

species must provide for movement within and between vernal pool complexes to provide for the varying nature and expression of vernal pool species, and also allow for gene flow and dispersal and habitat availability that accommodate natural processes of local extirpation and colonization over time (Stacey and Taper 1992; Falk *et al.* 1996; Davies *et al.* 1997; Husband and Barrett 1998; Holt and Keitt 2000; Keymer *et al.* 2000; Donaldson *et al.* 2002).

(4) In cases where more occupied areas were present than were needed for the conservation of the geographic or ecological distribution of the species, we gave priority to areas which already possessed a measure of protection or which possessed the largest unfragmented vernal pool complexes. Other criteria being equal, such areas are likely to contribute more to the conservation of the species because threats posed by habitat fragmentation are more easily minimized within them. Small, isolated habitat populations are more likely to be extirpated by direct or indirect natural or human impacts (Fahrig 1997; Noss and Csuti 1997; Debinski and Holt 2000; Grosberg 2002; Noss *et al.* 2002a), and are less likely to maintain the hydrological processes of pooling and drying on which the vernal pool species depend.

Based on these criteria, we determined that all currently known extant occurrences of the 11 vernal pool plants and 2 of the 4 vernal pool crustaceans (Conservancy fairy shrimp and longhorn fairy shrimp) are essential to the conservation of the species, due to their limited geographic and ecological distributions (criteria 1 and 2), low overall number of populations (criterion 1), and the seriousness of the threats posed to remaining populations, including fragmentation of habitat. For the other two vernal pool crustaceans (vernal pool fairy shrimp and vernal pool tadpole shrimp), we were able to meet the criteria listed above without designating all occupied areas.

Special Management Considerations

In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are

consistent with conservation objectives for these species.

Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Even the best-designed vernal pool preserve may still be susceptible to alterations that render it unsuitable for vernal pool species. Many of the factors that cause the decline and localized extirpation of vernal pool species can be controlled through special management actions. Examples of special management actions that may be necessary to prevent further declines and loss of populations of species addressed in this rule include the following:

(1) Actions to prevent or reduce competition of vernal pool plants with invasive species. Many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDDB 2001). Special management actions can be taken to reduce the negative effects of such invasions. For example, grazing can be effectively used to control a variety of upland exotic plants. However, the timing and intensity of grazing is critical to its success as a management tool, and these factors should be closely monitored. Alternatively, inappropriate grazing can also pose a threat to many of the vernal pool plant species (CNDDDB 2001). Prescribed burning is another management tool that may be effective in controlling nonnative plant species (Pollack and Kan 1998).

Fire must be appropriately timed, and fire frequency is important. The potential for alteration of nutrient cycling must be also considered. Other management techniques for control of invasive species include mowing, hand removal, and selective herbicide applications. Any technique employed must be carefully controlled and monitored to ensure that it does not negatively affect the vernal pool species.

(2) Actions to restore vernal pool hydrology. Alteration of natural hydrology threatens many of the species addressed in this rule (CNDDDB 2001). In many cases other threats, such as the invasion of nonnative species or contamination, are facilitated by alterations of natural vernal pool hydrology. Special management actions, such as the removal of dams or other structures that artificially increase the length of vernal pool inundation, the removal of ditches that artificially drain vernal pools, or the construction of berms or reconstruction of culverts to

prevent water from flowing artificially into vernal pools from adjacent areas, can be taken to restore natural vernal pool hydrology. Modification of grazing regimes may also restore natural vernal pool hydrology (Barry 1998). Monitoring of vernal pool hydrology is important to ensure that restoration actions are successful.

(3) Actions to reduce human degradation of vernal pools. Special management actions such as fencing, trail building, and posting signs can help to reduce human activities that threaten vernal pool species. These actions may reduce the damage resulting from off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

(4) Actions to restore severely degraded habitats. Active restoration of highly degraded vernal habitats may be necessary in some areas. Such restoration may involve earth-moving activities designed to restore historic pool and swale topography and to reestablish natural vernal pool hydrology (Ferren and Hubbard 1998; Black and Zedler 1998). These types of actions are extremely complex, and require diligent planning and monitoring to ensure their success. Active restoration is only recommended for seriously degraded habitats that otherwise would not maintain natural vernal pool ecosystem processes.

Critical Habitat Designation

The approximate area of critical habitat by county and land ownership is shown in Tables 1 and 2. Because many of the units of overlap due to species occurrences within the same area, the total of all critical habitat designated is much less than the sum of critical habitat areas for each species. Lands designated are under private, State, and Federal ownership and divided into 125 Critical Habitat Units. The tables provide separate columns for privately owned land subject to conservation easements or agreements and other privately owned lands. The amount of land area identified as critical habitat for vernal pool tadpole shrimp unit 15, Butte County meadowfoam unit 3, San Joaquin Valley Orcutt grass unit 2, and Contra Costa goldfields unit 3, differ from those identified in the tables due to changes in the GIS coverages used to calculate those areas. The total amount of critical habitat for all species is not affected.

Table 1. Approximate areas of critical habitat for the vernal pool crustaceans and plants in California and Oregon.