

increased human activity in the area, potentially disrupting mountain yellow-legged frog behavior.

Fire retardant chemicals contain nitrogen compounds and/or surfactants (a subset of chemical additives usually used to facilitate application). Laboratory tests of these chemicals have shown that they can cause mortality in fishes and aquatic invertebrates by releasing surfactants and ammonia when they are added to water (Hamilton *et al.* 1996), and similar effects are likely on amphibians. Therefore, if fire retardant chemicals were dropped in or near mountain yellow-legged frog habitat, they could have negative effects on individuals.

In some areas within the range of the mountain yellow-legged frog, long-term fire suppression has changed forest structure and conditions where fire severity and intensity are higher (McKelvey *et al.* 1996). Prescribed fire has been used by land managers to achieve various silvicultural objectives, including the reduction of fuel loads. In some systems, fire is thought to be important in maintaining open aquatic and riparian habitats for amphibians (Russel *et al.* 1999). But severe and intense wild fires may reduce the ability of amphibians to survive such a fire. However, amphibians display adaptive behavior that may minimize mortality from fire, by taking cover in wet habitats or taking shelter in subterranean burrows, though the moist and permeable skin of amphibians increases their susceptibility to heat and dessication (Russel *et al.* 1999). Neither the direct nor indirect effects of prescribed fire or wildfire on the mountain yellow-legged frog have been studied, but because the species generally occupies high elevation habitat, fire is not a likely risk to this species in much of its range.

In summary, historic grazing activities likely modified the habitat of the mountain yellow-legged frog throughout its range. Although grazing pressure has been significantly reduced from historic levels, grazing may continue to contribute to localized degradation and loss of suitable habitat, negatively affecting mountain yellow-legged frog populations. The effects of recreation, dams, water diversions, roads, timber harvests, and fire management activities on the mountain yellow-legged frog are not well studied, and though they may have negatively affected mountain yellow-legged frogs and their habitat, they have not been implicated as primary factors in the decline of this species (Bradford *et al.* 1993; Bradford *et al.* 1994a; Jennings 1996; Knapp and Matthews 2000). However, recreation,

dams, water diversions, roads, timber harvests, and fire management activities may be factors of secondary importance in the decline of the mountain yellow-legged frog and the modification of its habitat (Jennings 1996).

B. *Overutilization for commercial, recreational, scientific, or educational purposes.* There is no known commercial market for mountain yellow-legged frogs, nor are there documented recreational or educational use for mountain yellow-legged frogs, although it is likely that they have been handled by curious members of the public, used as bait by anglers, and collected as pets. The mountain yellow-legged frog does not appear to be particularly popular among amphibian and reptile collectors; however, Federal listing could raise the value of the animals within wildlife trade markets and increase the threat of unauthorized collection above current levels (K. McCloud, Service, pers. comm. 2002). Even limited interest in the species could pose a serious threat to this animal.

Scientific research may cause stress to mountain yellow-legged frogs through disturbance, including disruption of the species' behavior, handling individuals, and injuries associated with marking and tracking individuals. Scientific research has also resulted in the death of numerous individuals through the collection of museum specimens (Zweifel 1955; Jennings and Hays 1994). However, this is a relatively minor threat. Of greater concern are researchers contributing to the spread of pathogens via clothing and sampling equipment as they move between water bodies and populations (Bradford 1991; Bradford *et al.* 1994a; Fellers *et al.* 2001). Given the uncertainty surrounding the potential for researchers to contribute to the spread of pathogens, researchers have begun to implement equipment sterilization procedures between survey sites (H. Eddinger, *in litt.* 2002; R. Knapp, *in litt.* 2002; V. Vredenburg, *in litt.* 2002). For further discussion concerning the threat of disease, see Factor C below.

#### C. *Disease or predation.*

##### **Predation**

Native predators of mountain yellow-legged frogs include the mountain garter snake (*Thamnophis elegans elegans*), valley garter snake (*T. sirtalis fitchi*), Brewer's blackbird (*Euphagus cyanocephalus*), Clark's nutcrackers (*Nucifraga columbiana*), coyotes (*Canis latrans*), and black bear (*Ursus americanus*) (Camp 1917; Grinnell and Storer 1924; Mullally and Cunningham 1956; Bradford 1991; Jennings *et al.*

1992; Feldman and Wilkinson 2000; V. Vredenburg *et al.* (in press)).

Predation by introduced trout is the best-documented cause of the decline of the Sierra Nevada mountain yellow-legged frog, because it has been repeatedly observed that non-native fishes and mountain yellow-legged frogs rarely co-exist (Grinnell and Storer 1924; Needham and Vestal 1938; Mullally and Cunningham 1956; Cory 1962a, 1963; Bradford 1989; Bradford and Gordon 1992; Bradford *et al.* 1993, 1994a, 1998; Drost and Fellers 1996; Jennings 1996; Knapp 1996; Knapp and Matthews 2000; Knapp *et al.* 2001; V. Vredenburg *et al.*, (in press); USFS undated). The body of scientific research on the distributions of introduced trout and mountain yellow-legged frogs over time has conclusively demonstrated that introduced trout have negatively impacted mountain yellow-legged frogs over much of the Sierra Nevada (Bradford 1989; Bradford *et al.* 1993, 1994a, 1998; Knapp 1994, 1996; Drost and Fellers 1996; Knapp and Matthews 2000; Knapp *et al.* 2001). Mountain yellow-legged frogs and trout (native and non-native) do co-occur at some sites, but these co-occurrences probably are mountain yellow-legged frog populations that would have negative population growth rates in the absence of immigration (Bradford *et al.* 1998; Knapp and Matthews 2000). Non-native fish stocking programs have been recognized to have negative ecological implications because non-native fish eat native aquatic flora and fauna, including amphibians and invertebrates (Bahls 1992; Erman 1996; Matthews *et al.* 2001; Pilliod and Peterson 2001; Schindler *et al.* 2001; Moyle 2002).

Prior to extensive trout planting programs in the late 19th Century through the present, most streams and lakes in the Sierra Nevada at elevations above 1,800 m (6,000 ft) were without fishes. The distributions of several native fish species occur in lower-elevation aquatic habitats around the Sierra Nevada (Knapp 1996; Moyle *et al.* 1996; Moyle 2002). The only major exception to the 1,800 m (6,000 ft) elevational limit for fishes within the range of the mountain yellow-legged frog in the Sierra Nevada was the upper reaches of the Kern River where native fish such as the Little Kern golden trout (*Oncorhynchus mykiss whitei*) evolved (Moyle 2002). Natural barriers prevented fish from colonizing the higher elevation headwaters of the Sierra Nevada watershed (Moyle *et al.* 1996).

With the Gold Rush and its associated increase in human habitation, habitat alteration, fish distribution and species