

that repeatedly lower breeding success in isolated ponds that are too far from other ponds for migrating individuals to replenish the population can quickly extirpate a population.

The total number of individual California tiger salamanders in Sonoma County is not known. The difficulty of estimating total California tiger salamander population size has been discussed by a number of biologists (Shaffer *et al.* 1993; Jennings and Hayes 1994). However, estimates have been made for a few populations in Monterey (Barry and Shaffer 1994; Trenham *et al.* 1998b). Because data on numbers of individual California tiger salamanders are lacking since these amphibians spend much of their lives underground, and because only a portion of the total number of animals migrate to pools to breed each year, the availability of suitable habitat and documentation of its loss is thus an appropriate method for assessing the status of the species.

The life history and ecology of the California tiger salamander on the Santa Rosa Plain in Sonoma County make it likely that this population has a metapopulation structure (Hanski and Gilpin 1991). A metapopulation is a set of local populations or breeding sites within an area, where typically migration from one local population or breeding site to other areas containing suitable habitat is possible, but not routine. Movement between areas containing suitable habitat (*i.e.*, dispersal) is restricted due to inhospitable conditions around and between areas of suitable habitat. Because many of the areas of suitable habitat may be small, and support small numbers of salamanders, local extinction of these small units may be common. A metapopulation's persistence depends on the combined dynamics of these local extinctions and the subsequent recolonization of these areas by dispersal (Hanski and Gilpin 1991, 1997; McCullough 1996; Hanski 1999).

We believe habitat loss has reduced the sizes and connectivity between patches of suitable and occupied salamander habitat on the Santa Rosa Plain. The reduction in the extent and amount of suitable water bodies, grasslands, and other suitable upland habitats likely has eliminated connectivity among most of the known breeding sites, making recolonization of some sites more difficult following local extinction. In addition, the reduction of habitat below a certain size threshold has the effect of reducing the quality of the remaining habitat by reducing the size of habitat boundaries, and making effects of other factors such as amount

of food, availability of rodent burrows, pesticide use, mortality from vehicles, and predators more pronounced given the smaller area now exposed to such impacts. We do not have enough data to determine what the size threshold for habitat might be, whereby any further reduction would lower the quality of the remaining habitat. The acreage is probably dependent on factors such as the type of building occurring along habitat boundaries (*i.e.*, residential, industrial, community park), number of roads bordering the habitat and the amount of traffic those roads experience, amount of pesticide use within the breeding pool watershed, or whether domestic animals or people have access to the site during periods when salamanders are vulnerable, such as migrating to or from estivation sites. We believe there is a size threshold for habitat below which the combination of various impacts will result in the loss of more salamanders than the Sonoma County California tiger salamander population can produce, and thus local extinction will occur.

Distinct Vertebrate Population Segment

Under the Act, we must consider for listing any species, subspecies, or, for vertebrates, a DPS of these taxa, if there is sufficient information to indicate that such action may be warranted. To implement the measures prescribed by the Act and its Congressional guidance, we, along with the National Marine Fisheries Service, developed policy that addresses the recognition of DPSs for potential listing actions (61 FR 4722). The policy allows for a more refined application of the Act that better reflects the biological needs of the taxon being considered, and avoids the inclusion of entities that do not require its protective measures. Under our DPS policy, we use two elements to assess whether a population segment under consideration for listing may be recognized as a DPS. The elements are: (1) The population segment's discreteness from the remainder of the species to which it belongs; and (2) the significance of the population segment to the species to which it belongs. If we determine that a population segment being considered for listing represents a DPS, then the level of threat to that population segment is evaluated based on the five listing factors established by the Act to determine if listing it as either threatened or endangered is warranted.

Discreteness

A population segment of a vertebrate species may be considered discrete if it satisfies either one of the following two conditions: (1) It is markedly separated

from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.); or (2) it is delimited by international governmental boundaries within which significant differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist.

The Sonoma County California tiger salamander is discrete in relation to the remainder of the species. The population is geographically isolated and separate from other California tiger salamanders. The Sonoma County population is widely separated geographically from the closest populations, which are located in Contra Costa, Yolo, and Solano counties. These populations are separated from the Sonoma County population by the Coast Range, Napa River, and the Carquinez Straits, at a minimum distance of about 72 km (45 mi). There are no known records of the California tiger salamander in the intervening areas (D. Warenczyk, CDFG, pers. comm., 2002). We have no evidence of natural interchange of individuals between the Sonoma County population and other California tiger salamander populations. As detailed below, this finding is supported by an evaluation of the genetic variability of the species.

Dr. H. Bradley Shaffer has analyzed the population genetics of the California tiger salamander (Shaffer *et al.* 1993; Shaffer and Trenham 2002). The most recently available and most comprehensive mitochondrial DNA (mtDNA) sequence data indicate that there are six populations of California tiger salamander; these six populations are distinguished from one another by their mtDNA characteristics (Shaffer and Trenham 2002). Shaffer *et al.* 1993 reported that the sequence divergence (a percentage indicating the difference among DNA sequences studied) between the Sonoma County population was found to diverge on the order of 2 percent from other populations of this species. This high level of genetic divergence indicates that there has been little, if any, gene flow for a significant period of time between the Sonoma County population and other California tiger salamander populations. These results are supported by additional sampling and mtDNA work of Shaffer and Trenham (2002). The "first, deepest and most significant phylogenetic split within California tiger salamander samples is between Sonoma County and all others" (H.B. Shaffer, University of