Sensitive Species of Snakes, Frogs, and Salamanders in Southern California Conifer Forest Areas: Status and Management[1]

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Abstract

At least 35 species of amphibians and reptiles occur regularly in the conifer forest areas of southern California. Twelve of them have some or all of their populations identified as experiencing some degree of threat. Among the snakes, frogs, and salamanders that we believe need particular attention are the southern rubber boa (*Charina bottae umbratica*), San Bernardino mountain kingsnake (*Lampropeltis zonata parvirubra),* San Diego mountain kingsnake (*L.z. pulchra*), California red-legged frog (*Rana aurora draytonii*), mountain yellow-legged frog (*R. muscosa*), San Gabriel Mountain slender salamander (*Batrachoseps gabrieli*), yellow-blotched salamander (*Ensatina eschscholtzii croceater*), and large-blotched salamander (*E.e. klauberi*). To varying degrees, these taxa face threats of habitat degradation and fragmentation, as well as a multitude of other impacts ranging from predation by alien species and human collectors to reduced genetic diversity and chance environmental catastrophes. Except for the recently described San Gabriel Mountain slender salamander, all of these focus taxa are included on Federal and/or State lists of endangered, threatened, or special concern species. Those not federally listed as Endangered or Threatened are listed as Forest Service Region 5 Sensitive Species. All of these taxa also are the subjects of recent and ongoing phylogeographic studies, and they are of continuing interest to biologists studying the evolutionary processes that shape modern species of terrestrial vertebrates. Current information on their taxonomy, distribution, habits and problems is briefly reviewed and management recommendations are made. Further research is needed to elucidate their biological status and needs and to provide the basis for appropriate management programs. Programs must be monitored to ensure that desired objectives are achieved.

Key Words: collecting, degradation, endangered species, ensatina, extinction, extirpation, fragmentation, fuel wood, habitat loss, mountain kingsnake, off-highway vehicle, red-legged frog, riparian, rubber boa, salamander, special concern, threatened species, yellow-legged frog

Introduction

Our area of concern in this paper is limited primarily to the conifer forest and included riparian habitats above 1,230 m in roughly the southern two-thirds of the southern California mountains and foothills assessment region described by

[1] An abbreviated version of this paper was presented at Planning for Biodiversity: Bringing Research and Management Together, a Symposium for the California South Coast Ecoregion, February 29-March 2, 2000, California State Polytechnic University, Pomona, CA.

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Stephenson and Calcarone (1999). This elevation break generally corresponds to the lower limit for conifer forest habitats at this latitude. The area includes the south coast ranges (Sierra Madre, San Rafael, Santa Ynez, and Topatopa Mountains and Pine Mountain) in Ventura County, the Mount Pinos area straddling the Ventura-Kern County line, the Piute and Tehachapi Mountains in east-central Kern County, the transverse ranges (Santa Monica, San Gabriel, and San Bernardino Mountains) in Los Angeles and San Bernardino Counties, the peninsular ranges (San Jacinto, Santa Rosa, and Laguna Mountains) in Riverside and San Diego Counties, the Santa Ana Mountains in eastern Orange and western Riverside Counties, and certain isolated mountains in San Diego County. At least 35 species of amphibians and reptiles are known to occur regularly in the area: five salamanders, seven frogs and toads, one turtle, eight lizards, and 14 snakes (*table 1*). Many of these are wide-ranging species that include the mountains within their geographic range, but others are more or less restricted to montane habitats.

Mostly adjacent to the greater Los Angeles-San Diego metropolitan area, with a population of over 15 million people (Stephenson and Calcarone 1999), many of these amphibian and reptile species are impacted negatively by human activities, and 12 have some or all of their populations identified as experiencing some degree of threat (*table 1*). We discuss here three taxa of snakes, two taxa of frogs, and three taxa of salamanders that we believe are in particular need of attention as sensitive species. Although the California red-legged frog generally occurs at lower elevations peripheral to conifer forest areas, and ranges farther north along the coast, it is included because of its critically threatened status and omission from other habitat area discussions in these proceedings.

Southern Rubber Boa *Charina bottae umbratica* Klauber 1943

Description

A small (total length 35-55 mm, Hoyer and Stewart 2000a), rather stout-bodied snake with smooth scales and a blunt head and tail (*fig. 1*; Brown 1997). Adults are light brown or tan in dorsal color with an unmarked yellow venter; juveniles are pale without a distinct margin between dorsal and ventral coloration (Hoyer and Stewart 2000a). The subspecies may be further characterized as follows: frontal scale usually sub-rectangular with a straight or only slightly convex or angular posterior margin, generally 41 or fewer mid-dorsal scale rows, usually 196 or fewer full-sized ventral scales (Rodriguez-Robles and others 2001).

Table 1–*Amphibian and reptile species known to occur regularly above 1,230 m in conifer forest areas of southern California. (All names follow Crother 2000.)*

Salamanders
Ensatina-*Ensatina eschscholtzii* (SC, FS)*
Black-bellied Slender Salamander-*Batrachoseps nigriventris*
Tehachapi Slender Salamander-*Batrachoseps stebbinsi* (ST, FS)
San Gabriel Mountain Slender Salamander-*Batrachoseps gabrieli* (FS)*
Arboreal Salamander-*Aneides lugubris*
Frogs and Toads
Pacific Treefrog-*Pseudacris regilla*
California Treefrog-*Pseudacris cadaverina*
Red-legged Frog-*Rana aurora* (FT, SC)*
Mountain Yellow-legged Frog-*Rana muscosa* (FE, SC)*
American Bullfrog-*Rana catesbeiana* (introduced)
Western Toad-*Bufo boreas*
Arroyo Toad-*Bufo californicus* (FE, SC)
Turtles
Pacific Pond Turtle-*Clemmys marmorata* (SC, FS)
Lizards
Coast Horned Lizard-*Phrynosoma coronatum* (SC, FS)
Granite Spiny Lizard-*Sceloporus orcutti*
Western Fence Lizard-*Sceloporus occidentalis*
Common Sagebrush Lizard-*Sceloporus graciosus*
Common Side-blotched Lizard-*Uta stansburiana*
Western Skink-*Eumeces skiltonianus*
Gilbert's Skink-*Eumeces gilberti*
Southern Alligator Lizard-*Elgaria multicarinata*
Snakes
Western Threadsnake-*Leptotyphlops humilis*
Rubber Boa-*Charina bottae* (ST, FS)*
Ring-necked Snake-*Diadophis punctatus* (FS)
Striped Racer-*Masticophis lateralis*
Gophersnake-*Pituophis catenifer*
Common Kingsnake-*Lampropeltis getula*
California Mountain Kingsnake-*Lampropeltis zonata* (SC, FS)*
Western Terrestrial Gartersnake-*Thamnophis elegans*
Two-striped Gartersnake-*Thamnophis hammondii* (SC, FS)
Western Black-headed Snake-*Tantilla planiceps*
Western Lyresnake-*Trimorphodon biscutatus*
Nightsnake-*Hypsiglena torquata*
Speckled Rattlesnake-*Crotalus mitchellii*
Western Rattlesnake-*Crotalus viridis*

FE–Federally Listed Endangered Species
FT–Federally Listed Threatened Species
ST–State Listed Threatened Species
SC–State Species of Special Concern
FS–Forest Service Region 5 Sensitive Species
*Species discussed in text

Figure 1–Adult female southern rubber boa from Heaps Peak, San Bernardino Mountains, San Bernardino County, California. Photo by Robert H. Goodman, Jr.

Taxonomy

The infraspecific taxonomy of the rubber boa (*Charina bottae*) has been much debated (Brown 1997, Stewart 1988), with various authors recognizing either three (Klauber 1943, Stebbins 1985), two (Stewart 1977), or no subspecies (Collins 1990, Nussbaum and Hoyer 1974), or suggesting full species status for the southern form (Erwin 1974). While scalation patterns are highly variable within rubber boa populations, and there is considerable overlap among populations, Stewart (1977) noted fairly consistent differences between southern rubber boas (*C.b. umbratica*) and northern rubber boas (*C.b. bottae*). He recommended that these forms be retained as distinct subspecies and regarded populations in the Mount Pinos area and Tehachapi Mountains as intergrades. Recent analyses of mitochondrial DNA by Rodriguez-Robles and others (2001) have shown that the southern rubber boa populations form a clade that separated from all other rubber boa lineages approximately 4.4 to 12.3 million years ago. Together with existing morphological and allozyme data (Weisman 1988), this suggests *C.b. umbratica* could be recognized as a full species. Although the Mount Pinos area and Tehachapi Mountains populations cannot be identified reliably by morphological characters, they cluster with *C.b. bottae* in the mitochondrial DNA analyses (Rodriguez-Robles and others 2001).

Distribution

The southern rubber boa is restricted to the San Bernardino and San Jacinto Mountains (*fig. 2*) at elevations between about 1,540 m and 2,460 m (Stewart 1988, 1991). It is known from over 40 localities in the San Bernardinos (Stewart 1991) and eight in the San Jacintos (Keasler 1982, Loe 1985). Twenty-six of the San Bernardino localities occur in a 16-km-long strip of habitat in the Lake Arrowhead area between Twin Peaks on the west and Green Valley on the east (Stewart 1988, 1991).

Habitat and Habits

Typical habitat for this snake is mixed conifer-oak forest or woodland dominated by two or more of the following species: Jeffrey pine (*Pinus jeffreyi*), yellow pine (*P. ponderosa*), sugar pine (*P. lambertiana*), incense cedar (*Calocedrus decurrens*), white fir (*Abies concolor*), and black oak (*Quercus kelloggii*) (Stewart 1988). A relatively open canopy seems to be preferred, at least during the spring months (April and May), and rock outcrops evidently are important as hibernacula (Keasler 1982, Stewart 1988). In the Heaps Peak area near Lake Arrowhead, the boa occurs at rock outcrops in open areas characterized by mixed grasses and bracken fern (*Pteridium aquilinum*) together with variable numbers of shrubs and small trees (Hoyer and Stewart 2000a). Because it is semi-fossorial, primarily crepuscular or nocturnal, and

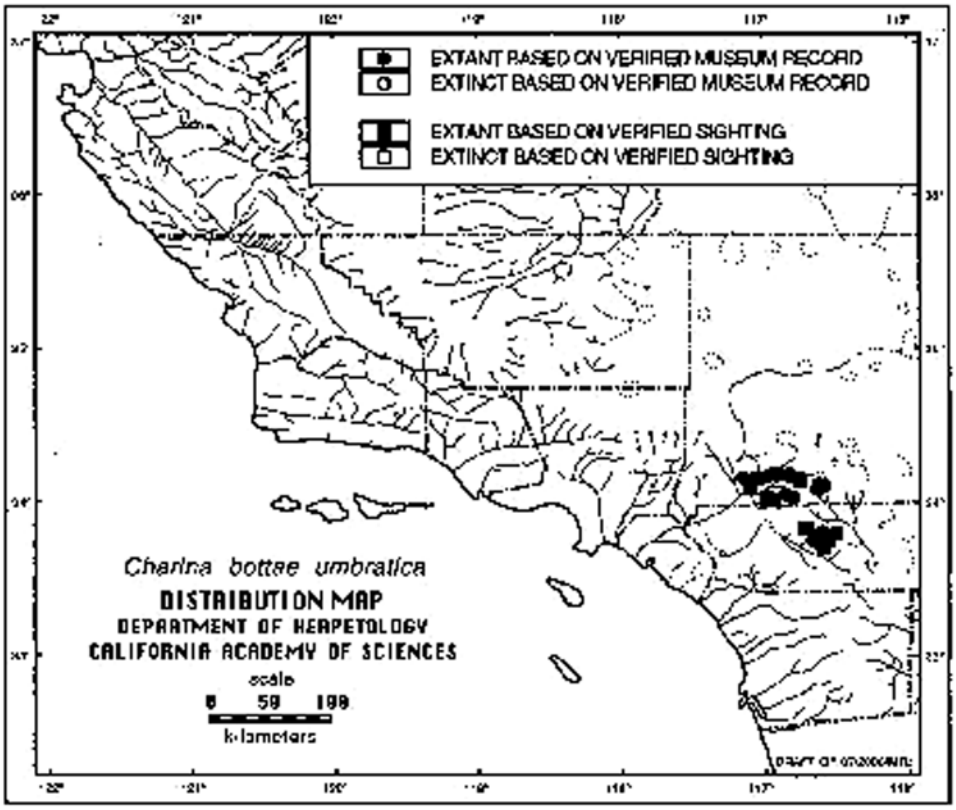

Figure 2–Historic and current distribution of the southern rubber boa

highly secretive, its seasonal activity and habitat use are difficult to determine. Boas are most easily found during the spring months at rock outcrops where scattered surface rocks and wood debris provide movable cover under which to search (Hoyer and Stewart 2000a, Keasler 1982, Stewart 1988,). The snakes essentially disappear during the summer months, though they may emerge for surface activity on humid nights (Alten and Keasler 1978) or after a rain (Stewart pers. observ.). It is likely that some individuals remain at the rock outcrops during the summer and retreat deeper into crevices (Stewart pers. observ.), but others apparently move into cooler, moister forest and riparian habitats (Loe 1985, Stewart 1988). In all habitat types, rock outcrops and surface materials (such as rocks, logs, and a well-developed litter/duff layer) are important habitat components because they provide cover and maintain soil moisture (Loe 1985). Lizards, particularly common sagebrush lizards (*Sceloporus graciosus*) and western fence lizards (*S. occidentalis*), often are associated with the outcrops where southern rubber boas are found. Hoyer and Stewart (2000b) demonstrated that both juvenile and adult boas readily consume lizard eggs, with adults also taking nestling voles (*Microtus* spp.) and shrews (*Sorex* spp.). These snakes are viviparous; Hoyer and Stewart (2000a) recorded a litter size of 2 to 5 in 12 females.

Status and Threats

The southern rubber boa is listed by the State of California as *Threatened* and is a Forest Service Region 5 *Sensitive Species* (Stephenson and Calcarone 1999). While an assessment of the boa's current status is hindered by its secretive behavior, it is continuing to experience significant habitat loss and degradation. Most of the prime habitat in the 16-km strip near Lake Arrowhead is private land subject to residential and commercial development (Stewart 1988, 1991). Elsewhere in the San Bernardino and San Jacinto Mountains, substantial areas of known or potential habitat are on San Bernardino National Forest lands (Loe 1985, Stewart 1991). However, Forest Service-permitted activities, such as personal fuelwood harvesting, off-highway vehicle use, and commercial timber sales, increasingly degrade and fragment what once were large, contiguous tracts of rubber boa habitat (Loe 1985, Stewart 1991). The combined factors of habitat degradation, fragmentation, and loss increase the likelihood of local extirpations and restrict gene flow, potentially leading to reduced genetic diversity and greater vulnerability to chance environmental catastrophes.

Management Recommendations

A Southern Rubber Boa Advisory Committee was established in 1980, and with its assistance the San Bernardino National Forest produced a comprehensive set of habitat management guidelines (Loe 1985). The guidelines seek to maintain habitat quality, minimize negative impacts on Forest Service lands, and coordinate management activities with county and city governments. We recommend continued adherence to these guidelines, with monitoring to insure that objectives are being met. A better understanding of seasonal movements and habitat utilization, obtained through radio telemetry studies, would permit fine-tuning of management to the needs of this snake. Special efforts should be made to establish protective management on a large (30 hectares or more) tract of private property containing boa habitat in the Heaps Peak area (Stewart 1991) and several smaller (10 hectares or so) tracts elsewhere within the boa's range. This could be done through conservation easements with willing landowners and/or by setting up a land-bank system that

developers pay into to get mitigation credits for their habitat impacts. Ideally, these acquired properties should be adjacent to public lands to maximize the size of contiguous habitat areas. Although rubber boa populations in the Mount Pinos area may now be assigned to the northern rubber boa (Rodriguez-Robles and others 2001), similar guidelines should be developed for these populations by the Los Padres National Forest. They are small and isolated (Alten and Keasler 1978, Hoyer and Stewart 2000b), and they provide opportunities for further study of evolutionary processes.

San Bernardino Mountain Kingsnake *Lampropeltis zonata parvirubra* Zweifel 1952

Description

A medium-sized (total length 55-111 cm, Jennings and Hayes 1994a) snake with a tricolor pattern of black, white, and red rings around the body (*fig. 3;* Brown 1997). Diagnosis of the different subspecies of the California mountain kingsnake (*Lampropeltis zonata*) is based almost entirely on color pattern characteristics. The basic color unit is a triad composed of a black ring, partly or completely divided by a red band or ring, and separated from adjacent black rings by a pair of white rings (Rodrigues-Robles and others 1999, Zweifel 1952, 1974). The number of body triads in *L.z. parvirubra* typically is 37 or more, and usually fewer than 60 percent are completely divided by a red ring (Zweifel 1974).

Figure 3–San Bernardino mountain kingsnake from Sawpit Canyon, San Gabriel Mountains, Los Angeles County, California. Photo by Robert H. Goodman, Jr.

Taxonomy

Identification of this taxon is problematic because of the wide range of variation and broad overlap of its color characteristics with other subspecies of *L. zonata*. Examining a large series of specimens representing all seven of the named subspecies, Rodriguez-Robles and others (1999) concluded that color patterns cannot be used to reliably differentiate among them. However, mitochondrial DNA analyses by these authors showed that the San Bernardino mountain kingsnake and San Diego mountain kingsnake (*L.z. pulchra*), together with two other subspecies from northern Baja California, Mexico, form a southern clade that may be distinct from the more northern subspecies (Rodriguez-Robles and others 1999). Resolution of California mountain kingsnake systematics must await the completion of additional morphological and genetic studies. In the meantime, we believe it is important to continue to recognize the named infraspecific taxa of this mountain kingsnake to help ensure that the diversity of the herpetofauna in the southern California mountains is adequately protected.

Distribution

The San Bernardino mountain kingsnake is restricted to the San Gabriel, San Bernardino, and San Jacinto Mountains (*fig. 4*) at elevations from about 370 m to 2,470 m (Jennings and Hayes 1994a).

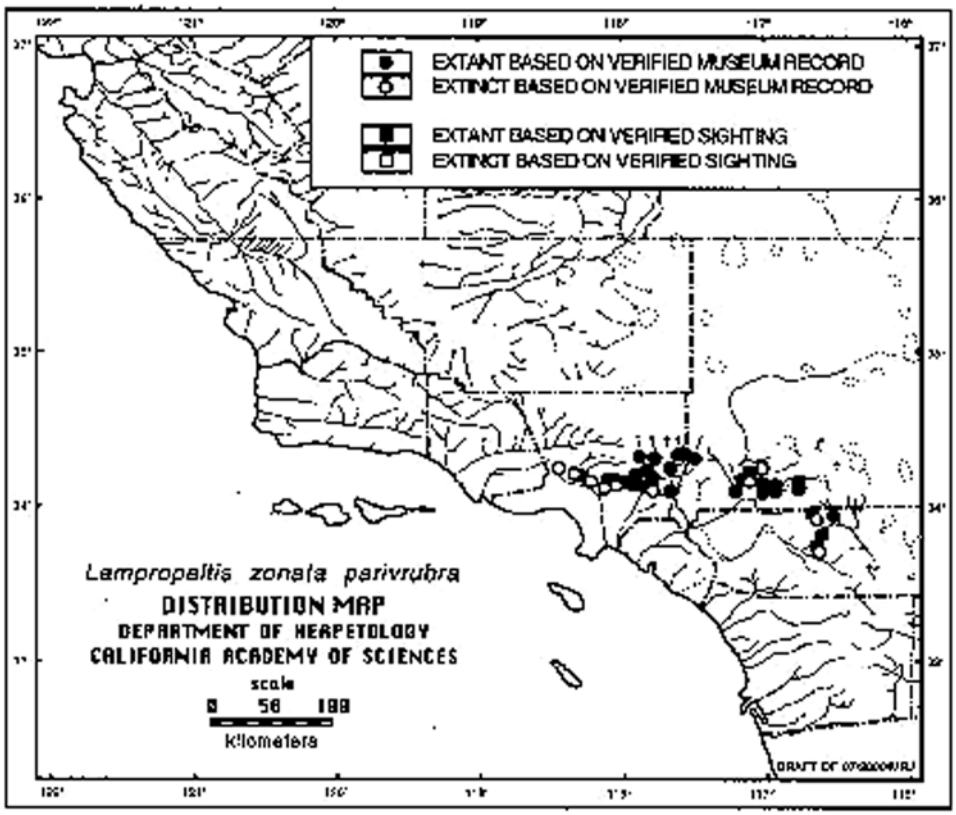

Figure 4–Historic and current distribution of the San Bernardino mountain kingsnake. Modified from Jennings and Hayes (1994a).

Habitat and Habits

This snake tends to occur in well-illuminated rocky canyons in association with big-cone Douglas-fir (*Pseudotsuga macrocarpa*) and various chaparral species at lower elevations and with black oak, incense cedar, Jeffrey pine, and yellow pine at higher elevations (Jennings and Hayes 1994a). Above 1,540 m in the San Bernardino and San Jacinto Mountains, it commonly is found in rock outcrops together with the southern rubber boa (Hoyer and Stewart 2000a, Keasler 1982). Rock crevices and outcrops likely serve as hibernacula and cover, and they also provide potential food sources. Mountain kingsnakes are known to be primarily lizard eaters, most often taking common sagebrush lizards, western fence lizards, and western skinks (*Eumeces skiltonianus*) (Jennings and Hayes 1994a). While secretive and infrequently observed, mountain kingsnakes are more likely to move about on the surface during daylight hours of spring months than are southern rubber boas (McGurty 1988, Stewart pers. observ.). Later in the season and at lower elevations, they may be active after dark (Jennings and Hayes 1994a). As in the case of rubber boas, rock outcrops and a variety of surface materials (rocks, logs, bark) probably are important habitat components in all habitat types (McGurty 1988). Mountain kingsnakes are oviparous and have been reported to produce clutches of 3-9 eggs (McGurty 1988).

Status and Threats

The San Bernardino mountain kingsnake is a State of California *Species of Special Concern* (Jennings and Hayes 1994a) and a Forest Service *Region 5 Sensitive Species* (Stephenson and Calcarone 1999). It is impacted by most of the same factors (habitat degradation, fragmentation, and loss) that affect the southern rubber boa. In addition, it is highly prized by reptile fanciers and continues to be collected despite State laws limiting collecting and preventing the sale of native reptiles in California (California Freshwater Sport Fishing Regulations 2002, Jennings and Hayes 1994a). While the impact of habitat alteration and collecting pressures is difficult to assess, it results from the ripping apart of decaying logs and stumps and removal of exfoliating pieces of granite boulders, practices that are prohibited by State law (California Freshwater Sport Fishing Regulations 2002). These microhabitats probably require decades to millennia to develop, but only seconds to minutes to destroy. Their loss may lead to local extirpations and reduced population viability, especially at locations easily accessed by roads.

Management Recommendations

Implementation of management recommendations for the southern rubber boa in the San Bernardino National Forest also benefits the San Bernardino mountain kingsnake. In addition, particular attention should be paid to maintaining surface cover and minimizing human impacts in rocky draws and canyons. Similar management guidelines should be developed for the Angeles National Forest. Because visitors to National Forest lands commonly confuse mountain kingsnakes with venomous coral snakes (Jennings pers. observ.), which also have a tri-color pattern but are not found in California, posters and other educational materials should be provided at convenient locations to counter misinformation about snake identification and biology. Again, radio telemetry studies would provide more

information on the activity and habitat use patterns of the San Bernardino mountain kingsnake and allow for more precise management prescriptions.

San Diego Mountain Kingsnake *Lampropeltis zonata pulchra* Zweifel 1952

Description

A medium-sized (total length 53-108 cm, Jennings and Hayes 1994a) snake with a tricolor pattern of black, white and red rings (*fig. 5*; Brown 1997) similar to the San Bernardino mountain kingsnake. On the average, however, there are fewer body triads and more of the triads have complete red rings (Rodriguez-Robles and others 1999). Zweifel (1974) gave the number of triads as typically 36 or fewer, and the number of triads with complete red rings as usually 60 percent or more.

Figure 5–San Diego mountain kingsnake from Boiling Springs, Cuyamaca Mountain, San Diego County, California. Photo by Robert H. Goodman, Jr.

Taxonomy

Taxonomic comments made for the San Bernardino mountain kingsnake also apply to this subspecies.

Distribution

The San Diego mountain kingsnake occurs in the Santa Monica, Santa Ana, Santa Rosa, and Laguna Mountains. In San Diego County, it also occurs on the more isolated Palomar, Hot Springs, Cuyamaca and Corte Madera Mountains (*fig. 6*). It ranges in elevation from near sea level to about 1,800 m (Jennings and Hayes 1994a).

Habitat and Habits

Much of the information given for the San Bernardino mountain kingsnake is applicable to the San Diego subspecies. In the interior mountain ranges, it occurs primarily in associations of yellow, Jeffrey and Coulter pine (*Pinus coulteri*) and black oak. At lower elevations and in coastal areas, it usually is found in canyon bottoms with western sycamore (*Platanus racemosa*), Fremont cottonwood (*Populus fremontii*), coast live oak (*Quercus agrifolia*) and willows (*Salix* spp.). Rock outcrops appear to be a particularly important habitat element for this snake in San Diego County (McGurty 1988).

Status and Threats

The San Diego mountain kingsnake is a State of California *Species of Special Concern* (Jennings and Hayes 1994a) and a Forest Service Region 5 *Sensitive Species*

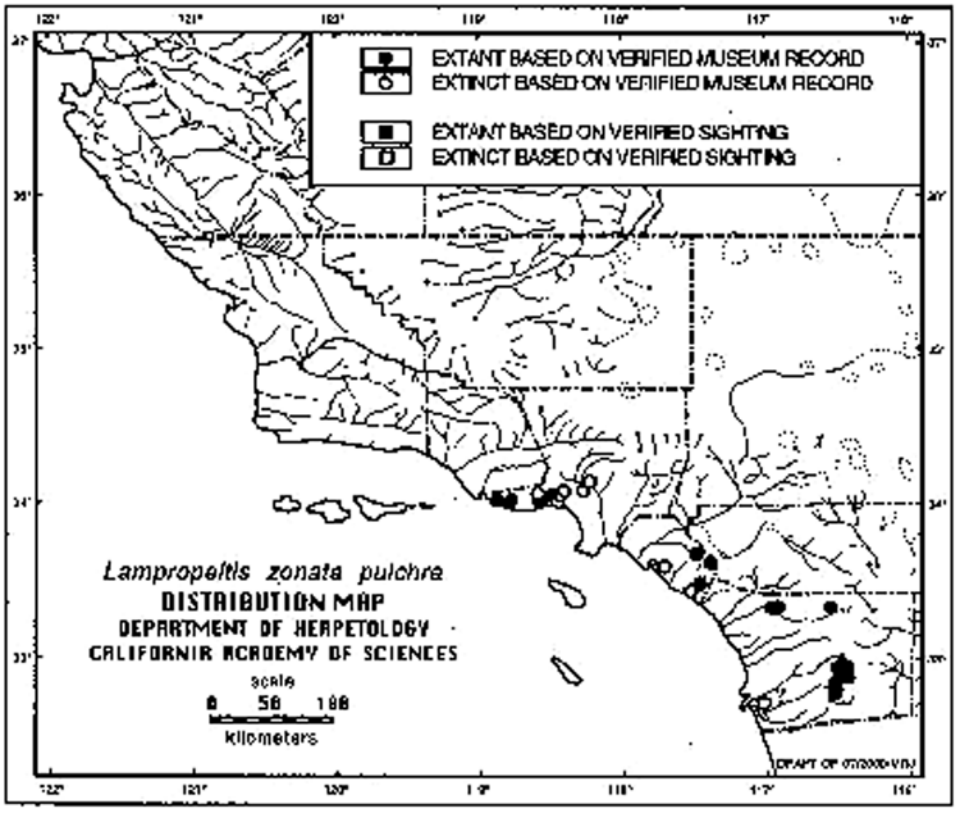

Figure 6–Historic and current distribution of the San Diego mountain kingsnake. Modified from Jennings and Hayes (1994a).

(Stephenson and Calcarone 1999). It is subject to the same anthropogenic impacts as the San Bernardino mountain kingsnake. Due to its tendency to display more red in its color pattern, however, it may be even more highly prized by collectors. McGurty (1988) has noted a local population decline and examples of habitat destruction (dismantling of rock outcrops and shredding of logs and stumps) in San Diego County. These activities continue despite California Department of Fish and Game and U. S. Forest Service regulations prohibiting such habitat alterations (California Freshwater Sport Fishing Regulations 2002, Jennings and Hayes 1994a).

Management Recommendations

All management recommendations made for the San Bernardino mountain kingsnake also apply to the San Diego subspecies and should be developed for the Cleveland National Forest. In addition, a program of systematic habitat monitoring and public education would be particularly important here to ensure that habitat impacts are minimized.

California Red-legged Frog *Rana aurora draytonii* Baird and Girard 1852

Description

A large (adult snout-urostyle length 85-138 mm, Jennings and Hayes 1994a) frog with a dorsal pattern of dark flecks and spots on a brown, gray, or reddish-brown background color (*fig. 7;* Stebbins 1985). The distribution of red or red-orange pigment is highly variable, but usually restricted to the belly and undersurfaces of the thighs, legs, and feet (Jennings and Hayes 1994a). Frogs in southern California often have red only on the undersurfaces of the feet (Jennings pers. observ.). There are prominent dorsolateral folds that are yellow or orange in juveniles (Stebbins 1985). The groin has a distinct black mottling on a white or yellow background. The iris is dark brown with iridophores on the upper and lower portions of the iris (Jennings and Hayes 1994a). Larvae (*fig. 8*) range from 14 to 80 mm long and have two or three upper and three or four lower rows of teeth (Stebbins 1985). Newly hatched tadpoles generally are blackish in color, gradually changing to a brown background color with darker marbling or spots after a week or two of growth (Storer 1925).

Taxonomy

Recent molecular phylogenetic analysis of red-legged frogs (*Rana aurora*) from across their range supports independent morphological (Hayes and Kremples 1986, Hayes and Miyamoto 1984), allozyme (Green 1985, Hayes and Miyamoto 1984), and life history data (Hayes and Miyamoto 1984, Jennings and Hayes 1994a) suggesting that *Rana aurora draytonii* should be considered a full species (Bradley [sic] and others 2000). Further, limited samples indicate that populations south of the Transverse Ranges form a clade distinct from those populations further north in coastal southern and central California (Bradley [sic] and others 2000).

Figure 7–Adult California red-legged frog from the Santa Rosa Plateau Preserve, Riverside County, California. Photo by Mark R. Jennings.

Figure 8–Larval California red-legged frog from Corral Hollow, San Joaquin County, California. Photo by Norman J. Scott, Jr.

Distribution

Historically, *Rana aurora draytonii* was found in Pacific slope drainages from the vicinity of central Mendocino County and Redding, Shasta County (Bradley [sic] and others 2000, Storer 1925) south to the Santo Domingo River drainage in Baja California, Mexico (Linsdale 1932). Isolated populations occurred in four desert drainages in southern California (Jennings and Hayes 1994b). In the area covered by this paper, it was historically found in low to mid-elevations of much of the South Coast Ranges, Tehachapi Mountains, Greenhorn Mountains, Transverse Ranges, Peninsular Ranges, and South Coast Plain between near sea level (Gaviota Creek, Santa Barbara County) and 1,706 m (Crystal Lake in the San Gabriel Mountains, Los Angeles County) (*fig. 9*). Currently, red-legged frogs still are extant over much of the South Coast Ranges and in drainages north of the Santa Clara River in Los Angeles and Ventura Counties (Jennings and Hayes 1994a). However, south of the Santa Clara River, frog populations appear to have been extirpated, with only two small populations still known in this area. All known populations in the Tehachapi and Greenhorn Mountains now appear to be extinct (Jennings and Hayes 1994a).

Habitat and Habits

The California red-legged frog typically is found in or next to livestock ponds and pools in perennial streams in southern California (Jennings pers. observ.). The most optimal habitat is characterized by dense, shrubby riparian vegetation associated with

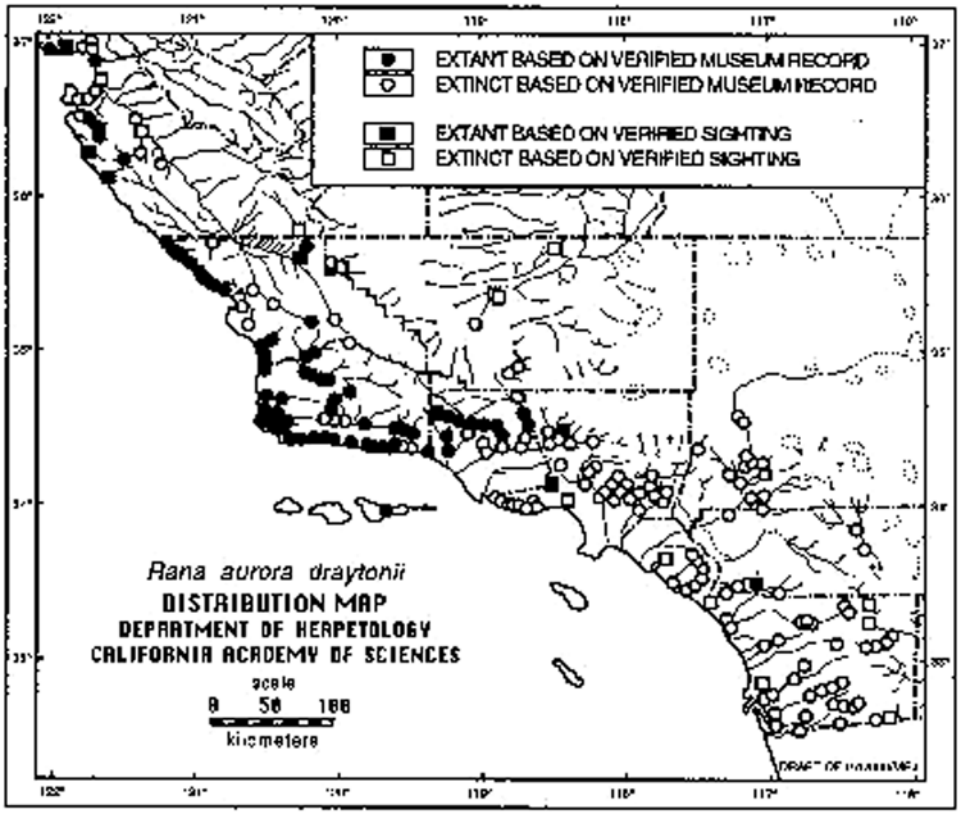

Figure 9—Historic and current distribution of the California red-legged frog in southern California. Modified from Jennings and Hayes (1994b).

deep (>0.7 m), still, or slow-moving water (Hayes and Jennings 1988, Jennings 1988). The shrubby riparian vegetation that structurally seems to be most suitable for this frog is that provided by arroyo willow (*Salix lasiolepis*), although cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) also can provide suitable habitat (Jennings 1988). Although California red-legged frogs are found in ephemeral streams and ponds, populations cannot be maintained where all surface water disappears (Jennings and Hayes 1994a). This frog is infrequent or absent in habitats where introduced aquatic predators such as green sunfish (*Lepomis cyanellus*), red-swamp crayfish (*Procambarus clarkii*), and bullfrogs (*Rana catesbeiana*) are present (Hayes and Jennings 1986, 1988), probably because its larval stages are susceptible to such predators (Jennings and Hayes 1994b). Subadult and adult California red-legged frogs often include other anurans and small mammals in their diet (Hayes and Tennant 1986). They are highly nocturnal and quite wary (Hayes and Tennant 1986, Storer 1925), but juveniles tend to be much less wary and frequently are active diurnally (Hayes and Tennant 1986). This frog breeds from late November to April, and females attach masses of 2,000 to 6,000 eggs to emergent vegetation in shallow water (Hayes and Jennings 1986, Jennings pers. observ., Storer 1925). Larvae require 4-5 months to metamorphose (Storer 1925) and apparently, under limited circumstances, will overwinter (Fellers and others 2001).

Status and Threats

The California red-legged frog is a State of California *Species of Special Concern* (Jennings and Hayes 1994a) and was federally listed as a *Threatened Species* on 23 May 1996, based on a range reduction of approximately 70 percent and continued threats to remaining populations (U.S. Fish and Wildlife Service 1996). Frogs in southern California have declined largely due to habitat loss and the introduction of non-native aquatic predators such as green sunfish, red-swamp crayfish, and bullfrogs (Jennings and Hayes 1994b). It is possible that a pathogen also helped to eliminate frog populations in southern California during the 1970s (Fellers and others 2001). Recent work suggests that nitrate/nitrite pollution (Marco and others 1999) and pesticide drift (Davidson and others 2001, 2002) also may be responsible for frog declines in California. Although California red-legged frogs still are present in some numbers in South Coast Range drainages north of the Santa Clara River, they are virtually extinct south of this location (Jennings and Hayes 1994a). The population in the Las Virgenes Creek drainage in extreme western Los Angeles County numbers fewer than 25 adults (R. Smith pers. comm.). The population at the Santa Rosa Ecological Preserve in western Riverside County was down to only two males in 2001 and no frogs were seen in 2002 (Jennings unpubl. data). Populations at both locations are at risk due to surrounding development, non-native aquatic predators, and native predators such as the raccoon (*Procyon lotor*) (Jennings unpubl. data).

Management Recommendations

Surveys at several sites on the Cleveland National Forest have failed to reveal any California red-legged frog populations (D. Holland pers. comm.), but searches need to continue, focusing especially on private lands in southern California. Known populations need to be protected from threats such as urban development, flood control projects, spread of known frog pathogens, increased raccoon populations, and introduced fishes and bullfrogs. Finally, the genetic diversity of extant populations

needs to be conserved, including breeding of captive populations, for possible reintroduction onto public lands with suitable remaining habitat. The largest pool of frogs for this task appears to be confined to northern Baja California, Mexico.

Mountain Yellow-legged Frog *Rana muscosa* Camp 1917

Description

A medium-sized (snout-urostyle length about 40-80 mm, Jennings and Hayes 1994a) frog with a variable dorsal pattern (*fig. 10;* Stebbins 1985). The markings usually range from discrete dark spots that can be few and large, to smaller and more numerous ones in a mixture of sizes and shapes, to irregular lichen-like patches, or a poorly defined reticulum (Zweifel 1955). Color also is highly variable, usually a mixture of brown and yellow, but often with gray, red, or green-brown (Jennings pers. observ.). The posterior half of the upper lip is weakly light-colored and dorsolateral folds are present but normally not prominent (Stebbins 1985). The throat is white or yellow, sometimes with a mottling of dark pigment (Zweifel 1955). Undersurfaces of the legs and lower belly are pale yellow to sun yellow; the latter color usually present on the largest individuals (Jennings and Hayes 1994a). The iris is gold with a horizontal, black counter-shading stripe (Jennings pers. observ.). Larvae (*fig. 11*) range in length from 10 to 65 mm long and have two to four upper and four lower rows of teeth (Stebbins 1985). Newly hatched tadpoles generally are

Figure 10–Adult mountain yellow-legged frog from Vincent Gulch, San Gabriel Mountains, Los Angeles County, California. Photo by Galen B. Rathbun.

blackish in color, gradually changing to a brassy background color with darker marbling and spots after a week or two of growth (Jennings pers. observ.).

Taxonomy

The mountain yellow-legged frog was originally described as two subspecies of *Rana boylii*, one in the Sierra Nevada and the other in southern California (Camp 1917). On the basis of morphological data, Zweifel (1955) separated these two forms from *R. boylii* and combined them as the distinct species *R. muscosa*. This arrangement was supported by subsequent genetic work (see Jennings and Hayes 1994a). Recent mitochondrial DNA studies indicate that mountain yellow-legged frog populations in all southern California mountain ranges form a clade distinct from the populations in the Sierra Nevada (Macey and others 2001). Further studies may suggest species level recognition for these southern California frogs.

Figure 11—Larval (2nd year) mountain yellow-legged frog from Little Rock Creek, San Gabriel Mountains, Los Angeles County, California. Photo: Norman J. Scott, Jr.

Distribution

In southern California, the mountain yellow-legged frog historically was present in most streams, watercourses, and natural lakes in the San Gabriel, San Bernardino, and San Jacinto Mountains, as well as on Mount Palomar in San Diego County (*fig. 12*). At many locations prior to 1965, the frogs could be extremely abundant (Jennings and Hayes 1994b, Stewart pers. observ.). The elevation range was from

370 m at Eaton Canyon, Los Angeles County, to over 2,290 m near Bluff Lake, San Bernardino County (Jennings and Hayes 1994a, Zweifel 1955). Today, mountain yellow-legged frogs are largely restricted to small watercourses at elevations greater than 1,500 m (Jennings 1993, 1994).

Habitat and Habits

This species inhabits mid- to upper-elevation perennial streams, often in locations with bedrock pools (Jennings 1993, 1994; Jennings pers. observ., Mullally 1959). Adult frogs are diurnal and often observed sitting in shallow pools of water with their back exposed to direct sunlight. Although streams may be partly shaded by riparian vegetation such as white alder (*Alnus rhombifolia*), most streams that contain frog populations are relatively open (Jennings pers. observ.). While life history data for southern California mountain yellow-legged frogs are very limited, the frogs appear to be strictly insectivorous and do not include vertebrates in their diet (Jennings and Hayes 1994a). In the late 1960s, Stewart (pers. observ.) found egg masses in April at 700 m elevation in Bear Creek in the San Gabriel River drainage. Oviposition probably occurs later at higher elevations. Egg masses typically are deposited in shallow water and not attached to objects (Jennings and Hayes 1994a, Stewart pers. observ.). In the Sierra Nevada, larvae are known to overwinter and take between 1 and 2.5 years to metamorphose (Jennings and Hayes 1994a). Overwintering of larvae has been observed at all locations where this species still occurs in southern California (Jennings pers. observ.).

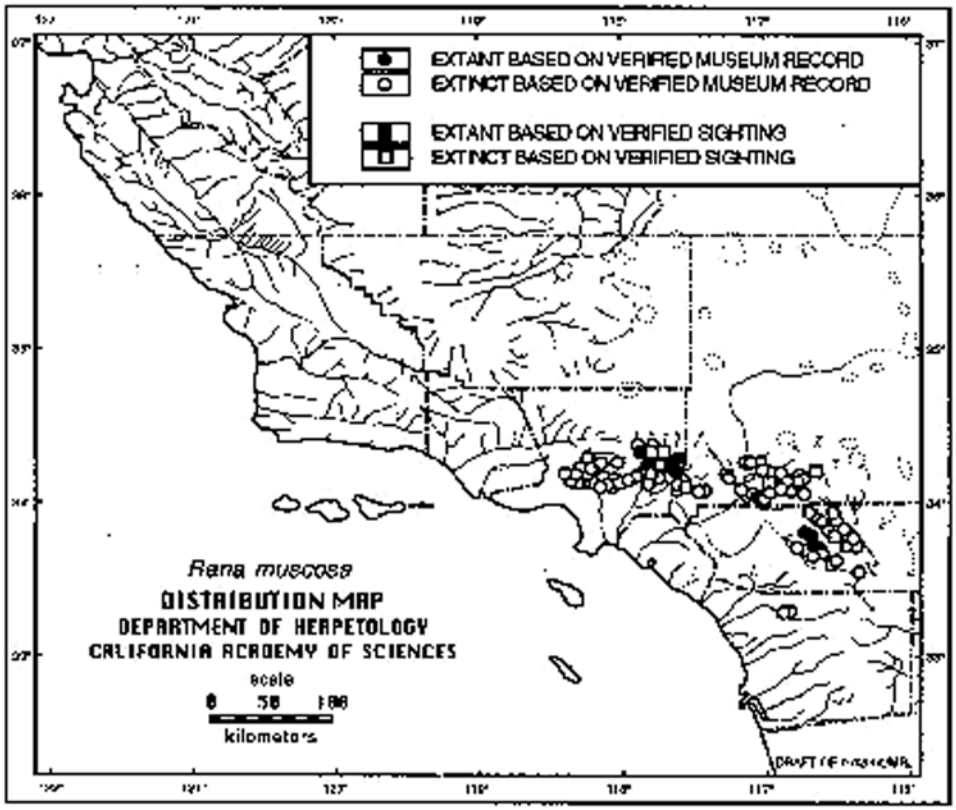

Figure 12—Historic and current distribution of the mountain yellow-legged frog in southern California. Modified from Jennings and Hayes (1994a).

Status and Threats

The mountain yellow-legged frog is a State of California *Species of Special Concern* (Jennings and Hayes 1994a) and a Forest Service Region 5 *Sensitive Species* (Stephenson and Calcarone 1999). It is believed to have been extirpated from approximately 99 percent of its historic range in southern California (Jennings 1995a, Jennings and Hayes 1994a), and the southern California population was federally listed as an *endangered species* on 2 July 2002 (U.S. Fish and Wildlife Service 2002). In the San Gabriel Mountains, small populations of frogs exist only in the upper reaches of Little Rock Creek, Big Rock Creek, Devil's Canyon, and the East Fork of the San Gabriel River (Jennings 1993, 1994, 1995b, 1998, 1999; Jennings and Hayes 1994b). In the San Bernardino Mountains, a small population currently exists in a short section of the lower portion of the East Fork of City Creek (Jennings pers. observ., U.S. Fish and Wildlife Service 2002). In the San Jacinto Mountains, small populations of frogs exist only in the upper reaches of the North Fork of the San Jacinto River, Hall Canyon, Dark Canyon, and Fuller Mill Creek (Jennings 1998, 1999). Current estimates put the total number of adult frogs in the nine known populations at fewer than 200 individuals (Jennings 1995a).

All of these populations are extremely vulnerable to extirpation via recreation (U.S. Fish and Wildlife Service 1999), especially when such activities occur on a repeated basis year after year (U.S. Fish and Wildlife Service 2002). For example, the second author has witnessed the children of rock climbers chasing frogs and adults disturbing sunning frogs in the Little Rock Creek drainage; adults hiking directly in and up the streams of Little Rock Creek and the North Fork of the San Jacinto River, disturbing the larval and metamorphosing frogs present; a mother and daughter photographing flowers in the North Fork of the San Jacinto River and disturbing a small population of metamorphosing frogs; and adults and children swimming (and associated litter) in Dark Canyon, Mill Creek, and the East Fork of the San Gabriel River where larvae and subadult frogs were present. Such activities are not limited to areas near roads. For instance, one individual reported hiking directly up a stream containing a known frog population on Mount San Jacinto because he “just wanted to get away from the crowds.”

Other recreational activities which negatively effect frog populations include fishing for trout (*Oncorhynchus mykiss* and *Salmo trutta*) at almost all known frog locations and camping at locations along the North Fork of the San Jacinto River and East Fork of the San Gabriel River where frog populations are still extant. All of these recreational activities greatly increase the chances of pathogen introduction (via shoes, clothing, and fishing equipment) that could decimate the small, isolated populations. Continuing requests for water removal for ski operations in the uppermost reaches of Little Rock Creek also threaten the small frog population there through potential dewatering of the stream (U.S. Fish and Wildlife Service 1999, 2002).

Finally, the negative effects of chance catastrophic events, such as fires, droughts and floods, also greatly endanger these localized populations (U.S. Fish and Wildlife Service 2002). The 1968-69 floods in southern California decimated many of the frog populations that formerly were abundant in the region (Jennings and Hayes 1994a, 1994b).

Management Recommendations

There needs to be a long-term, comprehensive program to determine and monitor the number of adults, juveniles, and egg masses or larvae for each of the remaining populations. This will require careful yearly surveys. Otherwise, most of these populations could become extinct without us knowing it. Additionally, campgrounds in sensitive frog breeding sites need to be closed for a portion of the year or removed. Also, trails near sensitive frog habitats need to be relocated well away from riparian areas. If possible, volunteers should be used to keep recreationists out of the most sensitive frog breeding habitats throughout the summer. Trout stocking should be discontinued in frog habitat, and existing trout populations should be removed. Finally, a captive breeding population of frogs from each southern California mountain range needs to be started to assure that the genetic diversity of this species is preserved for potential reintroduction programs.

San Gabriel Mountain Slender Salamander *Batrachoseps gabrieli* Wake 1996

Description

A slender salamander of medium size (snout-vent length 40-50 mm, Wake 1996) with a relatively broad, flattened head that is well demarcated from the neck (*fig. 13*; Wake 1996). It also has long limbs, large feet, a tapered tail, and 18 or 19 costal grooves between the front and hind limbs (Wake 1996). With a complete interlacing of melanophores, the ground color generally is black in this species throughout its range. Individuals from the western part of the range (San Gabriel Canyon, San Gabriel Mountains, Los Angeles County) have a dorsum overlain with a dense layer of coppery iridophores that are more concentrated around the shoulders and pelvic region, forming two short, broad stripes. Salamanders from the central part of the range (San Antonio and Lytle Canyons, San Gabriel Mountains, Los Angeles and San Bernardino Counties) usually have white-to-silvery iridophores in addition to the coppery iridophores. Specimens from the eastern part of the range (Devil and Waterman Canyons, San Bernardino Mountains, San Bernardino County) typically are devoid of any coppery iridophores, but have the white-to-silvery iridophores.

Taxonomy

Batrachoseps gabrieli is a recently described salamander known only from the cismontane side of the San Gabriel and San Bernardino Mountains in southern California (Goodman and others 1998, Hansen and others 2005, Wake 1996). Wake (1996) notes that this species is morphologically and genetically differentiated from all other *Batrachoseps*, with separation from other lineages occurring approximately 8-13 million years ago.

Distribution

The range (*fig. 14*) of *B. gabrieli* is poorly known. Originally, this species was known from only two locations within the San Gabriel Mountains (Wake 1996), but it recently has been collected and/or observed at 11 other sites within the San Gabriel

and San Bernardino Mountains (Goodman and others 1998, Goodman pers. observ.).

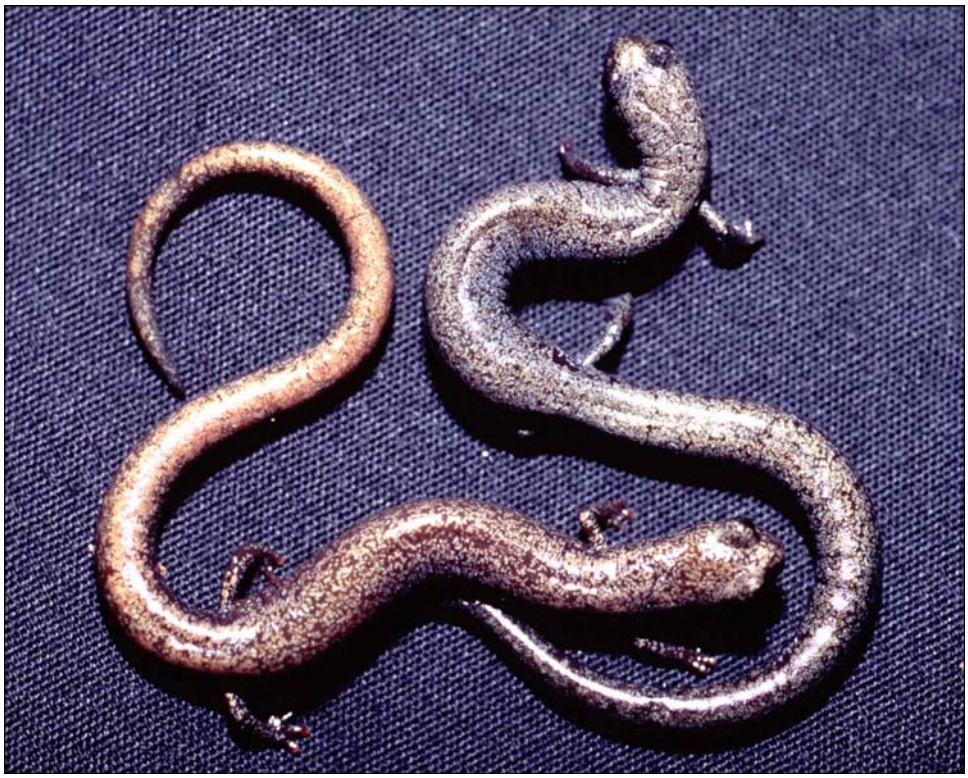

Figure 13—Two adult San Gabriel Mountain slender salamanders. The animal on the left is from Waterman Canyon, San Bernardino Mountains, San Bernardino County, California and the animal on the right is from Alpine Canyon, San Gabriel Mountains, Los Angeles County, California. Photo by Robert H. Goodman, Jr.

The distribution apparently is discontinuous, with populations restricted to narrow swaths of suitable habitat in separate drainages, bounded on the west by San Gabriel Canyon and on the east by Waterman Canyon. All specimens have been collected in either the Angeles or San Bernardino National Forests. The elevation range is from approximately 850 m to 2,380 m.

Habitat and Habits

Habitat associations for the new populations of *B. gabrieli* (Goodman and others 1998) are similar to those described by Wake (1996) for the type locality, although generally lower in elevation. Most individuals have been observed in and around talus, under rotting logs, bark, downed branches, downed fern fronds and rocks (Hansen and others 2005). Vegetation components present within and around the talus include canyon live oak (*Quercus chrysolepis*), bigcone Douglas-fir, Jeffrey pine, yellow pine, and chaparral components such as ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), mountain mahogany (*Cercocarpus betuloides*) and chaparral yucca (*Yucca whipplei*). Surface activity appears to peak during southern California's winter snow/rain season; individuals have been observed while snow was present (Goodman pers. observ., Wake 1996,). Three other plethodontid

salamanders—the Monterey salamander (*Ensatina eschscholtzii eschscholtzii*), black-bellied slender salamander (*Batrachoseps nigriventris*), and arboreal salamander (*Aneides lugubris*)—are known to occur sympatrically with *B. gabrieli* (Goodman pers. observ., Wake 1996).

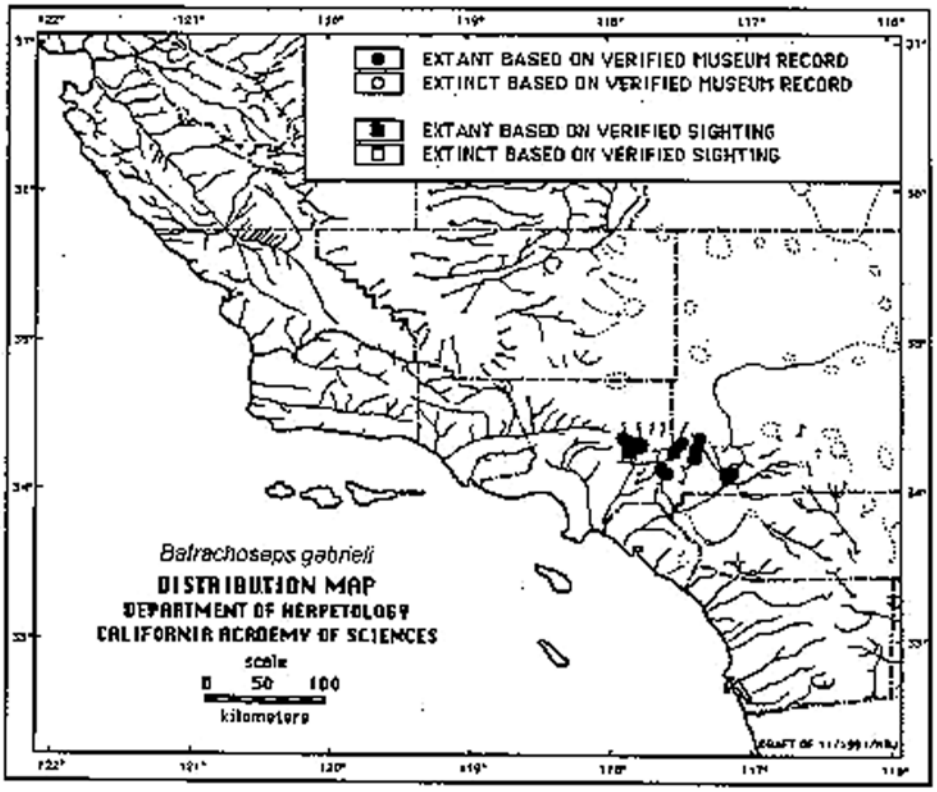

Figure 14—Current distribution of the San Gabriel Mountain slender salamander.

Status and Threats

The San Gabriel Mountain slender salamander currently has no State or Federal status, but it is a Forest Service Region 5 *Sensitive Species* (Stephenson and Calcarone 1999). Fortunately, all populations of *B. gabrieli* occur within national forest boundaries, and because it occurs within and around talus slopes and seems to be surface active only during the winter months, there appear to be no direct threats to it at this time.

Management Recommendations

Since this salamander currently is known from only 13 locations within the central to eastern San Gabriel Mountains and western San Bernardino Mountains, we recommend that it be listed by the State of California as a *Species of Special Concern.* For management purposes, and to obtain a better estimate of its range, further surveys should be conducted throughout the San Gabriel, San Bernardino, and San Jacinto Mountains to locate new populations. In addition, management guidelines should be developed to protect the talus habitat of this species.

Yellow-blotched Salamander *Ensatina eschscholtzii croceater* (Cope 1869)

Description

A medium-sized (snout-vent length 48-78 mm, Jennings and Hayes 1994a) salamander with large, irregular, pale, lemon-yellow to yellowish cream blotches on a deep blackish brown to black ground color (*fig. 15*; Stebbins 1985). As in other forms of *Ensatina*, there are 12-13 costal grooves and a noticeable constriction at the base of the tail (Stebbins 1949, 1985).

Figure 15—Adult female yellow-blotched salamander from San Emigdio Mountain, Kern County, California. Photo by Robert H. Goodman, Jr.

Taxonomy

The ensatina (*Ensatina eschscholtzii*) has long been considered a classic example of a "ring species" (Highton 1998, Wake and Schneider 1998). Seven named subspecies are distributed around the Central Valley of California, apparently intergrading in contact areas, but overlapping without interbreeding at the ends of the ring (*E.e. eschscholtzii* and *E.e. klauberi*) in southern California (Stebbins 1949). Behaving as closely related but distinct species, unblotched *eschscholtzii* and blotched *klauberi* are known to hybridize occasionally (Brown 1974, Wake and Yanev 1986), and Highton (1998) advocated species-level recognition with hybrid zones for all the infraspecific taxa within *Ensatina*. However, Wake and Schneider (1998), while ac-

knowledging that the ensatina does not meet all of the criteria for a true ring species, argued against disrupting the long-stable taxonomy of this species complex until further morphological and genetic studies are completed. We follow that policy here.

Distribution

The current known range of the yellow-blotched salamander essentially is restricted to east-central Kern and northern Ventura Counties, extending from the Piute Mountains in the Sequoia National Forest southwestward to the vicinity of Alamo Mountain in the Los Padres National Forest (*fig. 16*). Northwest of the Piute Mountains, ensatina populations appear to be intergrades between *E.e. croceater* and *E.e. platensis.* Two hundred km east of Alamo Mountain, blotched ensatina collected in the San Bernardino Mountains look like intergrades between *E.e. croceater* and *E.e. klauberi* (Stebbins 1949; *fig. 17*), with specimens from some localities looking more like one or the other of the two taxa (compare *figs. 16* and *19*). However, all are genetically closer to the latter (Wake and Schneider 1998). Interestingly, blotched ensatina seem to be absent from the intervening San Gabriel Mountains, an area known as "Bob's Gap" in reference to Robert Cyril Stebbins who did much of the early work with the species complex. *E.e. croceater* occurs from about 427 m to 2,285 m in elevation (Jennings and Hayes 1994a).

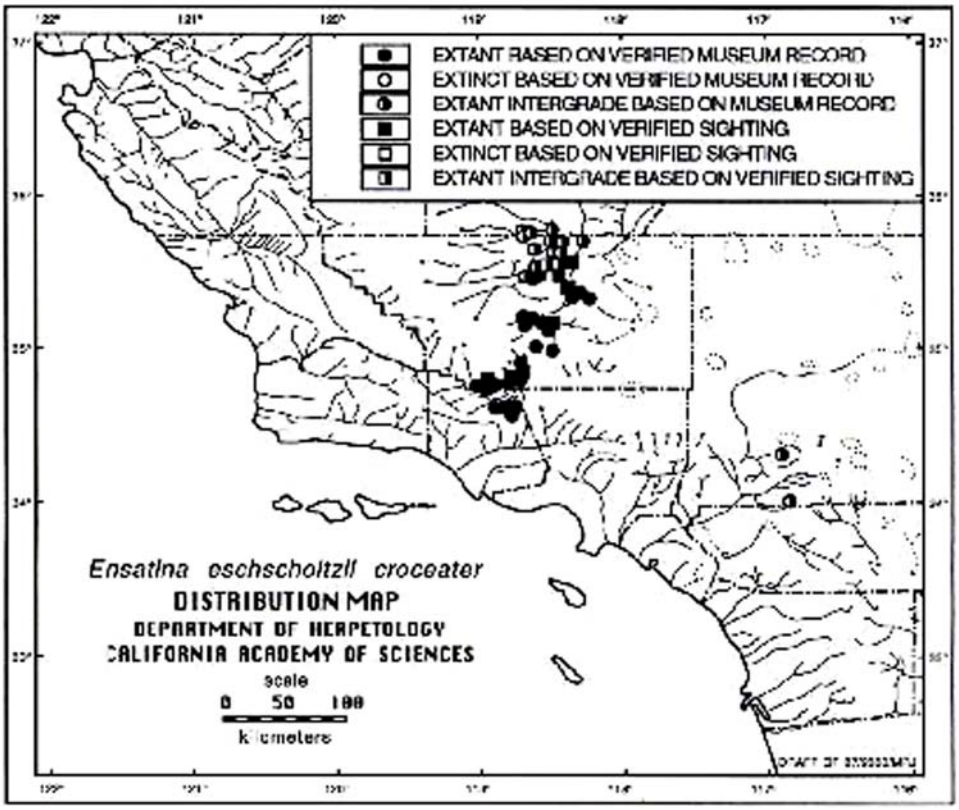

Figure 16—Historic and current distribution of the yellow-blotched salamander. Intergrades indicated in the San Bernardino Mountains look more like *E.e. croceater* than *E.e. klauberi*. Modified from Jennings and Hayes (1994a).

Habitat and Habits

The yellow-blotched salamander occurs in a wide variety of vegetation associations including oak (*Quercus douglasii* and *Q. kelloggii*) woodlands, pine (*Pinus jeffreyi* and *P. ponderosa*) and fir (*Abies concolor*) forests, and open chaparral (Jennings and Hayes 1994a, Stephenson and Calcarone 1999). It typically is found under downed logs, leaf litter and duff, woody debris, and medium-to-large rocks (Goodman pers. observ., Jennings and Hayes 1994a). As with most other southern California salamanders, the habits of this subspecies are poorly known, although surface activity generally peaks during the winter months. Gravid females have been observed in April and May (Jennings and Hayes 1994a).

Status and Threats

This salamander is a State of California *Species of Special Concern* (Jennings and Hayes 1994a) and a Forest Service Region 5 *Sensitive Species* (Stephenson and Calcarone 1999). Although it is more widespread and abundant than originally realized, there are concerns about increased development in the Tehachapi Mountains, Cummings Valley, and Bear Valley areas and increased wood harvesting on the Tejon Ranch (Jennings and Hayes 1994a). These activities occur primarily in oak woodlands and may have a direct impact on known and undiscovered salamander populations.

Figure 17—Subadult intergrade between yellow-blotched and large-blotched salamanders from Crystal Creek, San Bernardino Mountains, San Bernardino County, California. Photo by Robert H. Goodman, Jr.

Management Recommendations

Systematic surveys and habitat assessments should be conducted within known populations of the yellow-blotched salamander in order to gain a better understanding of this taxon's natural history. Similar work might then be able to locate populations in areas like the San Gabriel Mountains. If specimens are collected in "Bob's Gap," they may yield significant information on the phylogeography of the ensatina species complex (Wake and Schneider 1998). While *E.e. croceater* may be more directly impacted by habitat degradation on private lands than by prevailing land use activities on public lands (Stephenson and Calcarone 1999), we believe that guidelines should be developed by the Sequoia and Los Padres National Forests to prevent over-harvesting of standing trees, downed logs, and wood debris.

Large-blotched Salamander *Ensatina eschscholtzii klauberi* Dunn 1929

Description

A medium-sized (snout-vent length 45-82 mm, Jennings and Hayes 1994a) salamander with large, rectilinear, orange blotches (sometimes spots or bands) on a deep blackish-brown-to-black ground color (*fig. 18*; Stebbins 1985).

Figure 18—Subadult large-blotched salamander from near Julian, Cuyamaca Mountain, San Diego County, California. Photo by Robert H. Goodman, Jr.

Taxonomy

The taxonomic comments made for the yellow-blotched salamander also apply to this subspecies.

Distribution

The known range of the large-blotched salamander is from the San Jacinto Mountains, Riverside County to Cottonwood Creek, San Diego County (*fig. 19*). Its distribution is discontinuous, and as, previously noted, possible intergrades between *E.e. klauberi* and *E.e. croceater* occur in the San Bernardino Mountains (Stebbins 1949; *fig. 17*). Recently, *E.e. klauberi* has been observed in the Sierra San Pedro Martir, Baja California Norte, Mexico (Mahrdt and others 1998). The elevation range for this salamander is from about 518 m to 1,646 m (Jennings and Hayes 1994a).

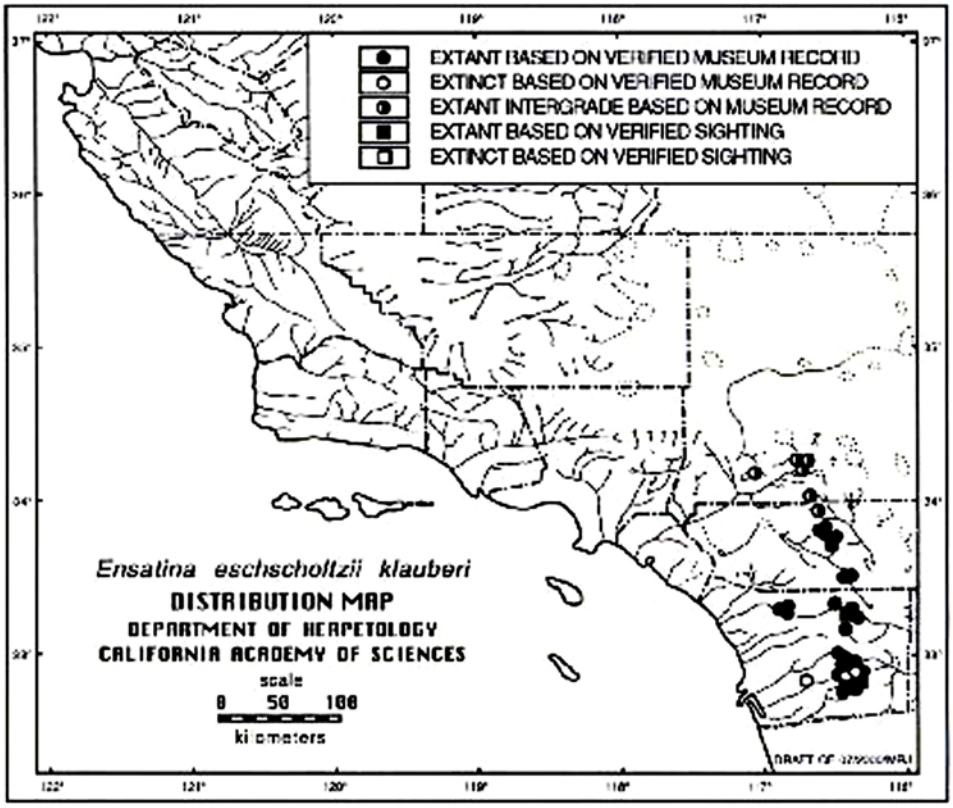

Figure 19—Historic and current distribution of the large-blotched salamander in southern California. Intergrades indicated in the San Bernardino Mountains look more like *E.e. klauberi* than *E.e. croceater*. Modified from Jennings and Hayes (1994a).

Habitat and Habits

Vegetation associations of this subspecies are similar to those of the yellow-blotched salamander, but the oaks are more likely to be *Quercus chrysolepis* and *Q. kelloggii*, and the pines *Pinus coulteri* and *P. ponderosa*, along with incense cedar (Jennings and Hayes 1994a, Stephenson and Calcarone 1999). Again, the salamanders typically

are found under various kinds of surface litter and rocks (Goodman pers. observ., Jennings and Hayes 1994a), and surface activity generally peaks when moisture is present.

Status and Threats

The large-blotched salamander is a State of California *Species of Special Concern* (Jennings and Hayes 1994a) and a Forest Service Region 5 *Sensitive Species* (Stephenson and Calcarone 1999). Even though it also is considerably more common than was formerly believed (Jennings and Hayes 1994a), threats from habitat destruction are increasing. As with the yellow-blotched salamander, the large-blotched salamander may be more impacted by habitat degradation resulting from development on private lands than land use activities on public lands (Stephenson and Calcarone 1999). However, potential impacts to populations from mining exist in the Crystal Creek area of the San Bernardino Mountains (Goodman pers. observ., Jennings and Hayes 1994a).

Management Recommendations

Recommendations discussed with respect to *E.e. croceater* are applicable here. According to D. Wake (pers. comm.), known populations of blotched salamanders from the San Bernardino Mountains are few and disjunct, and more surveys need to be done to locate additional populations for study. To maintain habitat quality for ensatinas, the Cleveland and San Bernardino National Forests should develop guidelines to prevent over-harvesting of trees, logs, and wood debris.

Conclusion

As described in the foregoing accounts, all of these taxa face varying degrees of threat—in some cases, severe threat—from a multitude of anthropogenic factors prevalent in southern California. Lest there be any doubt that these factors can result in extinctions here, the case of the foothill yellow-legged frog (*Rana boylii*) must be mentioned. In the south coast area, this frog historically occurred below the conifer forest habitats in parts of the South Coast Ranges and San Gabriel Mountains from near sea level (Gaviota Creek, Santa Barbara County) to 1,219 m (Indian Creek in the San Rafael Mountains, Santa Barbara County). It has not been observed in this area since before 1978 (H. DeLisle, M. Long, and S. Sweet pers. comm.; Jennings and Stewart pers. observ.), and all of these populations are now believed to be extinct (Jennings 1995a, Jennings and Hayes 1994a).

With their relatively low vagility, all of the taxa discussed in this paper face threats from habitat degradation, fragmentation, and loss. These may lead directly to extinction in the short term for those already reduced to very small, isolated populations or to a more gradual extinction process involving local extirpations, restricted gene flow, reduced genetic diversity, and increased vulnerability to environmental changes. To the extent that global warming scenarios prove to be correct, long-term climate change may become a serious problem for amphibians, and the taxa may be restricted to montane habitats that already are essentially insular relicts.

As specialists in herpetology, we want to emphasize that the taxa discussed here are the subjects of recent and ongoing phylogeographic studies using the most advanced techniques of phyletic and genetic analysis. Consequently, their taxonomy is in a state of flux. More importantly, however, they are of continuing interest to biologists studying the evolutionary processes that shape modern species of terrestrial vertebrates.

To prevent further declines and losses in the herpetofauna of the southern California mountains, additional research must be conducted to increase our knowledge of the distribution, habitat needs, life history, and phylogenetic relationships of the taxa occurring there. Collaboration between the scientific community, the private sector, and public agencies at the Federal, State and local levels will be essential to obtaining the necessary data and incorporating them into sound management programs. These programs must be monitored regularly to ensure that desired objectives are being met. Only then can we expect that the montane components of southern California's rich biodiversity will be maintained for continuing scientific study and public enjoyment.

Acknowledgments

We thank Harold F. DeLisle, Michael C. Long, and Samuel S. Sweet for providing unpublished field notes and other pertinent information. Galen B. Rathbun and Norman J. Scott, Jr. generously provided some of the photographs used in this paper. Timothy A. Shoemaker kindly assisted in formatting the manuscript. Portions of this work were funded by grants provided by the California Department Fish and Game, the U.S. Department of Agriculture Forest Service, and the U.S. Geological Survey. Finally, we thank the organizers of this symposium for inviting us to participate and the reviewers of our manuscript for their helpful comments.

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