

(Lemly 1998). Growth of filamentous bacteria on the bodies and gills of aquatic insects has been documented in association with nutrient loading in livestock use pastures, along with significantly lower densities of insects at downstream sites. In laboratory and field studies, aquatic insects with this bacterial growth experienced extensive mortality. This indicates that elevated bacteria levels associated with livestock use can negatively influence stream insect populations (Lemley 1998). Adverse effects to aquatic insects within the range of the mountain yellow-legged frog could result in a lowered prey availability, possibly increasing intraspecific competition for limited resources.

Throughout the range of the mountain yellow-legged frog in the Sierra Nevada approximately 79 currently active grazing allotments exist on USFS-administered lands. Of these grazing allotments, at least 29 have extant mountain yellow-legged frog populations within them. An estimated 13 percent of the approximately 210 known mountain yellow-legged frog populations, or populations that function as metapopulations, on Sierra Nevada national forests occur within active grazing allotments. Many of the mountain yellow-legged frog populations in the Sierra Nevada that occur within active grazing allotments are small. These populations may be more vulnerable to extirpation as a result of grazing-induced habitat modification, and if extirpated they might not be recolonized in situations where they are isolated from other populations and lack habitat connectivity to potential source populations.

In the 60-Lakes Basin of Kings Canyon National Park, packstock use is regulated in wet meadows to protect mountain yellow-legged frog breeding habitat in bogs and lakeshores from trampling and associated degradation (V. Vredenburg, *in litt.* 2002; H. Werner, NPS, *in litt.* 2002).

### Recreation

Recreation is the fastest growing use of national forests. As such, its impacts on the mountain yellow-legged frog are likely to continue and to increase (USDA 2001). Recreational activities take place throughout the Sierra Nevada and have significant negative impacts on several plant and animal species and their habitats (USDA 2001a). To further recreational opportunities and angling success, non-native trout stocking programs in the Sierra Nevada started in the late 19th Century (Bahls 1992; Pister 2001). Trout stocking throughout the

range of the mountain yellow-legged frog has contributed to the decline of this species (see Predation, Factor C, below). The recreational impact of anglers at high mountain lakes has been severe in the Sierra Nevada, with most regions reporting a level of use greater than that which the fragile lakeshore environments can withstand (Bahls 1992).

Recreation may threaten all life stages of the mountain yellow-legged frog through direct disturbance resulting from trampling by humans, packstock, or vehicles, including off-highway vehicles; harassment by pets; and associated habitat degradation (Cole and Landres 1996; USFS 2001). Studies have not been conducted to determine whether recreational activities are contributing to the decline of the mountain yellow-legged frog, and recreation has not been implicated as a cause of major decline of the mountain yellow-legged frog.

### Dams and Water Diversions

Dams and water diversions have altered aquatic habitats in the Sierra Nevada (Kondolf *et al.* 1996). Numerous reservoirs have been constructed within the range of the mountain yellow-legged frog. These include Huntington Lake, Florence Lake, Lake Thomas A. Edison, Saddlebag Lake, Convict Lake, Cherry Lake, and other reservoirs associated with Hetch Hetchy, Upper and Lower Blue Lakes, Lake Aloha, Silver Lake, Hell Hole Reservoir, French Meadow Reservoir, Lake Spaulding, and others. The extent of the impacts that these projects have had on the mountain yellow-legged frog is not known. The construction of dams probably has affected mountain yellow-legged frogs in the Sierra Nevada by altering their habitat and movements, and also by altering the distribution of predators (reservoirs are often stocked with non-native fish species that incidentally prey on mountain yellow-legged frogs (See Predation, Factor C, below)). Mountain yellow-legged frogs cannot live in or move through the exposed shorelines created by reservoirs, nor can they successfully reproduce in these environments with predatory fishes unless there are shallow side channels or disjunct pools that are free of predatory fishes (Jennings 1996).

Dams may alter the temperature and sediment load of the rivers they impound (Cole and Landres 1996). Dams, water diversions, and their associated structures can alter the natural flow regime with unseasonal and fluctuating releases of water, create habitat conditions unsuitable for native amphibians both upstream and

downstream of dams, and act as barriers to movements by dispersing juvenile and migrating adult amphibians (Jennings 1996). Where dams act as barriers to mountain yellow-legged frog movement, they would effectively prevent genetic exchange between populations and the recolonization of sites. Water diversions that remove water from mountain yellow-legged frog habitat may adversely impact breeding success and adult survivorship if the diversion results in a lowering of the water level to the extent that the entire water column freezes in the winter, or to the extent that the habitat is rendered dry. These factors are likely to have contributed to the decline of mountain yellow-legged frogs and probably continue to pose a risk to the species.

### Roads and Timber Harvest

Any activity that severely alters the terrestrial environment, including road construction and timber harvest, is likely to result in the reduction and extirpation of amphibian populations in the Sierra Nevada (Jennings 1996). Most of the mountain yellow-legged frog populations are in areas such as national parks or designated wilderness areas where timber is not harvested (Bradford *et al.* 1994a; Drost and Fellers 1996; Knapp and Matthews 2000). Some of these populations, and others outside of these areas, are located at too high an altitude for timber to be harvested, so this activity is not expected to affect the majority of extant mountain yellow-legged frog populations. There are some mountain yellow-legged frog populations in areas where timber harvests have occurred in the past and others where it may occur in the future. There are also roads within the range of the mountain yellow-legged frog; however, neither of these factors has been implicated as an important contributor to the decline of this species (Jennings 1996).

### Fire Management Activities

Mountain yellow-legged frogs are generally found at high elevations in wilderness areas and national parks where vegetation is sparse and fire suppression activities are implemented infrequently. Potential impacts to the species resulting from fire management activities include: Water drafting (taking of water) from occupied ponds and lakes, resulting in direct mortality or rendering the habitat unsuitable for reproduction and survivorship; construction of fuel breaks either by hand or heavy equipment, potentially resulting in erosion and siltation of habitat; fire suppression with water applications or fire retardants; and