

frog in the Sierra Nevada was reduced by 75 percent (C. Milliron, *in litt.* 2002; E. Pert, CDFG, pers. comm. 2002; E. Pert *et al.*, pers. comm. 2002). Water bodies within the same basin and 2 km (1.25 mi) from a known mountain yellow-legged frog population will not be stocked with fish unless stocking is justified through a management plan that considers all the aquatic resources in the basin, or unless there is heavy angler use and no opportunity to improve the mountain yellow-legged frog habitat (C. Milliron, *in litt.* 2002). This policy has not been finalized in writing (E. Pert *et al.*, pers. comm. 2002).

The CDFG is in the process of developing management plans for basins within the range of the mountain yellow-legged frog in the Sierra Nevada (CDFG 2001; C. Milliron, *in litt.* 2002; E. Pert, pers. comm. 2002; E. Pert *et al.*, pers. comm. 2002). For example, a plan has been developed, signed, and initiated for the Big Pine Creek wilderness basin in the Inyo National Forest's John Muir Wilderness (CDFG 2001), and a similar plan is proposed for the Gable Lakes basin, also in the John Muir Wilderness area of the Inyo National Forest (B. Miller, CDFG, *in litt.* 2001). The objectives of the Big Pine Creek wilderness basin plan specific to the mountain yellow-legged frog include management in a manner that maintains or restores native biodiversity and habitat quality, supports viable populations of native species, and provides for recreational opportunities that consider historic use patterns (CDFG 2001). Under this plan, some lakes are managed primarily for the mountain yellow-legged frog, with few or no angling opportunities, while lakes with high demand for recreational angling are managed primarily for that purpose (CDFG 2001). Preliminary results indicate that where the plans are being implemented, the management objective to restore mountain yellow-legged frog habitat is being achieved, and in some areas, mountain yellow-legged frog populations have responded positively (C. Milliron, pers. comm. 2002). We anticipate that the development and implementation of these basin management plans will be effective in reversing some of the negative impacts of introduced trout on mountain yellow-legged frog populations within a limited geographic area of the affected basins, providing that connectivity is restored between and within metapopulations.

Local

We are not aware of any specific county or city ordinances that provide

protection for the Sierra Nevada population of mountain yellow-legged frogs.

E. Other natural or manmade factors affecting its continued existence.

Several other natural or anthropogenically influenced factors, including contaminants, acid precipitation, climate change and drought, and ambient ultraviolet radiation, have been implicated as a cause of amphibian declines (Corn 1994; Alford and Richards 1999). These factors have been studied to varying degrees specific to the mountain yellow-legged frog. These factors are discussed below.

The following factors make the mountain yellow-legged frog, along with other amphibians, sensitive to environmental change or degradation: its aquatic and terrestrial phases; its highly permeable skin which is exposed to substances in the water, air, and terrestrial substrate; and the position at which it feeds on the food web, depending on its life stage (Blaustein and Wake 1990, 1995; Bradford and Gordon 1992; Stebbins and Cohen 1995). Environmental contaminants have been suggested, and in some cases documented, to negatively affect amphibians by causing the following: direct mortality (Hall and Henry 1992; Berrill *et al.* 1994, 1995; Carey and Bryant 1995; Relyea and Mills 2001); immune system suppression, which makes amphibians more vulnerable to disease (Carey 1993; Carey and Bryant 1995; Carey *et al.* 1999; Daszak *et al.* 1999; Taylor *et al.* 1999); disruption of breeding behavior and physiology (Berrill *et al.* 1994; Carey and Bryant 1995; Hayes *et al.* 2002); disruption of growth or development (Hall and Henry 1992; Berrill *et al.* 1993, 1994, 1995, 1998; Carey and Bryant 1995; Sparling *et al.* 2001); and disruption of the ability to avoid predation (Hall and Henry 1992; Berrill *et al.* 1993, 1994, 1995, 1998; Carey and Bryant 1995; Relyea and Mills 2001; Sparling *et al.* 2001).

Wind-borne pesticides and the compounds that carry pesticides from upwind agriculture that are deposited in the Sierra Nevada have been suggested as a cause of measured sublethal effects to amphibians (Cory *et al.* 1971; Davidson *et al.* 2001; Sparling *et al.* 2001). In 1998, more than 97 million kilograms (215 million pounds) of pesticides reported to be used in California (CDPR 1998). Originating from the agriculture in California's Central Valley, and mainly from the San Joaquin Valley where agricultural activity is greatest, pesticides are passively transported eastward to the high Sierra Nevada where they have

been detected in precipitation (rain and snow), air, dry deposition, surface water, plants, fish, and amphibians, including Pacific tree frogs and mountain yellow-legged frogs (Cory *et al.* 1970; Zabik and Seiber 1993; Aston and Seiber 1997; Datta *et al.* 1998; McConnell *et al.* 1998; LeNoir *et al.* 1999; Sparling *et al.* 2001; Angermann *et al.* 2002). Angermann *et al.* (2002) detected elevated contaminant (polychlorinated biphenyls and toxaphene) levels in Pacific tree frog larvae within the range of the mountain yellow-legged frog, and suggested that these contaminants originate in California's Central Valley and metropolitan areas. Spatial analysis of populations of the California red-legged frog (*Rana aurora draytonii*), foothill yellow-legged frog, Cascades frog (*R. cascadae*), and the mountain yellow-legged frog in the Sierra Nevada showed a strong, statistically significant pattern of population decline associated with greater amounts of upwind agriculture (Davidson *et al.* 2002).

Cholinesterase is an enzyme that functions in the nervous system and is disrupted by organophosphorus pesticides, including malathion, chlorpyrifos, and diazinon (Sparling *et al.* 2001). Reduced cholinesterase activity and pesticide residues have been found in Pacific treefrog larvae collected in the Sierra Nevada downwind of the Central Valley (Sparling *et al.* 2001). Cholinesterase activity was significantly lower in samples from the Sierra Nevada than in samples taken from coastal California, upwind of the Central Valley. No samples were taken above approximately 1,500 m (4,900 ft) elevation (Sparling *et al.* 2001), so in this study there is limited overlap with the 1,370 to 3,650 m (4,500 to 12,000 ft) elevational range (Stebbins 1985) of mountain yellow-legged frogs. Although pesticide detections decrease with altitudinal gain, they have been detected at elevations in excess of 3,200 m (10,500 ft) (Zabik and Seiber 1993; Aston and Seiber 1997; McConnell *et al.* 1998; LeNoir *et al.* 1999; Angermann *et al.* 2002). In addition to interfering with nerve function, contaminants such as industrial and agricultural chemicals may act as estrogen mimics (Jobling *et al.* 1996), causing abnormalities in amphibian reproduction and disrupting endocrine functions (Carey and Bryant 1995; Stebbins and Cohen 1995; Jobling *et al.* 1996; Hayes *et al.* 2002), thereby having a negative effect on amphibian populations, including the mountain yellow-legged frog.

In the late 1960s, dichlorodiphenyltrichloroethane (DDT)