” Elsewhere, when washing-machine facilities are available, remove nets from poles and wash (in a protective mesh laundry bag) with bleach on a “delicates” cycle.

4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolated species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps, and other equipment to each site being visited. Clean and store them separately at the end of each field day.

5. When amphibians are collected, ensure the separation of animals from different sites and take great care to avoid indirect contact between them (e.g., via handling, reuse of containers) or with other captive animals. Isolation from unsterilized plants or soils which have been taken from other sites is also essential. Always use disinfected and disposable husbandry equipment.

6. Examine collected amphibians for the presence of diseases and parasites soon after capture. Prior to their release or the release of any progeny, amphibians should be quarantined for a period and thoroughly screened for the presence of any potential disease agents.

7. Used cleaning materials (liquids etc.) should be disposed of safely and, if necessary, taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

APPENDIX G. GENERAL GUIDELINES FOR REESTABLISHMENT OF CALIFORNIA RED-LEGGED FROG POPULATIONS

General Guidelines

The successful reestablishment of frog populations as a conservation measure is largely unproven. However, reestablishment could be an important tool for repopulating large areas, especially in southern California, the foothills of the Sierra Nevada, and North Coast Range foothills that have lost their California red-legged frog populations. Reestablishment can also be used for the occupation of newly created habitats that cannot be easily reached from existing populations. Programs of reestablishment should not be entered upon lightly as they are expensive, and a long-term commitment of time and funds is imperative.

Attempts to reestablish the California red-legged frog should be made only if the following list of criteria are met. Detailed explanations of these criteria follow the list:

1) The California red-legged frog formerly occupied the general area;
2) The habitat appears to be suitable, is under long-term protection, and predators (especially exotic fishes and frogs) can be eliminated or kept to manageable levels;
3) The reasons for the species' absence have been determined and eliminated or minimized;
4) No reproducing populations of the California red-legged frog remain in the area, and it is not likely to be reinvaded from surrounding populations in the near future;
5) The effort can commit to:
   a) Releases of propagules at each site through at least 5 consecutive years, preferably at several sites within the area; and
   b) Monitoring for at least 10 years after the last release.

Explanations:

1) The historic range of the California red-legged frog encompassed the Central Valley of California, the Coast and Transverse ranges south of Mendocino County, southern California west of the deserts, and northern Baja California west of the Sierra San Pedro Mártir (see page 6 of the Introduction). Reestablishment can be considered in areas, including those with newly created habitats, that are currently unoccupied by the California red-legged frog, as long as the other criteria are fulfilled. Augmentation of any California red-legged frog populations is not recommended.

2) Habitat quality is defined in Section I. A favorable mix of breeding, rearing, and summer habitats relatively free of predators is the key element of habitat quality. At least three potential breeding/rearing sites should be identified within each habitat block. Single ponds, unsupported by a network of other ponds or streams, should not be considered for reestablishment programs.

   Sites must be protected from threats and incompatible uses in the foreseeable future. Biologists must be assured of access to the entire metapopulation habitat block for monitoring purposes. Top priorities for reestablishment should be those sites that have high quality habitat and that are most remote in distance from existing populations.

3) The reasons for the original disappearance or absence of the California red-legged frog must be identified and corrected.

4) Usually reestablishment will not be considered if there are populations present in the same recovery unit, unless the sites are isolated by habitats that are not easily crossed by

the California red-legged frog. Exceptions may also be made for newly created habitats that do not have an existing population nearby. Propagules should ideally be taken from the populations that are geographically closest to the reestablishment sites.

5) Reestablishment can be expensive, and unless the parties involved are dedicated to spending the necessary funds over a suitable time period, it is better not to embark on a program. This commitment must include the monitoring phase.

   a) Releases of about 1,000 eggs should be made at each breeding site within the habitat block for each of 5 years. If these goals cannot be achieved, the project should not be considered. In an emergency (extreme drought, flooding), a year might be skipped. In that case, the intended releases should be made in the sixth year instead. If more than 1,000 eggs are available, other sites should be considered for reestablishment. Each site should receive at least 500, but not more than 1,000, eggs each year.

   b) The cheapest and most efficient way to secure propagules for reestablishment is to collect as many whole or partial egg masses as necessary to provide 1,000 eggs for each reestablishment site. In different years, rotate the take of eggs among several subpopulations if at all possible.

   c) Monitoring reestablished populations is critical. If the fate of the population is not known, the effort is wasted. Much can be learned by monitoring even a failed reestablishment effort. Detailed monitoring is especially important during the first reestablishment program; the lessons learned will be used to guide all future efforts.

Implementation

Reestablishment as a recovery strategy should be considered in the following areas: Recovery Unit #1, the Sierra Nevada; Recovery Unit #2, the Coast Range foothills and western Sacramento River Valley; and Recovery Unit #8, the Southern Transverse and Peninsular ranges.

The steps to be taken are:

1. Survey the areas and determine their suitability, based on the above criteria. Choose suitable breeding/rearing sites.

2. Locate source metapopulations. Determine that enough adult females are present in each population to provide the necessary egg masses. As a rule of thumb, no more than 10 percent of the egg masses should be taken from a given site.

3. Collect either freshly laid eggs or those that are hatching. The intermediate stages are delicate and should not be disturbed. Keep the water cool and move the intact egg mass as quickly as possible to the release site. Divide the egg mass as necessary when you get to the release sites.

4. Monitoring should consist of annual survey sessions wherein all California red-legged frogs captured are sexed, weighed, measured, and examined for passive integrated transponder (PIT) tags. Tags should be inserted in those that lack them. The data should be immediately analyzed to examine the survival of each cohort. At the same time, the entire habitat block should be examined to document the rate of spread from the original release sites.

Summary of Section 10(j) of the Endangered Species Act of 1973: Experimental Populations

Reintroduction of the California red-legged frog is consistent with the goals of the Endangered Species Act. Guidelines for such activities are provided under section 10(j). This section allows the release (and the related transportation) of any population (including eggs, propagules, or individuals) of an endangered species or a threatened species outside the current range of such species if the Secretary of the Department of Interior determines that such release will further the conservation of a species.

Before authorizing the release of any population, the reintroduced population should be identified, on the basis of the best available information, as an essential population (i.e, the population is essential to the continued existence of an endangered species or a threatened species) or as a nonessential population. This section also provides the Secretaries of the Departments of Interior and Commerce with the power to designate certain populations of listed species as experimental populations. The term experimental population means any population (including any offspring arising solely therefrom) authorized for release that are wholly separate geographically from nonexperimental populations of the same species.

Each member of an experimental population shall be treated as a threatened species unless the experimental population is considered to be nonessential to the continued existence of a species. If it is nonessential, it is treated as a species proposed to be listed under section 4 of the Act. If the nonessential population occurs in an area within the National Wildlife Refuge System or the National Park System however, it is treated as threatened with either designation.

The best known cases in which the status "experimental/nonessential" has been used are the reintroductions of the endangered red wolf in North Carolina and the threatened gray wolf in Idaho and in Yellowstone National Park. Ordinarily, private landowners cannot chase an endangered species such as the red wolf off of their land or away from their livestock because section 9 of the Endangered Species Act prohibits "harassing" of listed animals. However, in both the red and gray wolf cases, the animals that were released were designated experimental/nonessential, allowing landowners to kill individual wolves caught preying upon livestock. This designation helped reduce public opposition to wolf reintroductions by giving landowners some control over problem animals. While this designation reduces Endangered Species Act protections, it can be an invaluable tool in gaining public support. This strategy can facilitate species recovery in appropriate circumstances.

Reestablished populations of the California red-legged frog may not be critical to the continued existence of the species and therefore will be considered as nonessential populations. Because recovery goals hinge on connectivity of habitat and maintenance of metapopulations of California red-legged frogs, whereby there is dispersal of individuals between populations and colonization and/or recolonization of habitats, most reestablished populations are not likely to be geographically isolated from existing populations and thus will not qualify as an experimental population. In some core areas, reestablished populations will be geographically isolated initially; in these cases, the experimental approach may be judged appropriate and should be considered on a site by site basis. Formal designation of nonessential/experimental status will be required.

APPENDIX H: SUMMARY OF AGENCY AND PUBLIC COMMENTS ON THE DRAFT RECOVERY PLAN FOR THE CALIFORNIA RED-LEGGED FROG

In May, 2000, we released the Draft Recovery Plan for the California Red-legged Frog (Draft Plan) for a 90-day comment period. This comment period was extended for an additional 90 days and the entire public comment period ended on November 7, 2000. During this open comment period, comments for Federal agencies, State and local governments, and members of the public were collected. Marc Hayes, John Bolger, Samuel Sweet, and Jerry Smith were asked to provide peer review of the draft plan. Comments were received from one peer reviewer.

This section provides a summary of general demographic information including the total number of letters received from various affiliations and States. It also provides a summary of the major comments. All letters of comment on the draft plan are kept on file in the Sacramento Fish and Wildlife Office at 2800 Cottage Way, Room 2605, Sacramento, California 95825-1846.

The following is a breakdown of the number of letters received from various affiliations:

Federal agencies—11
State agencies—3
local governments—25
environmental/conservation organizations—21
academia/professional—8
business/industry—18
individual citizens—159

This section summarizes the content of significant comments on the draft plan. A total of 245 letters were received, each containing varying numbers of comments. Many specific comments re-occurred in letters. Most letters provided new information or suggestions for clarity. In these cases, the information was incorporated into the final version of the recovery plan directly. Some letters requested an explanation of various points made in the draft plan or their scientific basis. In these cases, the final recovery plan was revised to include an expansion or clarification of the particular section. Most comments resulted in revisions to the draft recovery plan. Many commenters simply provided their voice of support or opposition to the recovery plan. Information and comments not incorporated into the final version of the recovery plan were considered, noted, and are on file with the entire package of agency and public comments; these may become useful in the future. Major comments that were not incorporated or that require clarification in addition to their incorporation are addressed below.

Summary of Comments and Our Responses

Introduction

Comment: One commenter suggested that the information used in the life history sections of the introduction is mostly outdated and speculative.

Response: The best available information was used to write the life history sections in the introduction. Most researchers agree that more information is needed to better understand the ecology of the California red-legged frog. Nevertheless, published research was used for most sections. Specific references mentioned in comments were re-evaluated and some sections were updated using new information. In some cases, anecdotal information provided by field biologists and/or land managers was used in the recovery plan. Many of these references refer to distribution and status information that has been collected in the field as part of ongoing survey and monitoring efforts. While this information is not peer reviewed and published, we feel that it provides valuable information related to the California red-legged frog. Where non-published information was used, we cited the biologists via personal communications or "in litt" references. These are listed in the bibliography and are in the administrative record which is available for review in the Sacramento Fish and Wildlife Office.

Comment: The scientific literature used in the discussion of mosquitofish and their predation on California red-legged frogs appears to be biased.

Response: This recovery plan acknowledges that more information is needed regarding the complex relationship between mosquitofish and California red-legged frogs; the plan recommends such research in the list of recovery actions. The recovery plan states that there are indeed several sites where mosquitofish and California red-legged frogs coexist. Nevertheless, the literature that is available at this time overwhelmingly suggests that there are some negative impacts on California red-legged frogs.

Comment: Address catastrophic fire and reduction of fuel buildup.

Response: We are aware of the need to control fuel buildup and thus preclude catastrophic fires. Recovery team members representing the U.S. Forest Service provided guidelines for activities related to fire control. These guidelines are included in the recovery plan in the *Guidance for Development of Watershed Management Plans and Implementation of Recovery Tasks.*

Comment: Several commenters suggested that the recovery plan address the threat of expansion of the University of California Santa Cruz Campus and how it may destroy frog habitat on Moore and Jordan Gulch drainages.

Response: There are many development projects impacting California red-legged frogs throughout its range. The recovery plan attempts to capture the nature and effects of threats to this species in a general manner, using some specific examples where appropriate. Urban development and expansion is indeed a threat that is contributing to the decline of the California red-legged frog. The effects of urban development is discussed in the Threats and Reasons for Decline section, in the Introduction.

The California red-legged frog habitat in Moore and Jordan Gulch drainages are included in Core Area # 19 which is called Salinas River-Pajaro River and includes the these drainages. As a result of this comment, the need for alternatives to, or mitigation for, the expansion of UC Santa Cruz has been added to the specific management and protection recommendations for this core area (Table 6). It is the goal of the recovery plan that watershed management plans will be developed for watersheds that harbor California red-legged frogs. As these plans are developed site specific impacts, such as the expansion of Santa Cruz campus, can be addressed and remedied.

Any such development proposal would be required to undergo extensive public review and authorization, including our review of likely effects on threatened and endangered species and wetlands.

Comment: Address the off-road vehicle interface issues in Calaveras County as a threat to the California red-legged frog.

Response: As mentioned above, the threats to California red-legged frogs are described in a general manner in the recovery plan. Off-road vehicle use of frog habitat is a serious concern and land management recommendations related to this threat are included in the recovery plan. Regarding this specific area, the off-road vehicle interface area is included in the recovery plan as a portion of a core area in Calaveras County. This land use is inconsistent with the goals of core areas, which are to restore and protect habitat and management for California red-legged frogs. Therefore, minimization of these impacts should be included in the site-specific watershed management plan.

Comment: A substantial number of non-indigenous animals are being purchased in live-food markets and then released into local waters and thereby is a means of introducing non-natives into the ecosystem. Suggest a ban on their importation.

Response: While non-native predators that have been introduced to the ecosystem are clearly a major reason for the decline of the California red-legged frog, the source of the majority of non-native species is not live-food markets. In fact, given the practice of stocking lakes for sport-fishing, using mosquitofish for mosquito abatement, and the degradation of habitat that has allowed the rampant proliferation of non-native species that have nearly naturalized in California, this source is relatively insignificant.

Recovery

Comment: Discuss the relationship between core areas for recovery and critical habitat.

Response: A section discussing this relationship has been added to the recovery plan in Section II. Core areas and critical habitat areas were selected based on similar criteria. The main criteria used for both were to capture areas: 1) that are occupied by California red-legged frogs, 2) where populations of California red-legged frogs appear to be source populations, 3) that provide connectivity between source populations, and 4) that represent areas of ecological significance. For the selection of core areas, areas of ecological significance include: watersheds that represent the limits of the current and historic range and/or that appear to be restorable and thus good sites for reestablishment projects. Unlike the selection of core areas, it is a requirement that primary constituent elements be defined for critical habitat. These primary constituent elements are described in the recovery plan and are present in all critical habitat areas and core areas.

The core areas and critical habitat areas differ in several ways. Unlike core areas which have no legal mandate for protection under the Endangered Species Act and solely rely upon voluntary implementation, the designation of critical habitat requires Federal agencies to consult with us regarding any action that could destroy or adversely modify critical habitat. Adverse modification of critical habitat is defined as any direct or indirect alteration that appreciably diminishes the value of the habitat for both the survival and recovery of the species.

Comment: Provide a better justification for identification of core areas that are currently not occupied.

Response: Restoration of populations in core areas within the historic range, where California red-legged frogs are currently not present, will prevent range collapse. If the goals of the recovery plan do not include the historic range, but rather focus on currently occupied areas, the result will be a vastly smaller range for this species; this limitation would preclude recovery of the California red-legged frog.

Comment: Remove from core area maps all urbanized areas.

Response: The Sacramento Fish and Wildlife Office has maps on file that were developed during the recovery planning process that exclude urban areas. The size of maps used in the recovery plan however, did not allow such a level of detail without compromising the visibility of core areas and geographic markers. The recovery plan discloses the fact that many areas within core areas are expected to remain unsuitable due to land uses such as agriculture and urban development, and are unlikely to be areas where recovery efforts will be implemented. If readers wish to view the urban areas within core areas, they may do so at the Sacramento Fish and Wildlife Office.

Comment: Be more specific, in terms of numbers, in defining the recovery criteria.

Response: Discussion of recovery criteria is given in Section II. Recovery strategies and other recommendations are based upon the best scientific information available. Current conservation biology and/or life history data were used to develop the standards. Most recommendations are preliminary because: 1) available data on the covered species are limited and 2) conservation biology has yet to resolve the details of how endangered species recovery is best achieved for any species. Recovery strategies and other recommendations may need to be altered as more data become available and as conservation science develops. We will review such information periodically.

In the meantime, the recovery plan uses an approach that focuses on ecological integrity, habitat availability, and metapopulation viability, rather than specific numbers of habitat acres, individuals, or populations. When the five recovery criteria are met, the result will be a series of populations that are linked by suitable, connected habitat.

Comment: Recovery goals are unrealistic and introduction of frogs is not necessary in all core areas.

Response: We agree that introduction of California red-legged frogs in all core areas that currently do not harbor the species may be challenging. However, given that most core areas are already occupied, reestablishment efforts are only recommended in several core areas. This effort may be achieved given adequate time and funding.

When comparing the historic range and number of populations, the core areas represent a comparatively low number of watersheds. Distribution of California red-legged frogs in all core areas, with adequate habitat protection in priority 2 watersheds, are necessary to spread the risk of extinction across the landscape rather than concentrating genetic diversity and habitat suitability where frogs currently exist or in a smaller number of watersheds. Maintaining (and establishing where necessary) frog populations in all core areas may optimize the chances for genetic diversity, habitat connectivity, and ultimately may allow the species to occupy its former range. These goals cannot be met unless there is an attempt to recover the frog in each core area.

Comment: Identify public support for recovery and potential resources for implementation.

Response: In Section I, Federal, State, local and private actions are listed that have contributed to conservation of the California red-legged frog. This section has been expanded to include more efforts by non-government organizations which are staffed by concerned, private citizens. Appendix E. lists potential funding sources for implementation; many of these programs provide financial assistance to willing participants.

Comment: Include recovery goals for the southern Sierra Nevada range, the Central Valley, and the National Wildlife Refuges.

Response: Aside from the core areas and priority 2 watershed, all other areas within the range of the species are listed as priority 3 watersheds. Here, the goals are to restore habitat, where feasible, and allow for recolonization. The recovery plan specifically identifies the southern Sierra Nevada, Central Valley, and wetlands on National Wildlife Refuges as priority 3 watersheds.

Comment: Eliminate the recommendation for commercial take of bullfrogs as it may pose an incidental threat to the California red-legged frogs.

Response: Initially, the recovery team agreed that this would be a great contribution to bullfrog eradication efforts. Several commenters, however, have suggested that the confusion between California red-legged frog and bullfrog appearances may lead to take of the California red-legged frog. This task has been removed as a result of these public comments.

Comment: Use consistent methods to define recovery units.

Response: Overall, the method used to delineate revised recovery units was by watershed boundaries using U.S. Geological Survey hydrologic units. Along the Sierra Nevada mountain range, the 1,500-meter (5,000-foot) elevation line was used because it is the general range limit of the California red-legged frog. This method has not changed in the final recovery plan.

Comment: Include East Las Virgenes Creek as a core area for recovery and address the threat of development at this site.

Response: This area is included in the Santa Monica Bay - Ventura Coastal Streams core area (core area #50, Figures 39-40 in draft plan; core area #27, Figure 29 in final plan).

Comment: The recovery plan should include a socio-economic impact analysis, particularly in regards to the potential economic impacts to agriculture.

Response: Because implementation of recovery plans is voluntary and not a legal mandate, there is no requirement for an economic impact analysis.

Comment: Eliminate certain core areas (e.g. Traverse Creek, Tejon/El Paso).

Response: While developing the final recovery plan, all core areas were re-evaluated to determine whether they fit the selection criteria. The selection criteria used were to include areas that: 1) are occupied by California red-legged frogs, 2) where populations of California red-legged frogs appear to be source populations, 3) that provide connectivity between source populations, and 4) that represent areas of ecological significance. Areas of ecological significance include watersheds that represent the limits of the current and historic range and/or that appear to be restorable and thus good sites for reestablishment projects. Based on these criteria, some proposed core areas were expanded, some were omitted, and new areas were added.

In 2001, a new population of California red-legged frogs was located in a watershed adjacent to Traverse Creek. This highlights the need for additional surveys and the opportunities for recovery implementation in all core areas listed in the recovery plan. In light of this new sighting, we feel that it is important to keep selected core areas until adequate surveys and habitat suitability assessments are conducted.

Outline of Recovery Actions

Comment: Three commenters suggested that recovery actions should focus on controlling predation rather than increasing habitat and protecting habitat.

Response: The recovery plan emphasizes the need to control predation as a means of recovering the California red-legged frog. At the same time, emphasis is put on the development of watershed management plans to meet the recovery needs at the watershed level and thus allow for customized, site-by-site management. It is in these watershed management plans that predator control can be focused and implemented, where appropriate. Where the preparers were aware of heavy predation, these watersheds were included in the stepdown narrative of recovery tasks and specified in the *Guidance for Development of Watershed Management Plans and Implementation of Recovery Tasks.* We urge land management agencies to manage non-native predatory species on their lands and is willing and eager to provide technical assistance and will consider funding any proposal regarding removal of non-native, predatory species.

Comment: Include as a recovery task the control, research, and monitoring of native predators.

Response: The recovery team did not wish to list removal of native predators as a task needed for recovery. Some recovery actions, however, will reduce the impacts of predation. For example, relocating picnic grounds and campsites farther away from known California red-legged frog habitat will reduce the proliferation and concentration of native predators such as raccoons. Further, when the ecosystems in which California red-legged frogs live are restored to ecological health, a balanced species composition is likely to be restored and will thus reduce the extent and effects of predation by native species.

Comment: Emphasize the need for research on the role of contaminants and the decline of California red-legged frogs.

Response: There is an extensive list of research needs and land management recommendations described in the stepdown narrative of the recovery plan and the *Guidance for Development of Watershed Management Plans and Implementation of Recovery Tasks*. A large portion of these outstanding needs and recommendations deal specifically with contaminants.

Implementation Schedule

Comment: Several commenters suggested that the costs for recovery are underestimated.

Response: These estimates represent best available information from various analyses that estimate costs for implementing recovery actions. As the recovery plan is implemented, the exact costs will become more apparent.

Comment: Many commenters expressed concern about actions proposed in the recovery plans that could affect private landowners.

Response: A recovery plan is not a regulatory document and does not provide for agreement to or implementation of any of the recovery tasks proposed. A recovery plan is a reference document that identifies actions that, if implemented, are expected to recover the species. Any actions that are implemented must follow appropriate State, local, or Federal laws and regulations. Any cooperation from private landowners is voluntary. Specific arrangements for accomplishing recovery actions would be worked out at the time of planning and implementing the action and should include all appropriate stakeholders.

Appendices

Comment: Include safe harbor provisions.

Response: A Safe Harbor Agreement is a voluntary agreement between us and one or more private or nonfederal landowners to restore, enhance, or maintain habitats for listed species, candidates, or other species of concern. Under the Agreement, the landowner would be provided assurances that we would not impose additional land use actions. If the Agreement provides a net conservation benefit to the covered species and the landowner meets all the terms of the Agreement, we would authorize the incidental taking of covered species to enable the landowner to return the enrolled lands to agreed upon conditions.

The recovery plan recommends the use of Safe Harbor Agreements for the conservation of the California red-legged frog. Such agreements are seen as a valuable tool that can be used to implement the recovery plan. Discussion of Safe Harbor Agreements has been added to the plan in Appendix E. which addresses incentives for recovery implementation.

Comment: Include a section on 10(J) for reintroduction.

Response: Because reestablishment of California red-legged frogs in portions of its range is recommended in the recovery plan, a description of section 10(J) of the Endangered Species Act has been added to Appendix G. which provides information on reestablishment opportunities and methods.

Comment: The boundaries of core areas should be refined and the maps of core areas should be clearer.

Response: Revised maps are included in Appendix C. Due to budget limitations, color maps and large maps are kept to a minimum in the recovery plan. Because of this, the maps are not as clear and refined as we would like. If any member of the public is interested in seeing maps of better clarity, they may visit the Sacramento Field Office to view the maps on file.

“You never see a frog so modest and straightfor'ard as he was, for all he was so gifted. And when it come to fair and square jumping on a dead level, he could get over more ground at one straddle than any animal of his breed you ever see.”

—Mark Twain, Celebrated Jumping Frog of Calaveras County