

which may also adversely affect California tiger salamanders and their habitat. For example, there is no State regulation of nonnative fish stocking into California tiger salamander ponds and waters. Agencies and individuals may purchase (from CDFG-licensed fish breeders) and stock into such waters sunfish, catfish and other nonnative fish for recreational fishing. Similarly, there is no State regulation of western mosquitofish stocking into California tiger salamander ponds and waters by the approximately 50 mosquito abatement districts that routinely stock this mosquito predator as a means for mosquito control. In addition, the act of controlling burrowing small mammals in places where their burrows may be highly essential to California tiger salamander survival is not State-regulated and is, therefore, still widely and commonly practiced throughout the California tiger salamander's range.

Local

We are not aware of any specific county or city ordinances or regulations that provide protection for the Central California tiger salamander. The Central California tiger salamander may be indirectly benefitting from the increased attention being given to conversions of grasslands, oak woodlands, row-crops, and other agricultural uses to vineyards and orchards. At least three Counties (Sonoma, Napa, and Santa Barbara) have recently begun applying regulatory oversight to such conversions. This oversight is resulting in requirements for full-scale environmental analyses, restrictions on the steepness of slopes onto which vineyards may be established, and requirements for erosion control plans and measures. However, in the majority of the State's Counties in the Central California tiger salamander's range, conversions to vineyards and orchards is an unregulated agricultural activity with significant potential to adversely affect the Central California tiger salamander.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

Several other factors may also be causing direct or indirect adverse effects to California tiger salamanders or their habitat, including direct mortality while they are crossing roads, the species' extensive hybridization with nonnative salamanders, their exposure to various contaminants, the effects from rodent population control efforts, livestock grazing, and decreased population viability because of the species' small remaining population size.

Contaminants

Like most amphibians, California tiger salamanders inhabit both aquatic and terrestrial habitats at different stages in their life cycle, and are likely exposed to a variety of pesticides and other chemicals throughout their range. They are extremely sensitive to these pollutants due to their highly permeable skin which can rapidly absorb pollutant substances (Blaustein and Wake 1990). Toxins at lower than lethal levels may still have adverse effects, such as causing abnormalities in larva and behavioral anomalies in adults, both of which could eventually lead to lethal effects (Hall and Henry 1992; Blaustein and Johnson 2003). California tiger salamanders also could die from starvation due to the reduction or loss of their prey base from the use of pesticides. Sources of chemical pollution which may adversely affect California tiger salamanders include hydrocarbon and other contaminants from oil production and road runoff; the application of numerous chemicals for agricultural production; roadside maintenance activities; urban/suburban landscaping applications; and rodent and vector control programs.

Road mortality is not the only risk factor associated with roads, as oil and other contaminants in runoff have been detected in adjacent ponds and linked to die-offs and deformities in California tiger salamanders and spadefoot toads, and die-offs of invertebrates that form most of both species' prey base (S. Sweet, *in litt.* 1993). Lefcort *et al.* (1997) found that oil had limited direct effects on 5-week-old marbled (*A. opacum*) and tiger salamanders (*A. t. tigrinum*). However, salamanders from oil-contaminated natural ponds metamorphosed earlier at smaller sizes, and those from oil-contaminated artificial ponds had slower growth rates than larvae raised in uncontaminated ponds. Their studies did not address effects on eggs and early larval stages, where the effects may be more pronounced.

Hatch and Burton (1998) and Monson *et al.* (1999) investigated the effects of one component of petroleum products and urban runoff (fluoranthene, a polycyclic aromatic hydrocarbon) on spotted salamanders (*A. maculatum*), northern leopard frogs (*R. pipiens*), and African clawed frogs (*Xenopus laevis*). In laboratory and outdoor experiments, using levels of the contaminant comparable to those found in service stations and other urban runoff, the researchers found reduced survival and growth abnormalities in all species. The effects were worse when the larvae were

exposed to the contaminant under natural levels of sunlight, rather than in the laboratory under artificial light.

There are a number of records of California tiger salamanders using roadside ditches. Many are in areas where there are no known breeding ponds, and these animals are utilizing the only marginal habitat remaining. Also, many pools in these areas have likely been destroyed, leaving these marginal sites as the only option for breeding. In light of increased urbanization, along with concurrent increases in traffic, the risk factor associated with contaminants in runoff likely will increase in both roadside ditches and across the general landscape.

Agricultural and Landscaping Contaminants

During 2001, the 23 California Counties where California tiger salamanders may occur used over 47,627,160 kilograms (105 million pounds) of pesticide active ingredients (California Department of Pesticide Regulation (CDPR) internet website 2002). Chemicals included were metam-sodium, methyl bromide, mancozeb, petroleum oil, phosmet, chlorpyrifos, pendimethalin, parathion, paraquat dichloride, fosetyl-aluminum, acephate, cryolite, malathion, and other chemicals, some of which are extremely toxic to aquatic organisms, including amphibians and the organisms on which they prey. Some of these pesticides, such as chlorpyrifos, malathion, and endosulfen are cholinesterase inhibitors. Reduced cholinesterase activity has been linked to uncoordinated swimming, increased vulnerability to predation, depressed growth rates, and increased mortality in tadpoles (de Llamas *et al.* 1985; Rosenbaum *et al.* 1988; Bridges 1997; Berrill *et al.* 1998; Sparling *et al.* 2001).

Although there is some evidence that some amphibians may be affected by chemicals applied during the migration and dispersal seasons (Sparling *et al.* 2001), Davidson *et al.* (2001, 2002) were unable to find a significant overall relationship between upwind agriculture and the California tiger salamander's decline.

Rodent Control

California tiger salamanders spend much of their lives in underground retreats, often in California ground squirrel burrows (Loredo *et al.* 1996; Trenham 1998a), so widespread control of ground squirrels may pose threats to the salamander. California ground squirrel control, which began in the early 1900s (Marsh 1987), may be done