U.S. Fish & Wildlife Service

Draft Recovery Plan for the Santa Rosa Plain

Blennosperma bakeri
(Sonoma sunshine)

Lasthenia burkei
(Burke's goldfields)

Limnanthes vinculans
(Sebastopol meadowfoam)

Sonoma County Distinct Population Segment
of the California tiger salamander
(Ambystoma californiense)

Lasthenia burkei
Jo-Ann Ordano
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Blennosperma bakeri
J. E. (Jed) and Bonnie McClellan
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Limnanthes vinculans
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Sonoma County California Tiger Salamander
Gerald Corsi and Buff Corsi
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California tiger salamander
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(Ambystoma californiense)

2014

Region 8
U.S. Fish and Wildlife Service
Sacramento, California

Approved: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Regional Director, Pacific Southwest Region, Region 8,
U.S. Fish and Wildlife Service

Date: XXXXXXXXXXXXXXXXXXXX

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LITERATURE CITATION SHOULD READ AS FOLLOWS:

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An electronic copy of this draft recovery plan is available at:
http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=D01T

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Executive Summary

CURRENT SPECIES STATUS

We listed *Blennosperma bakeri* (Sonoma sunshine), *Lasthenia burkei* (Burke's goldfields), and *Limnanthes vinculans* (Sebastopol meadowfoam) as endangered in 1991 (56 **FR** 61173). The State of California also listed these species as endangered (*L. burkei* and *L. vinculans* in 1979 and *B. bakeri* in 1992) (CDFW 2014). We listed the Sonoma County California tiger salamander, which we identified as a distinct population segment (DPS), as endangered in 2003 (68 **FR** 13497). In 2011, we published a final rule designating critical habitat for the Sonoma County California tiger salamander (76 **FR** 54346). The State of California listed the California tiger salamander as threatened state-wide in 2009 (CDFW 2009). The Central California tiger salamander and the Santa Barbara California tiger salamander are federally listed; however, they are considered distinct entities (as DPSs), and are not addressed in this plan.

HABITAT REQUIREMENTS AND LIMITING FACTORS

These species occur predominantly on the Santa Rosa Plain, which is located in central Sonoma County, California, and is characterized by seasonal wetlands, predominately in the form vernal pools, and associated upland grassland habitat. Vernal pools form in depressions having a shallow, impermeable soil layer that restricts the downward movement of water. The pools have an outlet barrier that further causes ponding (CH_2M Hill 1995) and may be connected and fed by shallow drainage pathways called "swales". Vernal pools generally fill during winter rains and dry in late spring or summer. "Natural" vernal pools are those that are found occurring naturally in the landscape. "Created" vernal pools are those that have been constructed in an area that was not a vernal pool in the recent past (within the last 100 to 200 years) and that is isolated from existing vernal pools (U.S. Environmental Protection Agency 2005)[1]. The listed plants grow only in seasonal wetlands. The Sonoma County California tiger salamander uses seasonal wetlands during the breeding season, and the surrounding uplands year-round.

The threats to *Blennosperma burkei*, *Lasthenia bakeri*, and *Limnanthes vinculans,* and the Sonoma County California tiger salamander that led to their listing as endangered are many-fold. These are discussed in Section II in detail, but the primary threats are the modification and destruction of suitable habitat due to urbanization, agricultural conversion, and competition with non-native plants. In addition to habitat loss, the fragmented condition of remaining Sonoma County California tiger salamander habitat restricts migration between aquatic breeding sites and upland non-breeding habitat, along with dispersal among aquatic breeding sites (Cook *et al.* 2005). Since 1991, these threats have continued to such an extent that many populations of the

[1] Vernal pool creation is considered an experimental science because the extent to which entire vernal pool plant and invertebrate communities can be successfully recreated is still unknown (M. Showers, CDFW, *in litt*, 2005).

listed plants and salamander appear to have been extirpated or severely reduced in numbers.

RECOVERY PRIORITY

Recovery priority numbers for listed species addressed in this recovery plan are determined per criteria published in the Federal Register (Service 1983) and are based on degree of threat, degree of conflict with construction or other development projects or other economic activity, recovery potential, and taxonomy. The recovery priority number for *Blennosperma bakeri* is 5C, meaning it is a full species exposed to a high degree of threat and conflict, with a low potential for recovery. *Lasthenia burkei* and *Limnanthes vinculans* are ranked 2C, meaning they are full species, are exposed to a high degree of threat and conflict, and have a high potential for recovery. The Sonoma County California tiger salamander is ranked as a 3C, indicating that this DPS faces a high degree of threat and conflict, and has a high potential for recovery.

RECOVERY STRATEGY, GOAL, OBJECTIVES, CRITERIA AND ACTIONS NEEDED

The species covered by this recovery plan, *Blennosperma bakeri*, *Lasthenia burkei*, *Limnanthes vinculans*, and the Sonoma County California tiger salamander, have naturally limited geographic ranges, and are further constrained by inhabiting naturally rare habitat within that geographic range. Because the main cause of the decline and the main current threat to all species is the loss and degradation of habitat, our recovery strategy focuses upon this threat. We will achieve recovery of these species by preserving high-quality habitat that provides essential connectivity, reduces fragmentation, and sufficiently buffers against encroaching development. Management of these preserved areas will provide additional protection to the habitat, and address non-habitat related threats. Surveys and habitat assessments (where data are lacking) will be conducted, as well as essential research to refine our knowledge on the recovery needs of the species. Additionally, habitat restoration (and potentially reintroductions) is necessary to provide additional populations to protect unique genetic diversity.

ESTIMATED DATE AND COST OF RECOVERY:

Date: 2065
Cost: $ 463 million

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I. Introduction

A. OVERVIEW

1. The Santa Rosa Plain Ecosystem

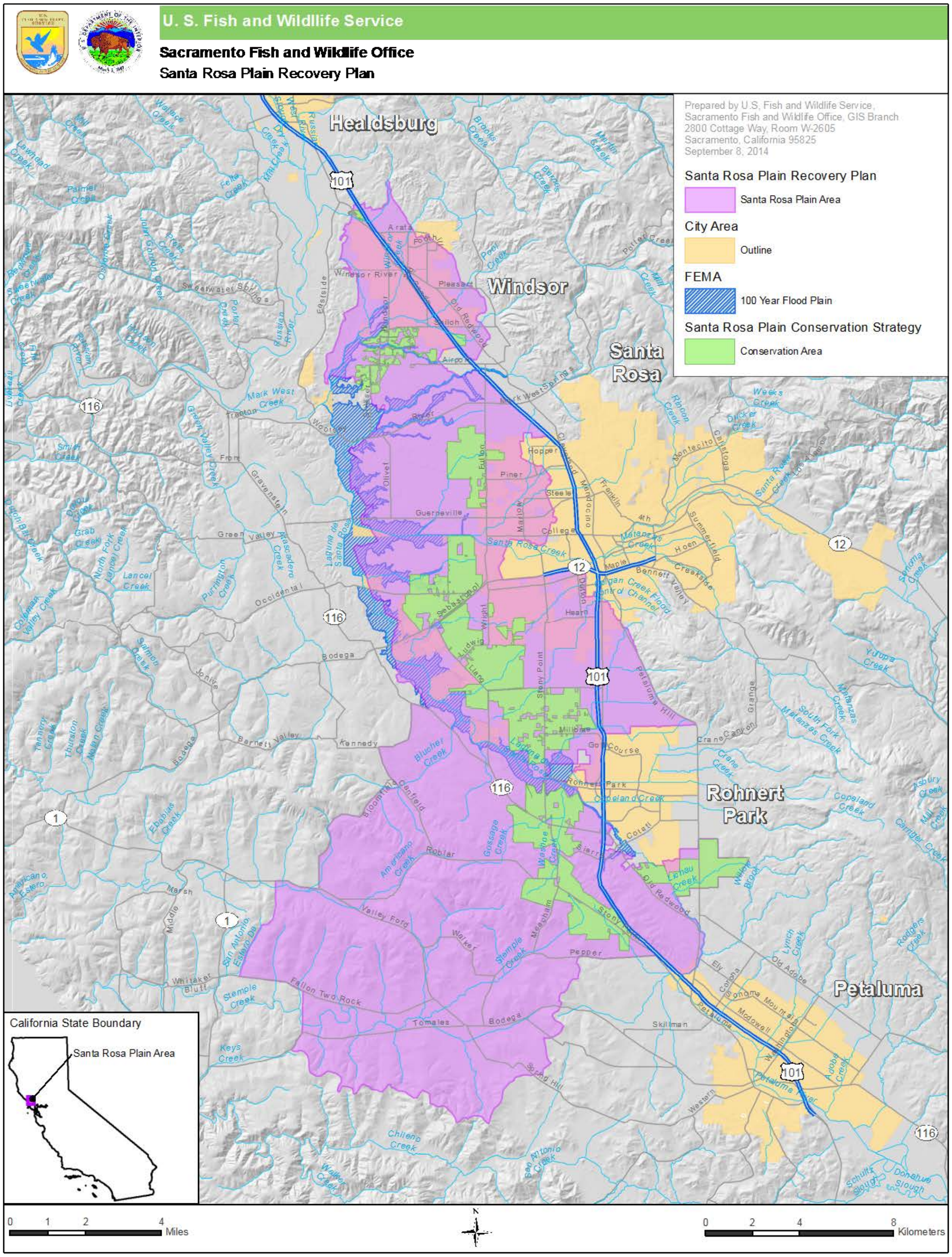
The Santa Rosa Plain (Plain) is located in central Sonoma County, California, bordered on the south and west by the Laguna de Santa Rosa, on the east by the Coast Range foothills, and on the north by the Russian River. The Plain and adjacent areas are characterized by seasonal wetlands and associated grassland habitat, which support – among other flora and fauna – three endangered plant species: *Blennosperma bakeri* (Sonoma sunshine)*; Lasthenia burkei* (Burke's goldfields); and *Limnanthes vinculans* (Sebastopol meadowfoam), and the endangered Sonoma County DPS of the California tiger salamander (*Ambystoma californiense;* Sonoma County California tiger salamander). These listed plants grow only in seasonal wetlands. The Sonoma County California tiger salamander requires seasonal wetlands for breeding, and the surrounding uplands (upland habitat) for dispersal, feeding, growth, maturation and maintenance of the juvenile and adult population. The distribution of *Blennosperma bakeri*, *Lasthenia burkei*, and *Limnanthes vinculans*, and the Sonoma County California tiger salamander is confined almost entirely to the Plain. This recovery plan focuses on the Sonoma County California tiger salamander and the three listed plant species. Although the present ranges of these species are predominantly located on the Plain, the area covered by this plan includes all known locations of the species, some of which are outside of the Plain. Figure 1 shows the Plain portion of the area covered by this plan.

2. Existing Threats To Listed Species Of The Santa Rosa Plain

Growth of the human population on the Plain has taken place for over 100 years. For the past 20 years, the encroachment of high- and low-density urban growth into areas inhabited by the Sonoma County California tiger salamander and the listed plants has intensified. The loss of seasonal wetlands to development has led to population declines for all these species. Voters in local municipalities have established urban growth boundaries for their communities. This is intended to accomplish the goal of city-centered growth, resulting in conservation of rural and agricultural land uses between the urbanized areas. Nevertheless, areas within the defined urban growth boundaries include lands currently inhabited by Sonoma County California tiger salamander and the listed plant species. This urban growth continues to threaten occurrences of these listed species.

While it is reasonable to expect that rural land uses will continue into the foreseeable future, the nature of such use has bearing on habitat quality for the listed plants and Sonoma County California tiger salamander. While ongoing agricultural practices

Figure 1. Santa Rosa Plain Portion of Recovery Planning Area



have disturbed seasonal wetlands on the Plain, certain agricultural practices, such as irrigated or grazed pasture, have protected habitat from intensive development and are compatible with persistence of these listed species. However, conversion of pastures to vineyards is a current threat of high magnitude.

B. SCOPE OF THE RECOVERY PLAN

1. Focal Listed Species

Santa Rosa Plants

Blennosperma bakeri, *Lasthenia burkei,* and *Limnanthes vinculans* were federally listed as endangered in 1991 (56 **FR** 61173). The California Fish and Game Commission also listed these species as endangered (*L. burkei* and *L. vinculans* in 1979 and *B. bakeri* in 1992) (CDFW 2014). The California Native Plant Society considers these three plants to be rare and endangered throughout their range and currently includes them on List 1B (which consists of plants that are rare, threatened, or endangered in California and elsewhere) (California Native Plant Society 2001). No critical habitat has been designated for these species.

Sonoma County California Tiger Salamander

On July 22, 2002 (67 **FR** 47726), we emergency listed the Sonoma County California tiger salamander, determining it is a distinct population segment (DPS) and was endangered. Emergency listings are in effect for a maximum of 240 days, and we issued a final rule to list this species as endangered on March 19, 2003 (68 **FR** 13497). A DPS is designated based upon a population segment's discreteness from the remainder of the species to which it belongs and the significance of the population segment to the species to which it belongs. On August 4, 2004, we subsequently reclassified the Sonoma County California tiger salamander to threatened (69 **FR** 47211). It was reinstated as endangered by court order on August 19, 2005. On August 31, 2011 we published a final rule designating critical habitat for the Sonoma County California tiger salamander (76 **FR** 54346). In total, approximately 47,383 acres (ac) of land are designated as critical habitat. The California tiger salamander is listed under the California Endangered Species Act (CESA) as threatened state-wide (CDFG 2010).

2. Recovery Priority

Recovery priority numbers are determined based on a 1 to 18 ranking system where 1 represents the highest-ranked recovery priority and 18 represents the lowest-ranked recovery priority (48 **FR** 43098). This ranking system considers the degree of threat to the listed entity, the recovery potential of the listed entity, and taxonomic status of the listed entity. Further, a "C" indicates conflict with construction or other development projects or other forms of economic activity. The recovery priority number for *Blennosperma bakeri* is 5C. This species is considered to be exposed to a high degree of threat and to have a low potential for recovery. *Lasthenia burkei* and *Limnanthes vinculans* are ranked as 2C. These two species are considered to be exposed to a high degree of threat, but to have a high potential for recovery. The

Sonoma County California tiger salamander is ranked 3C. This number indicates that the DPS faces a high degree of threat and has a high potential for recovery. The three plants and the Sonoma County California tiger salamander are considered to be in conflict with construction or other development projects or other forms of economic activity.

II. Species Accounts

A. *BLENNOSPERMA BAKERI* (SONOMA SUNSHINE)

1. Description and Taxonomy

Blennosperma bakeri is an annual plant in the aster family. It has been known by the scientific name *Blennosperma bakeri* (Heiser) since it was first described by Heiser (1947). Two other species are recognized in this genus; *B. nanum* (dwarf blennosperma) grows in California and *B. chilense* (Chilean blennosperma) occurs in Chile (Baldwin 2012).

Blennosperma bakeri plants are less than 30 centimeters (cm) (11.8 inches (in)) tall with alternate, linear leaves (Ornduff 1977*a*, Baldwin 2012). The leaves have smooth margins and are 5.1 to 15.2 cm (2.0 to 6.0 in) long with zero to five lobes (Baldwin 2012).

From March to May, the plants have a butter-yellow, daisy-like flower head at the tip of each branch. Each flower head is less than 1.5 cm (0.6 in) across. The 6 to 15 outer petals are 5 to 7 millimeters (mm) (0.20 to 0.28 in) long. Occasionally the flowers may be white instead of yellow. The pollen is white.

The flowers produce tapered achenes (dry, one-seeded fruits) that are 3 to 4 mm (0.12 to 0.16 in) long and have 4 to 6 sharp angles along the sides. The achenes are covered with tiny bumps and become slimy when wet giving the species one of its common names, "Baker's sticky seed" (Ornduff 1963, Munz and Keck 1968, Ornduff 1977*a*, Baldwin 2012).

2. Distribution and Abundance

Blennosperma bakeri occurs only in Sonoma County. In the Santa Rosa area, the species ranges from near the community of Windsor in the north to Rohnert Park in the south. Additionally, the species extends or historically extended from near Glen Ellen to near the junction of State Routes 116 and 121 in the Sonoma Valley, located just west of the Town of Sonoma. The type specimen (an individual specimen used as a basis for describing the species) of *Blennosperma bakeri* was discovered in 1946, not in the Santa Rosa Plain, but in the Sonoma Valley, just west of Sonoma (Ornduff 1963).

The majority of native occurrences (i.e., occurrences that formed naturally rather than by human intervention and planting of seeds) reported in the California Natural Diversity Database (CNDDB 2013), Adopt-a-Vernal Pool (AVP) records, and information from species experts, occur on the Santa Rosa Plain (see Figure 3). In addition, *B. bakeri* has been introduced to at least 12 sites during mitigation activities or to establish conservation banks within the historical range of the species. At least two

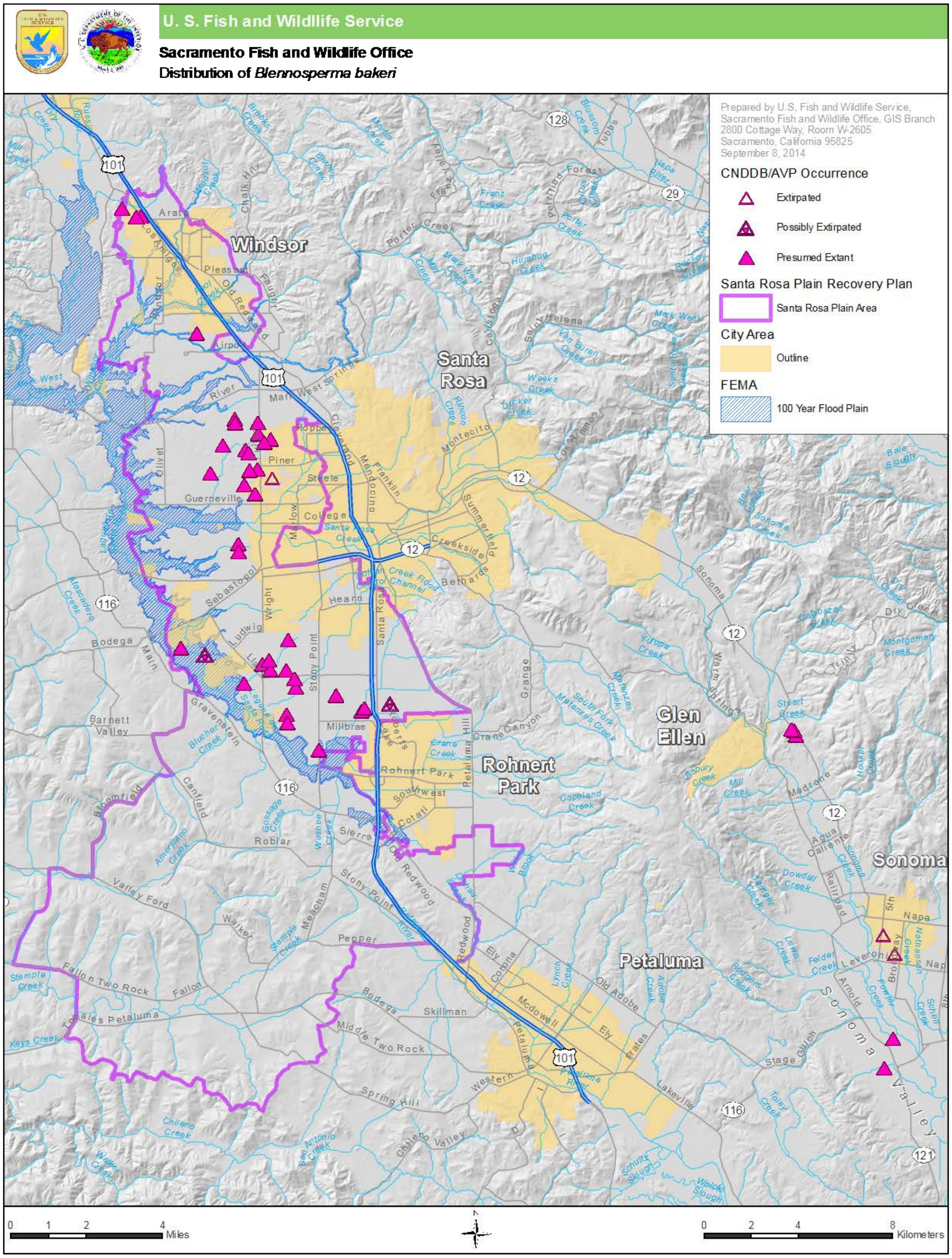
Figure 2. Photograph of *Blennosperma bakeri* (Sonoma sunshine)

Hattie Brown © 2014 Laguna de Santa Rosa Foundation
Yellow and white forms of *Blennosperma bakeri*

occurrences within or near the City of Santa Rosa and two occurrences, including the type locality (the site at which the type specimen was collected), in the City of Sonoma have been extirpated by grading for urban development and wastewater irrigation that resulted in altered hydrology and invasion by non-native plants (CNDDB 2013).

At the time of listing in 1991 (56 **FR** 61173), *Blennosperma bakeri* was documented from no more than 35 sites in the Santa Rosa area and 7 sites from the Sonoma Valley. The most current occurrence information shown on Figure 3 and in Table 1, documents the presence of 18 extant occurrences and five extirpated or possibly extirpated occurrences. Some occurrences have been fragmented into multiple locations, each of which is represented by a triangle on the map; therefore, more than 18 solid triangles are shown on the map for *B. bakeri*. As with all the three listed plant species addressed in this plan, the CNDDB defines an occurrence as a location occupied by the species that is separated by at least one-fourth mile from other locations of the species that contain populations, individuals, or colonies. Locations that are less than one-fourth mile apart can be considered to be a single occurrence and may contain one or more populations. A "population" is defined as a group of organisms of one species, occupying a defined area small enough to permit interbreeding among all members of the group, and isolated to some degree from other members of the same species (Barbour *et al.* 1987, Lincoln 1993). For

Figure 3. Distribution of *Blennosperma bakeri* (Sonoma sunshine)



this recovery plan, we are applying the CNDDB definition of "occurrence" to locations contained in the CNDDB, in the Adopt-a-Vernal Pool records, and information from species experts.

Populations exhibit extreme fluctuations in size among years, often varying by one or two orders of magnitude (CNDDB 2013). Individual occurrence sizes ranged over time from fewer than 100 plants to more than 1.5 million plants (CNDDB 2013). Collection of annual abundance data has been sporadic; therefore, determination of population trends is difficult. Years of peak abundance are often associated with copious rainfall, especially when storms occur at regular intervals throughout the growing season, whereas years of minimal abundance are typically drought years.

Table 1. Occurrences of *Blennosperma bakeri*[2]

Occurrences of *Blennosperma bakeri*	
CNDDB Occurrence No.	**Location**
2	Sonoma Valley
3 Extirpated	Town of Sonoma, type locality
5	Sonoma Valley Regional Park, east of Glen Ellen
6	Northwest of Santa Rosa
7 Possibly extirpated	East of Sebastopol
8	East of Sebastopol
9	West of Santa Rosa
10	West of Santa Rosa, near Piner Road
12	North of Laguna de Santa Rosa
13 Extirpated	Santa Rosa
15	West of Santa Rosa
16	South of Santa Rosa
17	South of Santa Rosa
18 Possibly extirpated	South of Santa Rosa
20	Northwest of Rohnert Park
22 Extirpated	West of Highway 12, Town of Sonoma
24	Northwest of Santa Rosa
29	North of Rohnert Park, west of Highway 101
32	Sonoma County Airport
33	Between Santa Rosa and Healdsburg
35	Bouverie Preserve, east of Glen Ellen
36	Hazel Preserve
37	Slippery Rock Mitigation Bank

[2] Occurrence identification numbers in CNDDB may change as new information reveals that some occurrences should be combined due to proximity. Combining or deleting of occurrence identification numbers has resulted in non-sequential numbering of CNDDB occurrences as seen in the Occurrences Tables for all three plant species.

The range of *Blennosperma bakeri* known at the time of listing has increased to the north by approximately 6 miles due to the discovery of an occurrence near the Town of Windsor (CNDDB 2013). Habitat fragmentation continues near Windsor (P. Chamberlin, Town of Windsor, pers. comm., 2008b). Although the 1991 listing notes that the estimated maximum number of occurrences at that time, no more than 35 sites in the Santa Rosa area and 7 sites from the Sonoma Valley, these numbers were based on an incongruous or inconsistent compilation of reports from several sources, as well as other information (Service 1991). No comprehensive, consistent surveys had been done for the species at the time of listing; therefore, the historical total number of occurrences and subsequent amount of loss is not known.

A 2009 study by Sloop and Ayres found that moderate genetic diversity existed among the occurrences of *Blennosperma bakeri* on the Santa Rosa Plain. A Sonoma Valley occurrence, however, was clearly genetically distinct from all of the Santa Rosa occurrences likely due to its isolation by a distance of approximately 20 kilometers (km) (12.4 miles (mi)) and resultant lack of interbreeding with Santa Rosa Plain plants (Sloop and Ayres 2009). Maintaining the breadth of genetic diversity by protecting occurrences that are genetically distinct is important for the species' ability to adapt to the effects of climate change.

3. Habitat

Blennosperma bakeri grows in vernal pools, the grassy margins of swales (shallow channels that connect vernal pools), and seasonally wet grasslands at elevations ranging from 9 to 101 meters (m) (30 to 330 feet (ft)) in the Sonoma Valley and between 21 to 43 m (70 to 140 ft) on the Santa Rosa Plain (Baldwin 2012, CNDDB 2014). The vernal pools supporting *B. bakeri* are of two types: northern hardpan (Sawyer and Keeler-Wolf 1995) and an unclassified type loosely referred to as northern vernal pools (Keeler-Wolf *et al.* 1998). On the Santa Rosa Plain, vernal pools and swales are found within valley oak woodlands and north coastal prairie grasslands (CH_2M Hill 1995, CDFG 2002). *Blennosperma bakeri* typically grows in shallow vernal pools, 30 to 50 cm (12 to 20 in) deep, and in swales (Patterson 1991, Patterson *et al.* 1994, CNDDB 2013). It may occur in swale bottoms, but more commonly grows near the upper edges (margins) or high-water lines of vernal pools. This pattern could be due to competition or dispersal patterns. This species typically is more abundant in portions of vernal pools and swales which lack dense cover by non-native plants, matted leaf litter, or algal mats.

Throughout its range, *Blennosperma bakeri* occurs in vernal pools on nearly level to slightly sloping loams, clay loams, and clays. A clay or hardpan layer typically occurs 0.6 to 0.9 m (2 to 3 ft) below the surface and restricts downward movement of water (USFWS 1991). The two disjunct groupings of *Blennosperma bakeri* occurrences on the Santa Rosa Plain occur on different soil types (Patterson *et al.* 1994). *Blennosperma bakeri* primarily grows on Huichica loam north of Highway 12 and on Wright loam and Clear Lake clay south of Highway 12 (Patterson *et al.* 1994). Huichica loam is a fine-textured clay loam over buried, dense clay and cemented layers. Wright loam is a fine silty loam over buried, dense clay and marine sediments. Clear Lake clay is hard, dense clay extending downwards from the surface (Patterson *et al.* 1994).

4. Reproduction and Ecology

Blennosperma bakeri is an annual; its entire life cycle from seed germination to seed set is completed in a single growing season. In nature, *B. bakeri* seeds germinate in the fall following heavy rains, and the plants can grow even when submerged (Patterson *et al.* 1994). The specific conditions that trigger seed germination in nature are not known, but *B. bakeri* seeds can germinate in as little as 3 days after wetting in the greenhouse. Seeds that were collected on the Santa Rosa Plain in 1989 and 1990, and maintained in cold storage, germinated readily when they were covered with a thin layer of soil and moistened (Mistretta *in litt.* 1991). A large percentage of seed (78 percent to 98 percent) germinated in such tests. This species usually blooms before other vernal pool plants such as *Limnanthes* spp. (meadowfoam), *Downingia* spp. (downingia), and *Lasthenia* spp. (goldfields) (Thorp and Leong 1998).

Blennosperma bakeri typically flowers in March and April (Munz and Keck 1968, Ornduff 1977*a*) but has been observed in flower as early as December (Ashley and Waaland 1990) and as late as mid-May (Patterson *et al.* 1994). The achenes probably mature by early summer (May and June) as adult plants die, as is true for the closely related dwarf blennosperma (*B. nanum*) (Ornduff 1963). Dispersal mechanisms for the achenes have not been studied. However, seed dispersal of *B. nanum* var. *nanum*, a species that occupies similar habitat to *B. bakeri*, was found by Ornduff (1964) to be within a small radius of the parent plants based on the area occupied by flower-color variants.

Like many other plants native to vernal wetlands, *Blennosperma bakeri* likely forms a persistent soil seed bank. Small populations of *B. bakeri* (those with fewer than 500 adult plants) are likely to remain dormant in the seed bank, and therefore undetected, during years of unfavorable conditions. For example, an occurrence located 5 miles south of El Verano in Sonoma Valley was considered to be extirpated in 2008; however, plants were observed at the site in 2011 and the occurrence is now considered extant (CNDDB 2013). Therefore, caution should be used before declaring that an occurrence of this species has been extirpated. The longevity of dormant *B. bakeri* seeds is not known. In a seedbank study of *B. bakeri* and *Limnanthes vinculans* by Sloop and Brown (2012b), *B. bakeri* seed was found from the soil surface to a depth of 7.6 cm (3 in); however, the majority of *B. bakeri* seed was found at the soil surface. Although only one vernal pool was sampled for each species, the results suggest that the amount of *B. bakeri* seed in the seed bank was substantially smaller than that of *L. vinculans* -- 165,000 *B. bakeri* seeds compared to 6 million *L. vinculans* seeds were estimated for the entire pool seedbank.

A pollinator study by Gilmore *et al.* (2012) showed that, of the three plant species in this Plan, *Blennosperma bakeri* had the most diverse pollinator community due to the higher number of generalist native bees visiting the plants. A diverse pollinator community benefits a plant species by reducing the risk of insufficient pollination and seed set as a result of pollinator loss (Gilmore, *in litt.*, 2014). The most abundant native pollinator of *B. bakeri* was the solitary bee, *Andrena blennospermatis*. Solitary bees are mostly native bees that do not form colonies. Each female bee constructs its own nest most commonly in tunnels in the ground. Other pollinators that visited *B. bakeri* included *Apis mellifera* (European honeybee), four species of generalist native bees, and syrphid flies. In the vernal pools that supported *B. bakeri,* solitary bees were more abundant in natural vernal pools than in created pools (Gilmore *et al.* 2012).

Only certain aspects of the demography of *Blennosperma bakeri* have been studied. The total number of achenes produced per plant varies because the number of flower heads is not consistent. Under dry conditions, or in dense populations, *B. bakeri* may bear only a single flower head per plant (Patterson *et al.* 1994), thus producing a maximum of 15 achenes. However, when pools dry and fill repeatedly in a single growing season, each plant may produce as many as 20 flower heads (Patterson *et al.* 1994), with potential for 300 achenes per plant. Seed dispersal mechanisms are not known.

As an annual species, it is expected that *Blennosperma bakeri* will respond to environmental stochastic events, such as changes in vegetative composition, climate, and disturbance, by partial germination of its seed bank. Baskin and Baskin (1998) indicate that species that are adapted to "risky environments" produce persistent seed banks to offset years of low reproductive success and to ensure the species can persist at a site without immigration. Considering the adaptations of these plants to a variable Mediterranean climate, it is likely that the seed of *B. bakeri* can persist in the seed bank for an undetermined number of years. Although formal studies of seed viability have not been conducted for this species, it is reasonable to expect its seed bank may persist for extended periods without germination until conditions are favorable to allow germination. Seeds of this species have been stored artificially for up to 6 years with little loss of viability, but those stored for 10 or more years have not germinated (Patterson *in litt*. 2000). The maximum duration of viable seed in the soil is not known, however, smaller seeds, such as those produced by *B. bakeri*, tend to withstand longer periods of dormancy than larger seeds.

Common, native associates of *Blennosperma bakeri* include *Blennosperma nanum* (common stickyseed), *Pleuropogon californicus* (semaphore grass), *Ranunculus lobbii* (Lobb's buttercup), *Lasthenia glaberrima* (smooth goldfields), and *Juncus* spp.(rushes) (CH_2M Hill 1995; Pavlik *et al.* 1998, 2000, 2001; CNDDB 2013).

Non-native plant species commonly associated with *Blennosperma bakeri* include annual Mediterranean grasses such as *Hordeum murinum* (foxtail barley) and *Festuca perennis* (Italian ryegrass), and broad-leaved herbs such as *Rumex crispus* (curly dock), *Erodium* sp. (filaree), *Mentha pulegium* (pennyroyal), *Lythrum hyssopifolium* (hyssop-leaved loosestrife), and *Cotula coronopifolia* (brass buttons) (Patterson 1990; Patterson *et al.* 1994; Pavlik *et al.* 1998, 2000, 2001; CNDDB 2013).

5. Critical Habitat

No critical habitat has been designated for *Blennosperma bakeri.*

LASTHENIA BURKEI (BURKE'S GOLDFIELDS)

1. Description and Taxonomy

The scientific name originally given to Burke's goldfields was *Baeria burkei* (Greene 1886). Both the specific epithet and the common name commemorate J. H. Burke, who collected the type specimen "near Ukiah, Mendocino County" (Greene 1886). Greene later placed the genus *Baeria* within *Lasthenia*, creating the new name *Lasthenia burkei* for Burke's goldfields (Greene 1894). However, for many years other botanists (*e.g.*, Hall 1914, Jepson 1925, Abrams and Ferris 1960) did not believe that Burke's goldfields was distinct from Fremont's goldfields (*Lasthenia fremontii),* a more widespread species to which it is very similar, nor did they agree with Greene's (1894) decision to lump *Baeria* with *Lasthenia*. Not until 1966, when Ornduff (1966) published a comprehensive study of the genus *Lasthenia*, was Burke's goldfields recognized as a distinct species and the name *Lasthenia burkei* accepted widely. Continuing research indicated that Burke's goldfields, Fremont's goldfields, and Contra Costa goldfields (*Lasthenia conjugens*) form a closely related species group (Ornduff 1969*b*, Crawford and Ornduff 1989). However, Burke's goldfields was found to be genetically distinct from Fremont's and Contra Costa goldfields (Crawford and Ornduff 1989). *Lasthenia burkei* and its relatives are members of the aster family (Asteraceae).

Lasthenia burkei is an annual herb that ranges in height from approximately 13 cm (5 in) (Patterson *in litt.* 2000) to as much as 61 cm (24 in) (Greene 1886), but is typically less than 30 cm (11.8 in) tall (Ornduff 1993*b*). It has hairy stems, which may be simple or branched. The narrow, opposite leaves are no more than 8 cm (3.1 in) long and may be lobed or not. From April to June, the end of each branch bears one daisy-like flower head approximately 1.5 cm (0.6 in) across. The fruits are achenes (dry, one-seeded fruits) less than 1.5 mm (0.06 in) in length. The fruits of *L. burkei* can be distinguished from those of other goldfields by the presence of one long awn (bristle and numerous short scales) (Hickman 1993). Individual *L. burkei* plants may exhibit some geographic variation in morphology (McCarten 1985 as cited in CH_2M Hill 1995, Patterson *et al.* 1994).

A diagnostic feature of *Lasthenia burkei* is the usual presence of a single long awn on the achene intermixed with 8 to 10 short scales (Ornduff 1993*b*, Patterson *et al.* 1994). However, several occurrences have mixtures of typical achenes with a single awn and atypical achenes with a varied number of awns. Species experts consider these mixed occurrences to represent Burke's goldfields (Ornduff 1969*b*, Patterson *et al.* 1994, CNDDB 2013).

Figure 4. Photographs of *Lasthenia burkei* (Burke's goldfields)

Hattie Brown © 2014 Laguna de Santa Rosa Foundation
Lasthenia burkei with pollinator (Bombyliid fly)

Stephanie Buss © 2014 California Department of Fish and Wildlife

2. Distribution and Abundance

Lasthenia burkei is endemic to the central California Coastal Range region and has been reported historically to be located within Mendocino, Lake, and Sonoma counties (Ornduff 1977b, Patterson *et al*. 1994). Historically, approximately 18 to 20 occurrences were known from the Santa Rosa Plain in Sonoma County (Patterson *et al*. 1994). Two occurrences were recorded from Lake County, at Manning Flat and at a winery on Highway 29. Both of these occurrences and three additional occurrences in Lake County are presumed extant. A single occurrence of *L. burkei*, located near the town of Ukiah, is the only known occurrence in Mendocino County. This occurrence was thought to be extirpated but was rediscovered in 2010 (CNDDB 2013). Within Sonoma County, one occurrence is known from north of Healdsburg (Patterson *et al*. 1994, CNDDB 2013). One occurrence is located outside of the Plain east of the City of Sonoma. The core of the current range of *L. burkei* is in the Plain north of the community of Windsor to east of the city of Sebastopol with three occurrences south of Highway 12.

Lasthenia burkei occurrences continue to become increasingly fragmented in the area of the Town of Windsor and are now nearly extirpated from that area (P. Chamberlin, Town of Windsor, pers. comm., 2008b). It is unknown to what extent occurrences have been lost entirely due to development or other human-caused, ground-disturbing activities.

The most current information from CNDDB, from survey data collected by the Adopt-a-Vernal Pool program, and from species experts is shown on Figure 5 and in Table 2 and indicates that there are 28 occurrences of *Lasthenia burkei* that are presumed extant and five occurrences that are extirpated or possibly extirpated. Occurrence sizes for *Lasthenia burkei* and other vernal pool annuals are difficult to document by numbers of plants because they fluctuate greatly from year to year. The particular conditions that contribute to large occurrences in certain years are not well understood. Most *L. burkei* occurrences contain a few hundreds or thousands of plants (CNDDB 2013). The largest known extant occurrences are at the Alton Lane Vernal Pool Preserve, with approximately 1.4 million plants in 2013; at the Wright Preservation Bank where the occurrence has ranged from approximately 5.3 million to 1 million over the past 5 years; and east of Fulton Road near Piner Road, where the occurrence has ranged between 350 plants in 1998 to 18.5 million plants in 2009; 24,860 were found at this site in 2012 (CNDDB 2014) (see Figure 5).

The Alton Lane and Wright Preservation Bank sites are introduced; the Fulton Road/Piner Road site is native. Plant densities tend to be higher in vernal pools than in swales, but most sites include both types of habitat (Patterson *et al*. 1994). Within the last 10 years, three additional occurrences have been recorded in Lake County south of Clear Lake and three in Sonoma County (one east of Santa Rosa near Fountaingrove Lake, another southeast of Santa Rosa near Todd Road, and the third south of Santa Rosa east of Highway 101 and south of Mountain View Avenue) (CNDDB 2013).

Figure 5. Distribution of *Lasthenia burkei* (Burke's goldfields)

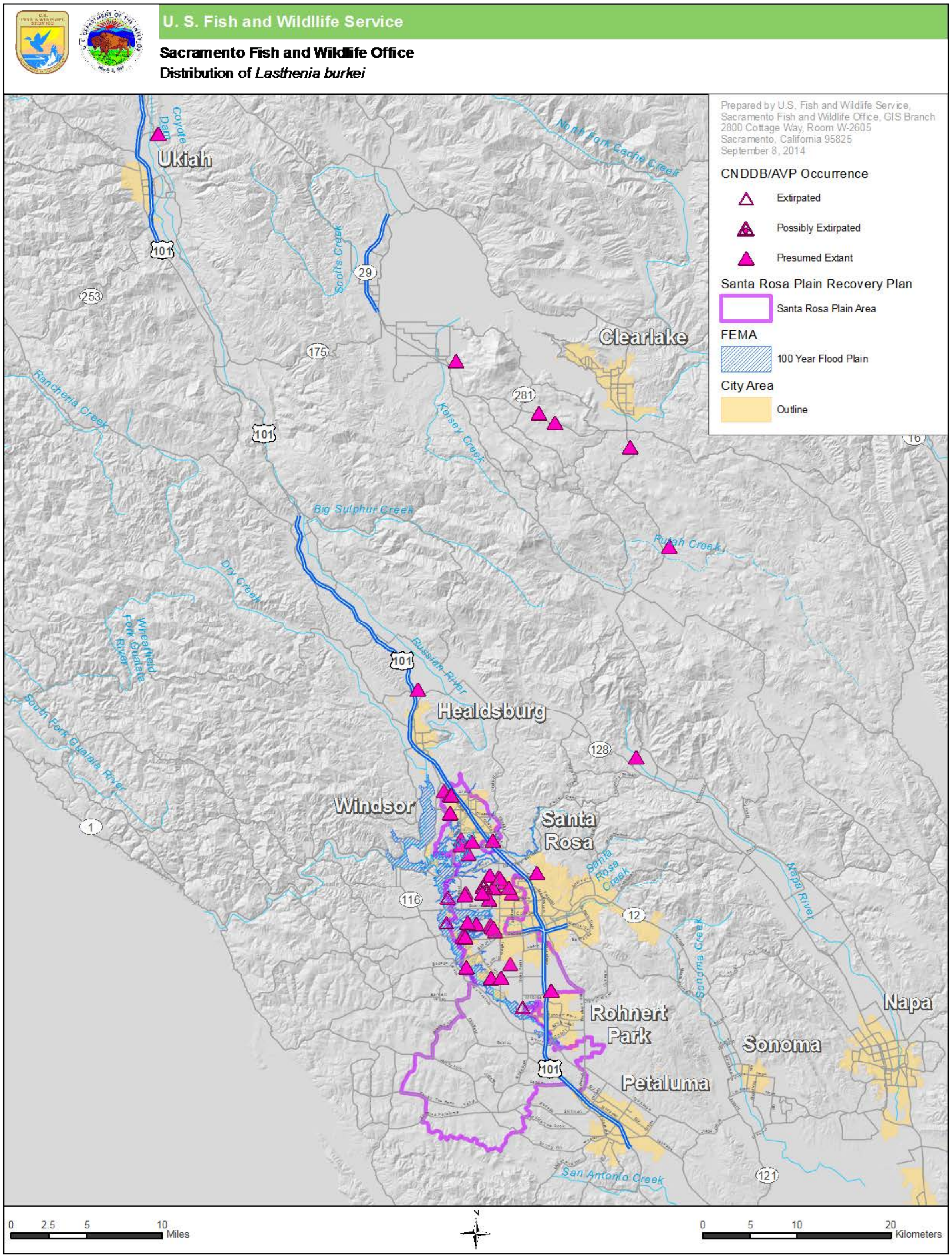


Table 2. Occurrences of *Lasthenia burkei*.[3]

Occurrences of *Lasthenia burkei*	
CNDDB Occurrence No.	**Location**
1	Todd Road Preserve, SW of Santa Rosa
2 Extirpated	Laguna de Santa Rosa
3 Extirpated	Laguna de Santa Rosa
4	Highway 101 and Arata Lane
5	Ukiah
6	Highway 29, south of Clear Lake
7	Sonoma County airport
11	Ployez Winery, Highway 29, south of Clear Lake
13	Abramson Road and Paradise Lane
14	Laguna de Santa Rosa, east of Sebastopol
15	Northeast of Sebastopol
16	North northeast of Sebastopol
17	Northeast of Sebastopol
19	Northwest of Santa Rosa, near Piner Road
21 Possibly extirpated	West of Santa Rosa
22	Town of Windsor
23	Northwest of Santa Rosa, Wood Road
24	Northwest of Santa Rosa, Wood Road
25	Alton Lane Vernal Pool Preserve, northwest of Santa Rosa
26 Possibly extirpated	Northwest of Santa Rosa
27	Northwest of Santa Rosa
28	West of Santa Rosa
29 Extirpated	West of Rohnert Park
30	Alexander Valley
31	Wikiup Wetlands Mitigation Bank
35	Kelseyville
36	Near Calistoga geyser
37	Near Fountaingrove Lake, east of Santa Rosa
38	South of Hidden Valley Lake
39	Southwest of Clear Lake, along Highway 29
40	Hale Mitigation Bank, southwest of Santa Rosa
41	Horn Mitigation Bank
Adopt-a-Vernal Pool Occurrence	**Location**
No Number	Swift Conservation Bank, southwest of Santa Rosa

[3] Occurrence identification numbers in CNDDB may change as new information reveals that some occurrences should be combined due to proximity. Combining or deleting of occurrence identification numbers has resulted in non-sequential numbering of CNDDB occurrences as seen in the Occurrences Tables for all three plant species.

The newly recorded Lake County occurrences are native. One of the Sonoma County occurrences is a transplantation to the Hale Mitigation Bank; the other two are native occurrences (CNDDB 2013).Most extant or presumed extant occurrences have been subjected to substantial loss or alteration of habitat. These occurrences are much smaller in area and numbers of plants than in the past (CNDDB 2013). Continued declines could result in the eventual extirpation of many of the remaining occurrences.

Genetic variation in thirteen *Lasthenia burkei* occurrences in Lake and Sonoma counties was assessed in 2009 (Sloop and Ayres 2009). Eleven of the thirteen occurrences are natural, while the Alton Lane and Sonoma County Airport (SCA) Preserve occurrences contain created pools with that were planted with seed from other sites. The study included the investigation of genetic variation of the thirteen occurrences by sampling approximately 35 individual plants from each occurrence (except one); DNA was extracted and genetic differentiation was analyzed including using standard statistical methods (Sloop and Ayres 2009). All thirteen *Lasthenia burkei* occurrences were genetically distinct despite showing some gene flow between them. Two *Lasthenia burkei* occurrences in Lake County (Manning Flat and Ployez Winery), which are geographically the most isolated from the eleven Sonoma County occurrences, were genetically distinct from each other and from the Sonoma County occurrences. It is unclear whether gene flow is historical or contemporary as vernal pool seed banks in general can persist for many decades. Maintaining the breadth of genetic diversity by protecting occurrences that are genetically distinct is important for the species' ability to adapt to the effects of climate change.

3. Habitat

Lasthenia burkei grows in vernal pools and wet meadows generally below 500 m (984 ft) (Chan and Ornduff 2012). At the Manning Flat occurrence in Lake County, *L. burkei* is found in a series of claypan vernal pools on volcanic ash soils (56 **FR** 61173, CNDDB 2013); this is the only location-specific information available on the type of soil on which *Lasthenia burkei* occurs. At this location, the species is associated with *L. californica* (common goldfields) and *Navarretia leucocephala* ssp. *pauciflora* (few-flowered navarretia) (CNDDB 2013). In Sonoma County, the vernal pools containing *L. burkei* are on nearly level to slightly sloping loams, clay loams, and clays. A clay layer or hardpan approximately 0.6 to 0.9 m (2 to 3 ft) below the surface restricts downward movement of water (56 **FR** 61173). Huichica loam is the predominant soil series on which *L. burkei* is found on the northern part of the Plain (Patterson *et al.* 1994). Huichica loam is a fine textured clay loam over buried dense clay and cemented layers (Patterson *et al.* 1994). More southerly *L. burkei* sites likely occur on Wright loam or Clear Lake clay (Patterson *et al.* 1994). Wright loam is a fine silty loam over buried dense clay and marine sediments. Clear Lake clay is hard dense clay from the surface to many feet thick (Patterson *et al.* 1994).

The primary habitats of *Lasthenia burkei* are shallow vernal pools and wet swales within valley grassland and oak woodland habitats (CNDDB 2013). On the Plain, *L. burkei* grows in the bottoms of pools ranging from less than 25 cm (10 in) in depth to 50 cm (20 in) (Patterson 1990, Patterson *et al.* 1994, Patterson *in litt.* 2000). *Lasthenia* *burkei* grows in naturally-occurring pools that range in surface area from approximately 2 square m (21.5 square ft) to 0.3 ha (0.75 ac (Patterson *in litt*. 2000)). Most of the vernal pools where *L. burkei* grows are loosely classified as northern vernal pools (Keeler-Wolf *et al.* 1998), but the Manning Flat occurrence in Lake County is in a northern volcanic ashflow vernal pool (Sawyer and Keeler-Wolf 1995). *Lasthenia burkei* also has been observed occasionally in artificially-created depressions such as drainage ditches and in disturbed sites such as orchards and disked fields (Patterson 1990, Patterson *et al*. 1994).

Lasthenia burkei grows at a wide range of elevations, which vary by region. The lowest-elevation occurrences are found between 27 and 46 m (90 to 150 ft) on the Plain, and in the Alexander Valley, where it occurs at 52 m (170 ft). The Ukiah occurrence is intermediate in elevation at 188 m (620 ft). The Lake County occurrences are at the highest elevations, with one at 427 m (1,400 ft) and the Manning Flat occurrence at 579 m (1,900 ft) (CNDDB 2013).

4. Reproduction and Ecology

Like many other rare vernal pool plants, *Lasthenia burkei* is an annual. *Lasthenia burkei* typically germinates in autumn following heavy rains, although late initiation of rains may delay seedling emergence (Ornduff 1969*b*). Laboratory germination tests (Rancho Santa Ana Botanical Garden, unpublished data) indicate that germination occurs rapidly in a single flush, with relatively high germination rates (49 to 100 percent). Plants that establish in autumn under natural conditions may tolerate prolonged submergence, but do not begin rapid stem growth until vernal pools and swales dry down during late winter or early spring (Ornduff 1969*b*, Patterson *et al.* 1994). If the pools undergo flooding and drying repeatedly, the stems of *L. burkei* can become long and decumbent (lying flat on the ground with the tips curving up) (Patterson *et al.* 1994), and may flower when the base of the stem is underwater (Ornduff 1969*b*). Flowering occurs any time between late-March and mid-June, although the typical flowering period is from mid-April to mid-May (Greene 1886, Ornduff 1966, Ornduff 1977*b*, Patterson *et al.* 1994); early dry and warm conditions favor early flowering. Seed set, maturation, and dispersal may occur from late-April to June, and may be prolonged by late rains or cool temperatures. Plants usually become senescent by early summer unless late-spring rains prolong reproduction (Patterson *et al.* 1994). Seed dispersal mechanisms are not known. Pappus awns (needle-like appendages attached to the achene) may assist in windborne seed dispersal. Other seed dispersal mechanisms may include water or wildlife.

The flowers of *Lasthenia burkei* are predominantly pollinated by outcrossing but they are capable of self-pollination (Sloop *et al*. 2012). They are thought to be insect-pollinated rather than wind-pollinated. Insects known to visit the flowers of the genus *Lasthenia* include butterflies (Lepidoptera), beetles (Coleoptera), flies (Diptera), true bugs (Hemiptera), bees (Hymenoptera), and wasps (Hymenoptera) (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of *Lasthenia* spp. are solitary bees (family Andrenidae); these include two species in the subgenus *Diandrena* (*Andrena submoesta* and *A. puthua*) and five or six species in the subgenus *Hesperandrena* (*Andrena baeriae, A. duboisi, A. lativentris*, and two or three undescribed species) (Thorp and Leong 1998). *L. burkei* has been the subject of a pollinator study by Gilmore *et al.* (2012). Although the solitary bee (*Andrena submoesta*) specializes on *L. burkei* and is apparently dependent on it as a food source, the plant may not rely on *A. submoesta* for pollination (Gilmore *et al.* 2012). The bombyliid fly (also called a bee fly), *Conophorus cristatus*, was found to be the dominant visitor of *L. burkei* and may be its primary pollinator. Syrphid flies (members of several genera in the family Syrphidae (hover flies)) were also found to be an important part of the pollinator community for this plant (Gilmore *et al.* 2012).

Both the ray and disk flowers of all goldfields species produce achenes, increasing the potential for seed production per head. However, the reproductive output of individual plants is highly variable, depending on plant density and vigor, and probably on pollinator behavior as well. Each flower head can produce as many as 35 achenes, and the number of flower heads per plant can range from 1 to more than 20 (Patterson *et al.* 1994). Annual survival rates and other demographic parameters have not been investigated.

Lasthenia burkei is also likely adapted to "risky environments" by producing a persistent seed bank. Some occurrences have reappeared after no plants were evident for 2 years, suggesting that viable seeds remained in the soil during that period (Patterson 1990). See the Reproduction and Ecology discussion of *Blennosperma bakeri* for further information.

Lasthenia burkei often occurs in dense, nearly pure occurrences within vernal pools (Ornduff 1966, Patterson 1990), but it also may occur in mixtures with other plant species. Over all sites, the most frequent associates are *Pleuropogon californicus* (semaphore grass), *Hordeum* spp. (wild barley), *Festuca perennis* (ryegrass), *Pogogyne douglasii* ssp. *parviflora* (small-flowered Douglas' pogogyne), *Plagiobothrys* sp. (popcorn flower), *Ranunculus lobbii* (Lobb's aquatic buttercup), *Downingia concolor* (maroonspot downingia), *Eryngium* sp. (button-celery), and owl's-clover (*Castilleja* or *Triphysaria* spp.). Other goldfields species that co-occur with *L. burkei* include *L. glaberrima* (smooth goldfields), *L. californica* (California goldfields), and *L. glabrata* (glabrate goldfields). *L. burkei* co-occurs with the other species featured in this recovery plan, *Blennosperma bakeri* and *Limnanthes vinculans*, at only one natural site, just east of the city of Sebastopol. *L. burkei* co-occurs with *B. bakeri* and *L. vinculans* at four additional sites, Alton Lane, Airport Business Center, Todd Road Preserve, and Slippery Rock; however, one or more of the listed species were planted at each of these sites (CNDDB 2014). Like *L. burkei*, some of the associated species cited here are moist soil obligates, while others occur in drier vegetation zones of vernal pools and swales.

5. Critical Habitat

No critical habitat has been designated for *Lasthenia burkei*.

B. *LIMNANTHES VINCULANS* (SEBASTOPOL MEADOWFOAM)

1. Description and Taxonomy

Limnanthes vinculans is an annual herb of the false meadowfoam family (Limnanthaceae) with weak, somewhat fleshy, decumbent stems up to 30 cm (11.8 in) long (stems grow longest when the plant is submerged while actively growing). The seedlings are unusual among *Limnanthes* species in that they have entire leaves. Leaves of mature plants are up to 10 cm (3.9 in) long and have 3 to 5 leaflets that are narrow and unlobed with rounded tips. Although the first leaves are narrow and undivided, leaves on the mature plant have three to five undivided leaflets along each side of a long stalk (petiole). The length of the petiole also appears to be promoted by submergence. The shape of the leaves distinguishes *L. vinculans* from other members of the *Limnanthes* genus.

Limnanthes vinculans has fragrant, white flowers during April and May. The flowers are borne in the leaf axils (upper angle between leaf and stem), are bell- or dish-shaped, with petals 12 to 18 mm (0.47 to 0.71 in) long. The sepals (green outermost whorl of flower parts that enclose the bud) are shorter than the petals, which turn outward as the nutlets (small, dry nuts) mature. The nutlets are dark brown, 3 to 4 mm (0.12 to 0.16 in) long, and covered with knobby pinkish tubercles (small wart-like projections) (Ornduff 1969*a*, Brown and Jain 1977, Hauptli *et al.* 1978, Wainwright 1984, Patterson *et al.* 1994, Ornduff and Morin 2012). The seeds of *L. vinculans* germinate after the first significant rains in fall. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems.

The earliest collection of *Limnanthes vinculans* was made in 1946 "between Bodega and Petaluma, south of Sebastopol" but this record most likely represents a site near Sebastopol (Wainwright 1984). The species was not described until 1969, when Ornduff (1969a) officially published the name *L. vinculans*. Another common name for this species is Cunningham Marsh meadowfoam (Wainwright 1984, Patterson *et al.* 1994). The type locality for *L. vinculans* is Todd Road, just west of the intersection with Llano Road, which is near Sebastopol in Sonoma County (Ornduff 1969*a*).

Limnanthes vinculans is similar to *L. douglasii* var. *nivea* (snowy meadowfoam) and *L. alba* (white meadowfoam) in flower characteristics, and to *L. bakeri* (Baker's meadowfoam) in leaf characteristics. However, seedlings of *L. douglasii* and *L. alba* have lobed leaves and the mature leaves have more, deeper lobes called leaflets (5 to 13 leaflets as compared to 3 to 5 leaflets in *L. vinculans*). In addition, the petals of white meadowfoam curve inward as the nutlets mature. *L. bakeri* has smaller flowers than *L. vinculans*, occasionally has two or three lobes on the leaflets, and occurs only in Mendocino County (Ornduff and Crovello 1968, Ornduff 1969*a*, Brown and Jain 1977, Wainwright 1984, Ornduff and Morin 2013). Other meadowfoam species that may occur within or near the range of *L. vinculans* have yellow or pink flowers (Ornduff 1993*c*).

Figure 6. Photographs of *Limnanthes vinculans* (Sebastopol meadowfoam)

Hattie Brown © Laguna de Santa Rosa Foundation

Michelle Halbur © 2009 Pepperwood Preserve

2. Distribution and Abundance

Historically, *Limnanthes vinculans* was documented at 40 occurrences in Sonoma County and one in Napa County at the Napa River Ecological Reserve. In Sonoma County, all occurrences were found in the central and southern portions of the Plain with the exception of two occurrences: one located at Atascadero Creek Marsh west of Sebastopol and another in the vicinity of Knights Valley northeast of Windsor. The southern cluster of occurrences extended 3 mi (5 km) from Stony Point Road west to the Laguna de Santa Rosa, and was bounded by Occidental Road to the north and Cotati to the south. The central cluster stretched 1.5 mi (2.4 km) on either side of Fulton Road extending northwards from Occidental Road to River Road. The current known range of the species includes Knights Valley to the north, the Napa River Ecological Reserve near Yountville to the east, an occurrence near Sonoma to the south, and an occurrence near Sebastopol to the west. Of the three occurrences located outside of the Plain, the Atascadero Marsh occurrence has been presumed to be extirpated since 1969; the Knights Valley occurrence has not been visited since 1994 but is presumed to be extant; and the Napa River Ecological Reserve occurrence is presumed extant.

The current status of numerous *Limnanthes vinculans* occurrences is unknown; however, the most current information from CNDDB, from survey data collected by the Adopt-a-Vernal Pool program, and from species experts is shown on Figure 7 and in Table 3 and indicates that there are 37 occurrences of *L. vinculans* that are presumed extant of which at least 3 have been introduced and 6 occurrences that are extirpated or possibly extirpated. Although many occurrences have been surveyed in recent years, several others have not been visited in over 20 years in part due to lack of access to the sites. Occurrences of *L. vinculans* can vary greatly in area and numbers of plants from year to year.

Limnanthes vinculans has not been the subject of demographic studies. Like other vernal pool species, *L. vinculans* occurrences exhibit extreme fluctuations in population size among years, often by one or two orders of magnitude (CNDDB 2013).

The genetic variability of *Limnanthes vinculans* is low compared to other *Limnanthes* species (Jain 1984). However, occurrences of this species do differ from each other in genetic makeup (Jain *in litt.* 1980).

A genetic survey of *Limnanthes vinculans* leaf-tissues from 16 native and 4 created sites within the Plain and Napa Valley was conducted in 2006 and 2008 (Sloop et al. 2012). The Napa Valley occurrence was clearly distinct from the Plain occurrences. Leaf morphology of the Napa plants differs from that of *L. vinculans* plants located on the Plain; and in some respects, the Napa plants are more similar to other *Limnanthes* species. Within Sonoma County occurrences gene flow seemed less restricted indicating adequate pollen and/or seed movement. High genetic diversity was observed in *L. vinculans* at all sites suggesting effective population sizes were large with low inbreeding and low or no genetic drift historically. No clear genetic trends or geographic groupings among Plain occurrences were found. Occurrences

Figure 7. Distribution of *Limnanthes vinculans* (Sebastopol meadowfoam)

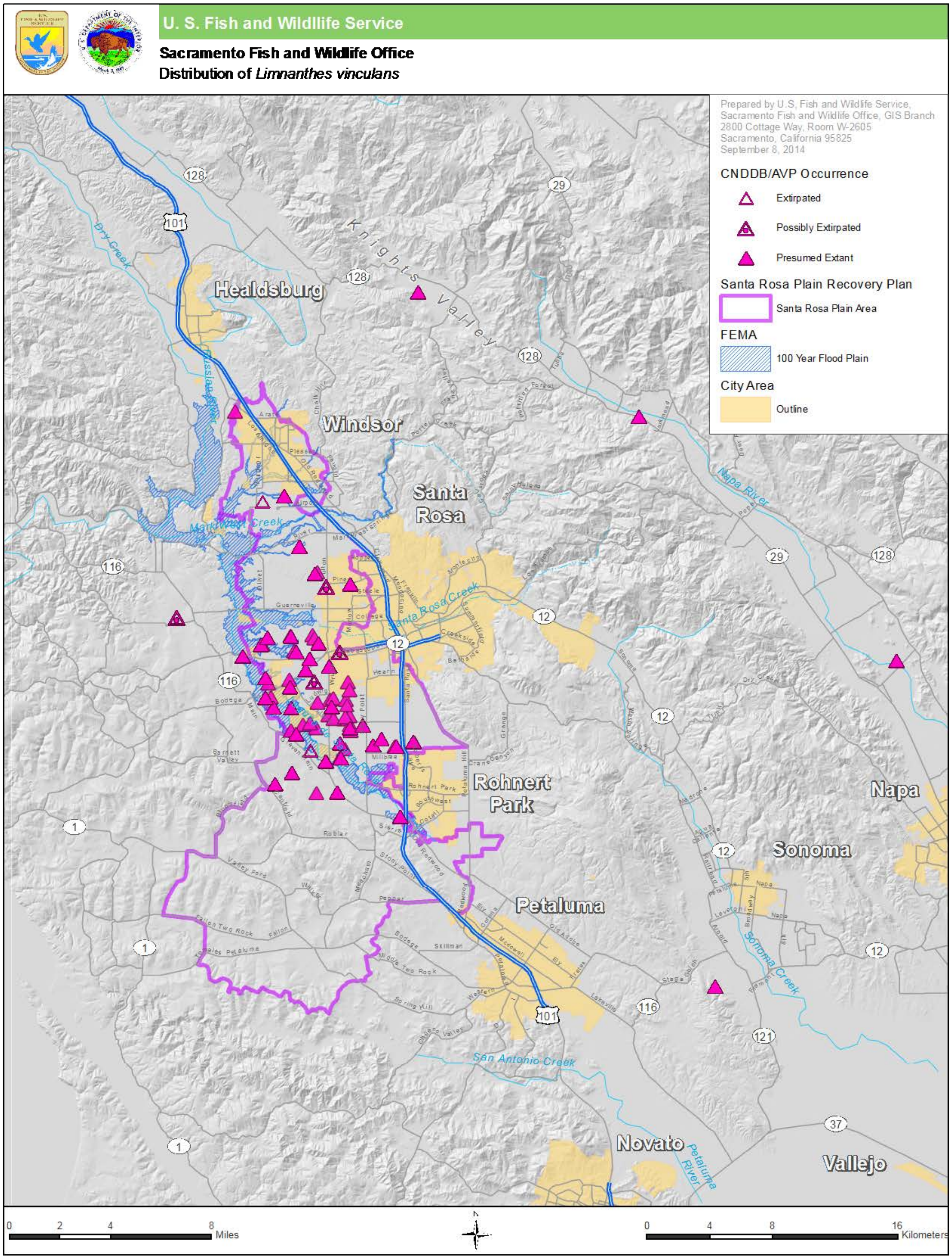


Table 3. Occurrences of *Limnanthes vinculans*.[4]

Occurrences of *Limnanthes vinculans*	
CNDDB Occurrence Number	**Location**
1	Santa Rosa Airpark, east of Sebastopol
2	Northwest of Santa Rosa Air Center
3	West of Santa Rosa
6	South of the Town of Llano
7 Possibly extirpated	East of the Town of Llano
9	North of Sebastopol
10	East of Sebastopol
12	Horn Mitigation Bank, Santa Rosa
14	South of Santa Rosa
15	Desmond Mitigation Bank
16	Theiller Sebastopol Meadowfoam Ecosystem Reserve
17	Southeast of Sebastopol
18 Possibly extirpated	Northwest of Santa Rosa
20 Possibly extirpated	Atascadero Creek Marsh, northwest of Sebastopol
21	Alton Lane Vernal Pool Preserve
22	Slippery Rock and Wright Preservation Banks
24	Northeast of Sebastopol
25	East of Sebastopol
26	South of Santa Rosa
27	North of Sebastopol
28	Northwest of Santa Rosa
29	East of Sebastopol
30	Santa Rosa
31 Possibly extirpated	South of Highway 12, west of Santa Rosa
33	Southeast of Sebastopol
34	Hazel Mitigation Bank, South of Santa Rosa
35	West of Rohnert Park
36	Santa Rosa
37	Southwest of Santa Rosa
38 Extirpated	Near Highway 116, north of Cunningham
39	Yountville Ecological Reserve, CDFW
40	Knights Valley near Highway 128
42	Haroutounian Property, Sonoma County Agricultural Preservation and Open Space District
43	Southwest of Santa Rosa
46 Extirpated	Sonoma County Airport Wildflower Preserve
47	Western Santa Rosa
48	South of Sebastopol
49	Between Sebastopol and Santa Rosa
50	Airport Business Center Mitigation Site
51	Laguna Vista, south of Highway 12
52	North of Sebastopol
53	Southeast of Calistoga
54	Northeast of Sebastopol

[4] Occurrence identification numbers in CNDDB may change as new information reveals that some occurrences should be combined due to proximity. Combining or deleting of occurrence identification numbers has resulted in non-sequential numbering of CNDDB occurrences as seen in the Occurrences Tables for all three plant species.

that are genetically distinct should be protected and are important for their potential ability to adapt to the effects of climate change.

The range of *Limnanthes vinculans* has not increased since the time of listing.

3. Habitat

This species grows in northern basalt flow and northern hardpan vernal pools (Sawyer and Keeler-Wolf 1995), wet swales and meadows, on the banks of streams, and in artificial habitats such as ditches (Wainwright 1984; CNDDB 2002). *Limnanthes vinculans* grows in both shallow and deep areas, but is most frequent in pools 25 to 51 cm (10 to 20 in) deep (Patterson *et al.* 1994). The species is most abundant in the margin habitat at the edge of vernal pools or swales (Pavlik *et al.* 2000, 2001). Most confirmed occurrences of *L. vinculans* on the Plain grow on Wright loam or Clear Lake clay soils (Patterson *et al.* 1994, CNDDB 2002). A few occurrences are on other soil types, including Pajaro clay loam, Cotati fine sandy loam, Haire clay loam (Patterson *et al.* 1994) and Blucher fine sandy loam (Wainwright 1984).

The surrounding plant communities range from oak savanna, grassland, and marsh in Sonoma County to riparian woodland in Napa County (CNDDB 2002). *Limnanthes vinculans* occurs at elevations of 15 to 41 m (50 to 135 ft) throughout most of its range, including Napa County. The Knights Valley occurrence, in Sonoma County, was at 116 m (380 ft) (CNDDB 2013).

4. Reproduction and Ecology

According to Patterson *et al.* (1994), the seeds of *Limnanthes vinculans* germinate after the first significant rains in fall, although late initiation of rains may delay seed germination. *L. vinculans* plants grow slowly underwater during the winter, and growth rates increase as the pools dry. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. *L. vinculans* begins flowering as the pools dry, typically in March or April. The largest plants can produce 20 or more flowers. Flowering may continue as late as mid-June, although in most years the plants have set seed and died back by then. Each plant can produce up to 100 nutlets.

Nutlets of *Limnanthes vinculans* likely remain dormant in the soil, as do other species of *Limnanthes* (Patterson *et al.* 1994). For example, in the late 1980's and early 1990's, a site in Cotati remote from other *L. vinculans* occurrences was surveyed for several years by independent qualified botanists. None of these botanists identified flowering occurrences of *L. vinculans* on the project site. Conditions of the pools on the site were highly degraded by wallowing hogs (*Sus scrofa*) and subsequent eutrophication (over enrichment by nutrients) of the pools. Following several years of negative surveys, 12 plants of Sebastopol meadowfoam emerged simultaneously in one pool in the first year following removal of hogs.

A study by Gilmore *et al.* (2012) found that *Limnanthes vinculans* was visited most frequently by Bombyliid flies in the genus *Conophorus*. Two species of *Limnanthes*-specialist bees, *Panurginus occidentalis* and *Andrena pulverea* (*A. limnanthis* in older literature), pollinate *L. vinculans*. *Andrena pulverea* survives drought years, when few meadowfoams reach flowering, by remaining inactive for 2 years or more (Thorp 1990). Jain (1984) determined that the rate at which *L. vinculans* flowers were fertilized by pollen from other *L. vinculans* flowers rather than self-pollination (outcrossing rate) was 10 to 50 percent. Mechanisms for dispersal of nutlets in this species have not been studied. Likely dispersal agents include water (Wainwright 1984), birds, and livestock (Jain 1978). Jain (1978) studied dispersal of nutlets similar to those of *L. vinculans* in two species of meadowfoam, *L. bakeri* (Baker's meadowfoam) and *L. striata* (striped meadowfoam). Nutlets of *L. bakeri* did not disperse beyond the point where they were placed. Nutlets of *L. striata* moved a short distance within the same pool where they were placed but did not disperse to other pools (Hauptli *et al.* 1978, Jain 1978).

On the Plain, *Limnanthes vinculans* typically occurs with *Festuca perennis* (ryegrass), *Vulpia octoflora* (vulpinegrass), and *Juncus phaeocephalus* (brown-headed rush) (Pavlik *et al.* 2000, 2001). Other, less abundant species include *Limnanthes alba* (snowy meadowfoam), *Triphysaria eriantha* (butter-and-eggs), *Eleocharis* sp. (spikerush) (Wainwright 1984, Patterson *et al.* 1994), *Downingia concolor* (downingia), *Ranunculus lobbii* (Lobb'sbuttercup), *Plagiobothrys* sp.(popcorn flower), *Pleuropogon californicus* (semaphore grass), *Mentha pulegium* (mint), and *Lasthenia glabberima* (smooth goldfields) (CDFG 2002, Pavlik *et al.* 2000). Three subspecies of *Limnanthes douglasii* (Douglas' meadowfoam) have also been reported growing with *L. vinculans* (CNDDB 2014). At the occurrence near Knights Valley, *L. vinculans* grew in a vernally wet grassland. In Napa County, the Napa River Ecological Reserve occurrence of *L. vinculans* was associated with *Juncus dubius* (dubious rush), *Juncus oxymeris* (pointed rush), *Plantago* spp. (plantain), *Lotus purshianus* (prairie trefoil), *Geranium dissectum* (cutleaf geranium), and *Rubus discolor* (Himalayan blackberry).

5. Critical Habitat

No critical habitat has been designated for *Limnanthes vinculans.*

C. CALIFORNIA TIGER SALAMANDER (*Ambystoma californiense,* SONOMA COUNTY Distinct Population Segment)

1. Description and Taxonomy

The California tiger salamander is a large, stocky, terrestrial salamander with a broad, rounded snout. Total length in adult measurements range approximately from 16 to 24 cm (6 to 9.5 in) long (Storer 1925, Stebbins 1985, C. Searcy, *in litt,* 2013a). The coloration of the adults generally consists of random white or yellowish markings against a black body. California tiger salamander larval coloration is variable, with most larvae being pale colored (Hansen and Tremper 1993; Figure 8).

California tiger salamanders are endemic to the Santa Rosa Plain, the San Joaquin-Sacramento River valleys and bordering foothills, and the coastal valleys of Central California south to Santa Barbara. All California tiger salamanders are federally listed, however, they are listed as three unique entities: the Sonoma County DPS of California tiger salamander, the Santa Barbara DPS of California tiger salamander, and Central DPS of California tiger salamander. When we list a DPS of a species under the Act, it must be discrete in relation to the remainder of the species and significant to the species as a whole. In our final listing rule, we determined that the Sonoma population of California tiger salamander is a DPS, as it is geographically isolated and genetically unique from the Santa Barbara and Central DPSs (69 **FR** 47211).

Much of the research on the California tiger salamander is from the Central DPS. Information presented herein is used interchangeably when life history, ecology, biology and threats may be shared between these two DPSs.

2. Distribution and Abundance

The historical range of the Sonoma County California tiger salamander included the Plain and Petaluma lowlands, an area approximating 100,000 acres. Prior to alteration of the Plain by humans, the landscape contained numerous vernal pools scattered across an area dominated by oak savannah, and representing a large, mostly continuous mosaic of suitable upland and aquatic habitat. By the mid-1990's, it was estimated that vernal pool habitat on the Plain had been reduced by more than 80 percent (Patterson *et al*. 1994).

The current core range of Sonoma County California tiger salamander encompasses approximately 18,000-20,000 acres of fragmented habitat, with extant occurrences displayed in Figure 9. This distribution has been curtailed primarily in two areas in recent times: the Santa Rosa Air Center area (southwest Santa Rosa) where observations have decreased since the early 1990s; and in the south Cotati area, where salamanders were once commonly observed in the late 1980s to early 1990s (D. Cook, *in litt*, 2009).

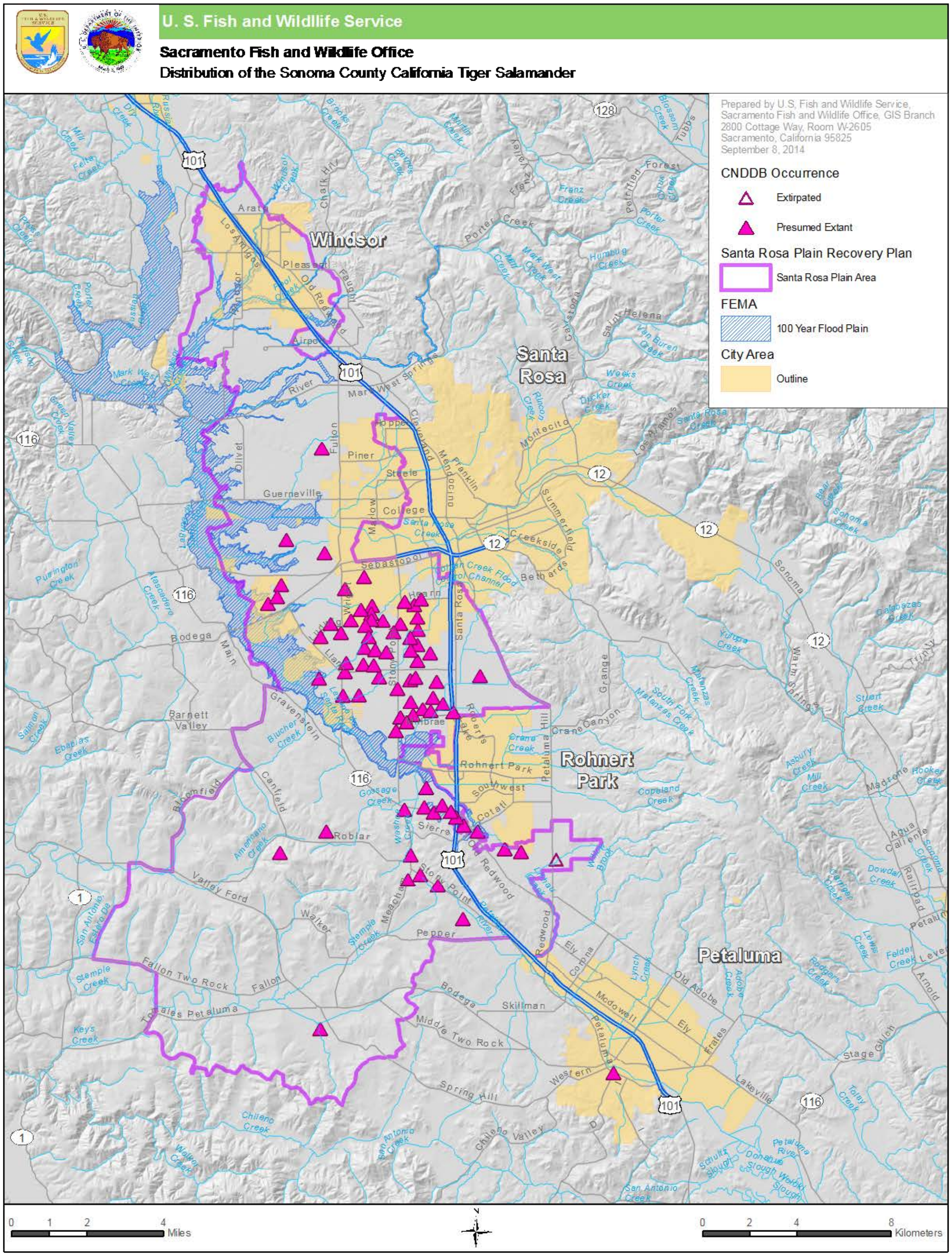
Figure 8. Photographs of Sonoma County California tiger salamander

Greg Damron © www.wildvinestudios.com

Carlos Alvarado © 2013

Brandon Amrhein ©

Figure 9. Distribution of the Sonoma County California Tiger Salamander



Virtually nothing is known concerning the historical abundance of the Sonoma County California tiger salamander. Its reclusive nature and life history make it difficult to estimate abundance, as individuals spend most of their lives underground. The available data suggest that most extant populations consist of relatively small numbers of breeding adults—in the range of a few, to a few dozen pairs—and populations that number above 100 breeding individuals are rare (CDFG 2010). California tiger salamanders also exhibit high year-to-year variation in survey counts. Studies show high variability in numbers of breeding adults observed, as well as numbers of larvae produced in a given year (Shaffer, 2009; Bobzien and DiDonato 2007; Trenham *et al.* 2000; Loredo and Van Vuren 1996). Cook *et al.* (2005) reported large annual variation in breeding activity by Sonoma County California tiger salamanders.

The numbers of reproductively active adults may vary substantially from one year to the next, while absolute population size may be less variable over time (CDFG 2010). It is believed that adults forego breeding in unsuitable years, or may switch breeding sites depending on conditions. The environmental factors that play a role in this observed variability likely are related to climatic conditions, including the timing of rainfall events, amount of rainfall, or unseasonably high temperatures (Cook *et al.* 2005). However, extirpation by site-specific predator/prey assemblages may also be a factor as these species prey on or compete with California tiger salamander larvae for limited resources. For example, Bobzien and DiDonato (2007) monitored nine ponds occupied by Central California tiger salamanders and reported that when these ponds were colonized by predatory aquatic insects, no larval salamanders were found to co-occur.

3. Habitat

The Sonoma County California tiger salamander inhabits vernal pools and seasonal ponds, associated grassland, and oak savannah plant communities below 200 feet (60 meters) (68 **FR** 13497). Sonoma County California tiger salamanders spend the majority of their lives underground in small mammal burrows in uplands, while ephemeral ponds play a critical role because they are necessary for breeding.

Although California tiger salamanders are members of a family of "burrowing" salamanders, they are not known to create their own burrows. They depend on persistent small mammal (e.g., pocket gopher) activity to create, maintain, and sustain sufficient underground refugia (Loredo *et al.* 1996). These underground burrow systems are critical during the drier months of the year, though juveniles and adults use them throughout the year to grow and survive (Loredo *et al.* 1996; Pittman 2005; Seymour and Westphal 1994; Shaffer *et al.* 1993). California tiger salamanders may also use landscape features such as leaf litter or desiccation cracks in the soil for upland refugia. Such underground refugia provide protection from the sun and wind associated with a dry California climate, which can otherwise desiccate (dry out) and kill amphibians in upland terrain.

Because they spend most of their lives underground, California tiger salamanders are rarely encountered, even in areas where they are abundant. Most evidence suggests that California tiger salamanders move, feed, and remain active in their underground dwellings (Trenham 2001; Semonsen 1998; Van Hattem 2004). Adult California tiger salamanders are rarely seen except during nocturnal breeding migrations, which begin with the first seasonal rains, usually in November or December (Barry and Shaffer 1994).

Although historical breeding habitat for California tiger salamanders is natural vernal pools and ponds, they also use modified ephemeral or permanent ponds and manmade features such as constructed ponds or livestock ponds. This species is not known to breed in streams or rivers, and individuals do not typically breed in flowing aquatic habitats (Cook *et al.* 2005). However, breeding individuals have been reported in roadside ditches in areas that contain seasonal wetlands. California tiger salamanders are sometimes found within permanent ponds, however these occupied permanent ponds do not typically have predatory fish or breeding bullfrog populations (Fisher and Shaffer 1996).

Vernal pool wetlands likely provide higher-quality breeding habitat, as vernal pools and ephemeral ponds have been observed to better support larger populations than perennial wetlands (Riley *et al.* 2003; Wang *et al.* 2011). Wang *et al.* (2011) studied Central California tiger salamander populations in both vernal pools and more permanent livestock ponds, and found that salamanders breeding in natural vernal pools had higher reproductive success and overall abundance than those breeding in livestock ponds. The absence of predatory fish species and non-native predators (e.g., bullfrogs) within the breeding pools plays a significant role in the reproductive success, as larvae are vulnerable to the predation (Shaffer *et al.* 1993). If these predator populations persist in the same habitat, they outcompete and prey upon salamander eggs and larvae. Thus, optimum breeding habitat holds water long enough to allow metamorphosis of salamanders from the larval stage into the air-breathing juvenile lifestage (which takes at least 3 months every year) but not so long as to allow bullfrogs or non-native fish species to breed or survive (Petranka 1998).

It is not evident whether the origin of the pool matters for habitat selection. Cook *et al.* (2005) studied Sonoma County California tiger salamander larvae capture rates and occupancy, and found that breeding activity was similar between constructed and natural vernal pools. Cook *et al.* (2005) did find that the probability of detecting Sonoma County California tiger salamander breeding activity was positively associated with pool depth, as years with higher annual rainfall amounts resulted in higher numbers of larvae. In drought years, ponds may not form at all, and the adults cannot breed (Barry and Shaffer 1994). Typically, breeding pools have moderate to high levels of turbidity. California tiger salamanders rarely use ponds with clear water (Bobzien and DiDonato 2007). The turbidity may help larvae and adults avoid predators.

In addition to both upland and aquatic habitat that is essential to the Sonoma County California tiger salamander, maintaining connectivity between these two types of habitat is important for the long-term viability of the Sonoma County California tiger salamander. Connectivity can be maintained when there are large areas of upland habitat that contain multiple breeding ponds within dispersal distance of each other.

Their home range ideally contains multiple breeding ponds, which are necessary for the California tiger salamander to persist. If a local population becomes extinct due to unfavorable conditions, having connectivity between ponds is important to ensure that recolonization occurs at individual pond sites (Shaffer *et al.* 1993).

4. Reproduction and Ecology

Life Cycle

The California tiger salamander has a two phase life cycle, split between the aquatic lifestages and the upland lifestages (Shaffer *et al.* 2004). Larval salamanders hatch and develop in vernal pools and ponds, before going through metamorphosis where external gills for respiration appear along with developing legs. As the pools dry down, metamorphs (the term for this transitional lifestage) transform from predominantly gill-breathing to predominantly lung-breathing (though they also breath through their skin) juveniles, and disperse to their underground burrows to grow.

For the majority of their lives, they are terrestrial and survive widely dispersed in "upland habitat" underground retreats (Shaffer *et al.* 2004; Trenham *et al.* 2001). Outside of occasional switching of burrows during the rainy season (and other rare instances), adult California tiger salamanders spend roughly 90 percent of any given year underground (Van Hattem 2004; Trenham 2001; Holland *et al.* 1990). Juveniles may spend more time underground than adults, as they have not yet reached sexual maturity and do not typically leave their burrows in the fall and winter to reproduce.

Once fall or winter rains begin, adult salamanders emerge from their upland sites on rainy nights to feed and to migrate to the breeding ponds (Stebbins 1985; Shaffer *et al.* 1993). Mating typically occurs November through April, although most breeding occurs from December through February (C. Searcy, *in litt,* 2013a; Petranka 1998). Migrating adults have been observed as early as October and as late as May (Hansen and Tremper 1993; Petranka 1998). The actual time that adults spend in breeding ponds is short, lasting on average from a few weeks for females to over a month for males (Trenham *et al.* 2000).

After mating, females attach their eggs to submerged twigs, grass stems, vegetation, or debris (Storer 1925; Twitty 1941). California tiger salamander eggs hatch into larvae within 10 to 28 days, (Petranka 1998; Hansen and Tremper 1993; C. Searcy, *in litt,* 2012a), with observed differences likely related to water temperatures.

The larval stage of the California tiger salamander usually lasts 3 to 6 months, with metamorphosis beginning in late spring or early summer (Petranka 1998). This ponding requirement restricts California tiger salamander breeding to deeper vernal pools and wetlands that have sufficiently long periods of inundation. Larvae develop faster in smaller, more rapidly drying pools, while the developmental period is prolonged in colder weather and in larger pools (Feaver 1971).

After metamorphosis, juveniles move away from breeding ponds into the surrounding uplands, where they live continuously for several years while maturing. Juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows (Petranka 1998). Peak periods for metamorph migration from their natal ponds (emergence) have been reported from May to July (C. Searcy, *in litt,* 2012a; Loredo and Van Vuren 1996; Trenham *et al.* 2000).

California tiger salamanders are infrequent breeders (H. Shaffer, *in litt*, 2009) and lifetime reproductive success is low (Trenham *et al.* 2000, 2001). They typically require at least 2 years to reach sexual maturity (Shaffer *et al.* 1993), although Trenham *et al.* (2000) found that most California tiger salamanders in Monterey County did not reach sexual maturity until 4 to 5 years of age. Trenham *et al.* (2001) reported that although individuals may survive for more than 10 years, many breed only once, and juvenile mortality is high—exceeding 50 percent of individuals during the first summer. In addition, less than 5 percent of marked metamorphs survived to become breeding adults (Trenham *et al.* 2001).

Diet

California tiger salamander larvae typically feed on invertebrate prey. This includes zooplankton, small crustaceans, and aquatic insects until they grow large enough to switch to larger prey (Anderson 1968). Larger larvae consume aquatic invertebrates, as well as the tadpoles of other amphibians such as Pacific chorus frogs (*Pseudacris regilla*), western spadefoot toads (*Spea hammondii*), California red-legged frogs (*Rana draytonii*), and bullfrogs (*Rana catesbeiana*) (Anderson 1968; Bobzien and DiDonato 2007). Less is known about the dietary habits of subterranean lifestages. Burrows often harbor camel crickets and other invertebrates that provide likely prey for the California tiger salamander. Stomach contents of several Santa Barbara County California tiger salamander sub-adults included spiders, earthworms, and aquatic insects (Hansen and Tremper 1993). Van Hattem (2004) anecdotally reported on a Central California tiger salamander eating a moth while being observed underground.

Dispersal

California tiger salamanders have the second longest dispersal distance reported for any salamander, and the longest among their taxonomic family (Searcy *et al.* 2013). Based on distances travelled per night, Searcy and Shaffer (2011) estimated that Central California tiger salamanders are physiologically capable of moving up to 2.4 km (1.5 mi) each breeding season, with an average dispersal distance estimated to be 0.56 km (1,840 ft). Orloff (2007) found that the majority of California tiger salamanders dispersed at least 0.5 mile (0.8 km) from the breeding site, with a smaller number of salamanders appearing to move even farther—from 1.2 to 2.2 km (0.75 to 1.3 mi) between breeding ponds and upland habitat. One possible explanation for this long dispersal distance is that salamanders must travel farther to locate suitable upland habitat when there is a scarcity of ground squirrel burrows and other refugia in proximity to the ponds (Orloff 2007). It appears that dispersal into the terrestrial habitat occurs randomly with respect to direction (Trenham 2001; Orloff 2007).

Based on studies at Jepson Prairie (in the range of the Central California tiger salamander), researchers estimated it would take approximately 2,706 acres of upland habitat to successfully protect the area occupied by 95 percent of a population, with a dispersal distance of 1.86 km (1.16 mi) from a single central breeding pool (Searcy and Shaffer 2008, 2011; H. Shaffer, *in litt*, 2009). More recent refined calculations using additional years of data from the same population suggest this figure to be closer to 2,108 acres, with a dispersal distance of 1.65 km (1.02 mi) from the most outlying pool edge (C. Searcy, *in litt,* 2013b, Searcy *et al.* 2013).

California tiger salamanders appear to disperse similar distances regardless of the types of habitat being dispersed through—researches have observed similar movement distances between the relatively flat terrain of Jepson Prairie versus the more rugged, rolling oak woodland habitat of Hastings Biological Preserve (Searcy and Shaffer 2011). While such topographic differences might not be a factor in dispersal distance, land use and vegetation appear to play a role in dispersal route. Trenham and Cook (2008) found that Sonoma County California tiger salamanders are more likely to disperse towards grasslands and will actively avoid areas that have urban development. Wang *et al.* (2009) found that Central California tiger salamander populations in Monterey County were most likely to successfully traverse chaparral, followed by grassland, and then oak woodland habitat, which they appeared to actively avoid. Trenham (2001) found that adults were more abundant in grasslands with scattered large oaks than in more densely wooded areas, also suggesting an affinity for chaparral and grasslands, and aversion to oak woodland. Trenham (2001) also found they did not appear to move along creeks or riparian vegetation. California tiger salamanders appear to actively avoid areas that are more likely to flood (Searcy *et al.* 2013).

Evidence suggests that juvenile California tiger salamanders disperse further into upland habitats than adults (Trenham and Shaffer, 2005). In addition, rather than staying in a single burrow, most individuals used several successive burrows at increasing distances from the pond. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather, because summer rain events seldom occur as metamorphosis is completed. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond (C. Searcy, *in litt,* 2012a).

Migratory Behavior, Metapopulation Structure and Dynamics

The California tiger salamander has a metapopulation structure. 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. California tiger salamanders appear to have high site-fidelity, returning to their natal pond as adults and commonly returning to the same terrestrial habitat areas after breeding (Orloff 2007, 2011; Trenham 2001). Wang *et al.* (2009) studied genetic distinctness across 16 Central California tiger salamander breeding sites (Fort Ord, Monterey County), and confirmed genetic differences amongst almost every site.

However, some salamanders will migrate to new breeding ponds. Trenham (2001) found that Central California tiger salamander travelled as far as 670 m (2,200 ft) between ponds. Migrants have been observed to be both first time breeders (last captured as newly metamorphosed juveniles) or experienced breeders (individuals last captured as breeding adults) (Trenham *et al*. 2001). Factors that repeatedly lower breeding success in isolated ponds that are too far from other ponds for migrating individuals to recolonize the pond can quickly drive a local population to extinction. Large, contiguous vernal pool complexes containing multiple breeding ponds are ideal to ensure that recolonization occurs at individual pond sites (Shaffer *et al*. 1993).

5. Critical Habitat

We designated revised critical habitat for the Sonoma County California tiger salamander on August 31, 2011 (76 **FR** 54346). The physical or biological features used to determine critical habitat for Sonoma County California tiger salamander are: 1) aquatic habitat, 2) upland nonbreeding habitat with underground refugia; and 3) dispersal habitat connecting occupied Sonoma California tiger salamander locations.

III. Existing Santa Rosa Plain Conservation, Restoration, and Management

A. SANTA ROSA VERNAL POOL ECOLOGICAL RESERVE SYSTEM

The Santa Rosa Vernal Pool Ecological Reserve System (Reserve) was established in the late 1990s (Pavlik *et al.* 1998) to integrate properties owned or controlled by the California Department of Fish and Wildlife (Department) on the Plain into a scientifically based planning, management and public service system. The establishment of the Reserve was the first attempt to create a coordinated preserve network, to specify how research could identify essential habitat factors, and to develop appropriate management prescriptions for improving quality of vernal pool habitat. A long-term research program was subsequently initiated on three Reserve properties to determine those management prescriptions (Pavlik *et al.* 2000, 2001).

B. SANTA ROSA PLAIN CONSERVATION STRATEGY

The listing of the California tiger salamander, following endangered designation given the three listed Santa Rosa Plain plants, caused a level of uncertainty for local jurisdictions, landowners, and developers regarding their activities in the presence of endangered species. Consequently, the Santa Rosa Plain Conservation Strategy (Strategy) was developed by the Service, Department, the Army Corps of Engineers, U.S. Environmental Protection Agency, Regional Water Quality Control Board, and local jurisdictions, interest groups, and community representatives in order to coordinate development with the conservation needs of the species (USFWS 2005).

The purpose of the Strategy is threefold: (1) to establish a long-term conservation program sufficient to mitigate potential adverse effects of future development on the Plain, and to conserve and contribute to the recovery of the listed species and the conservation of their sensitive habitat; (2) to accomplish the preceding in a fashion that protects stakeholders' (both public and private) land use interests, and (3) to support issuance of an authorization for incidental take of Sonoma County California tiger salamander and listed plants that may occur in the course of carrying out a broad range of activities on the Plain. The Strategy establishes interim and long-term mitigation requirements and designates conservation areas where mitigation will occur. It describes how habitat preserves will be established and managed. It also includes guidelines for translocation, management plans, adaptive management and funding.

The Strategy identifies areas within the Plain that should be conserved to benefit both the listed plants and Sonoma County California tiger salamander. Their designation was based upon the following factors: 1) known distribution of the California tiger salamander; 2) the presence of suitable habitat; 3) presence of large blocks of natural or restorable land; 4) proximity to existing Preserves; and 5) known location of the listed plants. The designation of conservation areas also generally attempted to avoid future development areas established by urban growth boundaries and city general plans. The objective of these conservation areas is to ensure that preservation occurs throughout the distribution of the species.

C. PROGRAMMATIC BIOLOGICAL OPINIONS

As with the filling of other wetlands, the filling of seasonal wetlands (such as vernal pools and swales) is regulated under Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers is responsible for reviewing proposed wetland fills, and granting permits if warranted. Under Section 7 of the Endangered Species Act, the U.S. Army Corps of Engineers shall, in consultation with the U.S. Fish and Wildlife Service, ensure that the proposed fill project does not jeopardize any federally listed endangered or threatened species. In 1998, a programmatic biological opinion was signed to implement this process for the three listed plant species. In 2007, we released a programmatic biological opinion based on the Strategy, which included the recently listed Sonoma County California tiger salamander. Section 7 consultation currently moves forward within the framework of the existing Strategy. For more information about consultation under the ESA, see *Section IV. Reasons for Listing and Current Threats*. With the development of this recovery plan, conservation efforts will further be aligned with the biological and ecological needs of the covered species in order to achieve recovery goals.

D. CONSERVATION BANKS

Since the Sonoma County California tiger salamander and three plants were listed, multiple conservation banks have been established and vernal pool and grassland habitat have been protected with conservation easements. Although the trend of habitat loss has continued since the species were listed protection of land through conservation easements and other conservation tools has resulted in the preservation of wetland and upland habitat for the California tiger salamander and for the listed plant species.

Several conservation banks have been authorized to offer credits as compensation for impacts to the four listed species addressed in this plan for projects that result in habitat loss or degradation. All have funding mechanisms such as endowment funds for the perpetual management of the habitat to ensure the survival of the listed species present within the conservation banks. Table 4 summarizes these conservation banks.

E. OTHER COOPERATIVE CONSERVATION EFFORTS

The Laguna de Santa Rosa Foundation, a local conservation group, is leading an effort to maintain a volunteer-based monitoring program to conduct yearly plant surveys using Laguna de Santa Rosa Foundation staff and expert California Native Plant Society volunteers. Data from these assessments date back to 2007, and volunteers are monitoring local populations as time permits, when conditions are appropriate, and when access is granted. The surveys aspire to establish a framework that allows for hypothesis testing to assess the success of various management regimes over the long-term (C. Sloop, pers. comm., 2007). However, as a volunteer effort, it is difficult to assure comprehensive coverage and systematic data collection. Existing conservation efforts work within available funding and align ongoing permitting using strategic planning in order to meet the conservation needs of the covered species. Collectively, they contribute towards meeting recovery needs. However, to achieve downlisting and delisting goals, coordinated planning and active restoration and adaptive management is needed to reduce ongoing threats to species persistence and to implement restoration in a manner consistent with appropriate recovery benchmarks. This Plan provides the systematic framework for this process, including action prioritization, and includes tangible performance measures (ecological criteria) to track progress towards our recovery goals.

Table 4. Summary of conservation banks established for Santa Rosa Recovery Plan Species.

Bank	Total Acreage	Habitat Created/Restored	Pool Habitat Preserved	Sonoma CTS Habitat Preserved	Owned by State of CA
Alton North Conservation Bank	22.5	12.48	7.24[5]	9.92	Y
Carinalli Todd Road Mitigation Bank	66.55	21.06	21.06[6] 0.50[7] 2.56[8]	45.49	N
Desmond Mitigation Bank	48.3	13.6	13.6[3]		N
Hale Mitigation Bank	75	23	9.3[3]	52	N
Hazel Mitigation Bank[9]	101	31.25		69.75	Y
Horn Mitigation Bank parcel 2[10]	14.23	5		9.23	N
Laguna (Carinalli) Mitigation Bank	28	5.17	5.17[11]		N
Margaret West Conservation Bank	21.62	0[7]		21.62	Y

[5] *Lasthenia burkei* and *Blennosperma bakeri*
[6] *Blennosperma bakeri*, *Limnanthes vinculans*, and Sonoma County California tiger salamander
[7] *Limnanthes vinculans*
[8] *Blennosperma bakeri*
[9] Sonoma County California tiger salamander not yet observed onsite
[10] Not a Sonoma County California tiger salamander bank, but discovered onsite recently
[11] *Limnanthes vinculans* present but acreage unknown.

Bank	Total Acreage	Habitat Created/Restored	Pool Habitat Preserved	Sonoma CTS Habitat Preserved	Owned by State of CA
Martin Conservation Bank[5]	12.3	0.14		12.16	Y
Slippery Rock Conservation Bank	38.06	5.69[12]		32.37	Y
SW Santa Rosa Vernal Pool Preservation Bank	39.4	0	2.33[4] 10.73[3]	39.4	Y
Swift/Turner Conservation Bank	34.18	0	2.45[3] 1.00[13] 0.10[14] 3.89[15]	34.18	Y
Wright Preservation Bank	174	0		174	Y
Total Acreage	**606.85**	**103.73**		**503.12**	**451.07**

[12] *Blennosperma bakeri* present. *Limnanthes vinculans* present in small, unconfirmed areal extent
[13] *Blennosperma bakeri* and *Limnanthes vinculans* at Swift
[14] *Lasthenia burkei*, *Blennosperma bakeri* and *Limnanthes vinculans* at Swift
[15] *Limnanthes vinculans* at Turner

IV. Reasons for Listing and Current Threats

The following is a summary of the interacting influences of physical, chemical, and biological factors that threaten *Blennosperma bakeri*, *Lasthenia burkei*, *Limnanthes vinculans,* and the Sonoma County California tiger salamander. In determining whether to list, delist, or reclassify a species under section 4(a) of the Act, we evaluate the threats to the species based on the five categories outlined in section 4(a)(1) of the Act: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence.

A. THREE ENDANGERED SANTA ROSA PLANTS

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The loss and fragmentation of habitat due to urban development, associated road construction, agriculture-land conversion, and habitat degradation from poor grazing practices, agriculture, and other human-related changes to vernal pool hydrology are listed as the primary threats to these species in the 1991 listing rule (56 **FR** 61173). Additional secondary threats identified in the 1991 rule include off-road vehicles and erosion. During the past 40 years, the Santa Rosa Plain has changed from a primarily rural residential/agricultural area with large expanses of open space to a more urbanized and intensely agricultural area with less open space. This change in land use has resulted in a substantial loss and alteration of seasonal wetland habitat, especially of vernal pools (U.S. Army Corps of Engineers 2014). Vernal pool habitat on the Plain now occurs as remnants in a matrix of agriculture, development, and fragmented remains of valley oak woodland, grassland, and persistent wetland vegetation (City of Santa Rosa 2014).

Today, the largest continuing threats to these species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities. The most recent estimates from the California Department of Conservation (2002), are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, wastewater irrigation, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although, the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit wastewater discharge to surface waters during the summer, the regulations did not contemplate that wastewater would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007).

These three major threats, urban development, land conversion to agriculture and associated agricultural activities, and wastewater irrigation, overlap in the types of effects these activities have on the plant species. Effects on the listed plants include complete loss of habitat from fill or excavation of vernal pools and swales. Another major change to the landscape is altered hydrology which degrades habitat. Because vernal pool plants are sensitive to variations in the timing and duration of vernal pool inundations (Bauder 2000), alteration of hydrology, whether increasing or decreasing, can have cascading effects on the habitat and species. Following disturbance (such as urban development, waterwater irrigation, and some agricultural practices), non-native plants occur commonly in vernal pool complexes and are a threat to native vernal pool plants through their capacity to change pool hydrology and through competition with native plants (Zedler and Black 2004).

Some actions, such as runoff from irrigation or wastewater irrigation, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural run-off continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, wastewater irrigation and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients that can alter the vernal pool plant community, prevent germination, or kill seedlings.

Other actions can alter the hydrologic regime by decreasing the water to the landscape. For example: breaking the clay hard pan (deep ripping) can result in draining the pools; loss of vernal pool habitat to residential, commercial, and industrial development can lead to changing or removing the hydrological connections that sustain the remnant vernal pools; regular disking, a common activity for fire prevention, can result in "smearing" (flattening the landscape), interrupting the normal flow of water into the pools and swales; and truncation of runoff from upstream sources and trenching to promote drainage directs water away from the vernal pools. Without the hydrologic connections, the vernal pools and swales do not fill sufficiently to promote seed germination and seedling growth. However, the plants can still persist in the seedbank and have been known to "reappear" once appropriate hydrologic conditions are reestablished (Rosburg, 2001; Kivilaan *et al.* 1981; Zedler *et al.* 2004).

Additionally, creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005).

Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants;. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour *et al.* 1987).

Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, *in litt.*, 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005).

Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (*Phalaris aquatica*), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two And grazing will not remove this species once it is established (G. Cooley, *in litt.* 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-management livestock grazing may be beneficial to vernal pool ecosystems, poor grazing management adversely impacts the three listed plants.

Damage by off-highway vehicles was noted as a threat to *Blennosperma bakeri* in the listing. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur; however, without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from Mosquito Vector Control vehicles driving through the vernal pools to spray for mosquitoes during the time when the pools are wet. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, *in litt*. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor.
In summary, *Blennosperma bakeri, Lasthenia burkei*, and *Limnanthes vinculans* are threatened primarily by urban development and conversion of vernal habitat to agricultural uses, which can result in complete habitat loss, alteration of hydrology, habitat fragmentation, and invasion by non-native plants. In addition, the species are threatened by damage to their vernal pool habitat from vehicles during mosquito abatement activities.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The 1991 final rule stated that the three Santa Rosa plant species may be vulnerable to overutilization for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants consequent to increased publicity and notoriety following Federal listing (56 **FR** 61173). Additionally, the final rule noted that *Limnanthes* species have high potential value to agricultural research, and that collection may become more of a threat. We are not aware of any information to suggest that these activities have become a threat since listing.

The collection of seed and inoculum (soil containing seeds, plant parts, etc.) from extant locations for the purpose establishing additional populations of *Blennosperma bakeri* and *Lasthenia burkei* in preserves is becoming more important in recovering these species because of the very low number of remaining viable populations. There may be some amount of risk of collecting seeds from extant populations, but it is anticipated that the level of risk is likely much less than the benefits from establishing new populations at restored sites. To reduce the potential for unacceptable risk to these extant populations, the Department is requiring baseline surveys prior to the collection of seeds and follow-up monitoring surveys to gauge any potential adverse effects (S. Wilson pers. comm. 2007). The Department also requires a take permit for collection of seed from any State-listed plants (S. Buss, pers. comm. 2014).

FACTOR C: Disease or Predation

The 1991 final rule to list the three plants did not include any information on disease. We are not aware of any disease or predation factors that threaten occurrences of these species to date.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

In the final rule (56 **FR** 61173), we found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity.

Local Protections

We are not aware of any county or city ordinances or regulations that provide specific protection for the listed plants. These include land management regulations addressing vegetation control for fire prevention, water quality ordinances, or limitations within grading ordinances for agricultural conversion in habitat adjacent to vernal pool habitat that supports the species. Sonoma County began applying regulatory oversight to conversions to vineyards, which requires full-scale environmental analyses, restrictions on the steepness of slopes on which vineyards may be established, and requirements for erosion control plans and measures. However, it is unclear if the restriction on planting vineyards on steep slopes may effectively place more pressures to cultivate flat areas that contain habitat for the listed plants.

Federal Protections

National Environmental Policy Act: This law (42 U.S.C. 4371 et seq.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, the National Environmental Policy Act (NEPA) requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, this law does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

Clean Water Act: Under section 404, the U.S. Army Corps of Engineers (Corps) regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the Corps' criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Any action involving placement of fill material into waters of the United States must be reviewed under the Clean Water Act (CWA), NEPA, and (where listed species are present) the Endangered Species Act (Act). These reviews require evaluations of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts.

The Corps interprets "the waters of the United States" expansively to include not only traditional navigable waters and wetlands, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. However, recent Supreme Court rulings have called this definition into question. On June 19, 2006, the U.S. Supreme Court vacated two district court judgments that upheld this interpretation as it applied to two cases involving "isolated" wetlands. Currently, Corps regulatory oversight of such wetlands (e.g., vernal pools) is in doubt because of their "isolated" nature. In response to the Supreme Court decision, the Corps and the U.S. Environmental Protection Agency have released a memorandum providing guidelines for determining jurisdiction under the Clean Water Act. The guidelines provide for a case-by-case determination of a "significant nexus" standard that may protect some, but not all, isolated wetland habitat (USEPA and USACE 2007). The overall effect of the new permit guidelines on loss of isolated wetlands, such as vernal pool habitat, is not known at this time.

Endangered Species Act: The Act is the primary Federal law providing protection for the listed species covered within this recovery plan. Our responsibilities include administering the Act, including sections 7, 9, and 10 that address "take." Protection of listed plant species by the jeopardy standard in the section 7 consultation process applies to the seedbank and habitat of listed plants as well as to above ground individuals. Plants are protected in two particular circumstances. Section 9 prohibits (1) the removal and reduction to possession (i.e., collection) of endangered plants from lands under Federal jurisdiction, and (2) the removal, cutting digging, damage, or destruction of endangered plants on any other area in knowing violation of a state law or regulation. Section 9 also makes illegal the international and interstate transport, import export and sale or offer for sale of endangered plants and animals. The Act may provide incidental protection to federally listed plants that co-occur with federally listed wildlife species (such as the Sonoma County DPS of California tiger salamander) when Federal agencies consult with the Service under section 7(a)(2) (see Factor D for Sonoma County California tiger salamander below for more information). We did not designate critical habitat for any of the three plant species.

The Strategy and the 2007 Programmatic Biological Opinion for U.S. Army Corps of Engineers (Corps) Permitted Projects that May Affect California Tiger Salamander and Three Endangered Plant Species on the Santa Rosa Plain, California (Service 2007), provide a conservation framework for the Santa Rosa Plain and require conservation for impacts to the four listed species (see further discussion in B. Existing Santa Rosa Plain Conservation, Restoration, and Management).

California State Laws

The State's authority to conserve plants is comprised of four pieces of legislation: The California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA).

California Endangered Species Act (CESA): CESA (California Fish and Game Code, section 2080 et seq.) prohibits the unauthorized take of State-listed threatened or endangered species. This law requires State agencies to consult with the Department on activities that may affect a State-listed species and mitigate for any adverse impacts to the species or its habitat. Pursuant to the California Endangered Species Act, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities.

California Environmental Quality Act (CEQA): This law requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through this law is, therefore, dependent upon the discretion of the lead agency involved.

Natural Community Conservation Planning Act: The Natural Community Conservation Program (NCCP) is a cooperative effort to protect habitats and species on a regional level. The program helps identify and provide for area-wide protection of plants, animals, and their habitats while allowing compatible and appropriate economic activity. Many NCCPs are developed in conjunction with Habitat Conservation Plans prepared pursuant to the Federal Endangered Species Act.

Lasthenia burkei and *Limnanthes vinculans* became State-listed as endangered in 1979 and *Blennosperma bakeri* in 1992. Unlike the take prohibition in the Act, the State prohibition includes plants; however, landowners are exempt from this prohibition for plants taken via habitat modification. Where landowners have been notified by the State that a rare or endangered plant is growing on their land, the landowners are required to notify the Department 10 days in advance of changing land use in order to allow salvage of listed plants (NPPA Division 2, Chapter 10, section 1913); however, it is unlikely the three listed plants would survive such transplanting.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other manmade threats stated in the 1991 final rule include competition from non-native grasses and forbs, trampling associated with grazing, and the maintenance of roadway shoulders through grading and application of herbicides (56 **FR** 61173). In general, the potential for stochastic (random or unpredictable) extirpations of occurrences increases with their isolation and small size (Patterson *et al*. 1994; CNDDB 2008). Current threats include those discussed in the 1991 final rule, and the new threats of thatch build-up, potential disruption of normal gene flow, and climate change. Thatch accumulation and competition with nonnative plants are discussed under Factor A, although they were originally addressed in Factor E in the final listing. Additionally, reduction or loss of species-specific pollinators could result in reduced seed production.

Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences

Chance events constitute a serious threat to *Blennosperma bakeri, Lasthenia burkei,* and *Limnanthes vinculans*. Because the known occurrences of the three plant species, particularly *B. bakeri* and *L. burkei*, are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species.

Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens *et al.* 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998).

The predominant breeding system of *Blennosperma bakeri, Limnanthes vinculans*, and *Lasthenia burkei* is out-crossing via insect pollinators, with some potential for self-fertilized seed set (Sloop *et al.* 2012). If pollinators are absent or present in low numbers, there may be insufficient viable seeds produced to maintain the seedbank. In the study by Sloop *et al.* (2012), occurrences of all three species with plant cover greater than 35 percent showed significant increase in average seed set, suggesting that pollination is a factor of floral density, therefore, plant density is directly relevant to attracting pollinators. Floral display helps bees and other pollinators find flowers, and if floral density is high, pollinators can travel more efficiently between flowers, increasing seed set (Sloop *et al.* 2012).

Loss of Genetic Diversity / Inappropriate Mixing of Populations

An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department.

Climate Change

Since the 1950's, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly *et al.* 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly *et al.* 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al.* 1999, Cayan *et al.* 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) by up to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan *et al.* 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level; and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field *et al.* 1999)].

Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion.

Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including *B. bakeri*, *L. burkei*, and *L. vinculans*.

B. SONOMA COUNTY CALIFORNIA TIGER SALAMANDER

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

At the time of listing, we determined that the primary cause for the decline of the Sonoma County California tiger salamander was loss, degradation, and fragmentation of habitat as the result of urbanization (68 **FR** 13497). This DPS occurs in scattered, and increasingly isolated, breeding sites within a small portion of its historical range on the Plain. Habitat may also be altered or degraded by land management activities, some of which negatively impact the hydrology and vernal pool/grassland plant community structure to which the Sonoma County California tiger salamander is adapted. Climate change was not discussed as a threat at the time of listing; however, it is considered to be a threat at this time.

Habitat Destruction and Loss

It is estimated that, by 1990, 25 percent of the 28,000-acre range of this DPS within the Plain had been converted to subdivisions, ranchettes, golf courses, and commercial buildings, while an additional 17 percent of this area had been converted to agricultural uses by 1990 (Waaland *et al.* 1990). At the time of listing, five known breeding sites had been destroyed in the previous 2 years (68 **FR** 13497). There were eight known remaining breeding sites distributed in the City of Santa Rosa and immediate associated unincorporated areas, an area approximately 8 km (5 mi) long by 6 km (4 mi) wide. At listing, we determined that all eight of these breeding sites were threatened by urbanization (68 **FR** 13497).

Habitat fragmentation also plays a role in reducing Sonoma County California tiger salamander abundances. California tiger salamanders require a large amount of barrier-free landscape for successful migration (Shaffer *et al.* 1993; Loredo *et al.* 1996). Urbanization and conversion to intensive agriculture can create permanent barriers that can isolate California tiger salamanders and prevent them from moving to new breeding habitat, or prevent them from returning to their breeding ponds or underground burrow sites. Roads and highways also create permanent physical obstacles and increase habitat fragmentation. Road construction can reduce or completely eliminate the viability of a breeding site, and in some cases, larger portions of a metapopulation (68 **FR** 13497).

Since the time of listing of the Sonoma County California tiger salamander, preserves and conservation banks have been established. However, current preserve sizes for remnant populations are insufficient to support stable metapopulation dynamics. Cook *et al.* (2005) recommend that preserves contain multiple breeding pools and at least 2,067 feet (630 meters) of upland habitat sounding the pools in all directions, based on research by Trenham and Shaffer (2005). Because California tiger salamanders commonly move thousands of feet from breeding pools (Searcy and Shaffer 2008, 2011; Trenham and Shaffer 2005; Orloff 2007; Searcy *et al.* 2013), it is likely that none of the current preserves in Sonoma County are large enough on their own to encompass the normal movements of all, or even most, salamanders dispersing from the breeding pools.

We still consider habitat loss and fragmentation to be the primary threat to the Sonoma County California tiger salamander. With rapid development of the Plain for a variety of human uses, many vernal pools have been eliminated or degraded, and large areas of upland habitat have been converted to high-intensity human uses, which are unsuitable for salamanders because they lack the aquatic and upland habitat necessary for the salamander (Cook *et al.* 2005). In addition to complete loss of habitat, residential and agricultural development has also reduced terrestrial habitat quality and connectivity. Overall, although the pace of urbanization has slowed over the past half-decade, market forces are driving expansion and conversion of agricultural uses from rangelands to less compatible land uses (i.e., vineyards). This continues to threaten remnant habitat, as does the lack of management within these areas to benefit endangered and native vernal pool animal and plant assemblages, including the Sonoma County California tiger salamander.

Habitat Alteration

Sonoma County California tiger salamander habitat is also degraded by certain activities, including measures to control burrowing rodents, and alteration of hydrology due to wastewater irrigation (effluent disposal), as well as proliferation of dense invasive weeds that overtake vernal pool habitats in the absence of grazing or mowing. These stressors have been discussed in the threats analysis for the three listed plants, and as they affect vernal pool communities, they also degrade conditions for Sonoma County California tiger salamander.

California tiger salamanders are strongly associated with California ground squirrel and pocket gopher populations, as the burrows created by active colonies of ground squirrels are necessary for the salamanders to survive (Loredo *et al.* 1996; Shaffer *et al.* 1993; Van Hattem 2004). Botta's pocket gopher burrows are most often used by Sonoma County California tiger salamanders (D. Cook and P. Northen, *in litt*, 2001). Because ground squirrels and pocket gophers are critical for burrow construction and maintenance, and therefore critical to the California tiger salamander, rodent population control efforts are a potential threat. However, the effects of these control efforts are often short-lived, as recovery of ground squirrel populations can be very rapid through immigration from nearby populations with high levels of reproductive success (Gilson and Salmon 1990). The extent to which small mammal eradication efforts are conducted within the range of the Sonoma County California tiger salamander is unknown at this time, therefore it is difficult to ascertain the magnitude of this particular risk factor.

Livestock grazing was regarded as a potential threat to the species at the time of listing (68 **FR** 13497). We expressed concerns regarding cattle use within livestock ponds because such use can result in lower water quality via increased siltation from excessive trampling as well as increased nitrogen levels from cattle excrement. Despite these concerns, we concluded that light to moderate livestock-grazing is compatible with Sonoma County California tiger salamander habitat use, provided the grazed areas do not also have intensive burrowing rodent control efforts.

Grazing plays an important role in vernal pool habitat management, as grazed vernal pools have longer ponding durations (Marty 2005). Taller grass, or grass with significant thatch build-up, may make dispersal more difficult for migrating California tiger salamanders. In addition, taller grass heights have been associated with declines in ground squirrel populations (Ford *et al.* 2012). We believe that threats from cattle grazing to California tiger salamanders are far outweighed by the benefits provided by appropriate cattle grazing to this species.

Wastewater irrigation is a factor affecting vernal pools on the Plain. This practice began in the 1970s and continues today. Wastewater irrigation changes seasonal wetland plant composition, and has possibly extirpated listed plant occurrences (CNDDB, 2014). Such habitat modification also impacts upland suitability for maturing and over-summering adult Sonoma County California tiger salamanders as the fundamental habitat characteristics of grazed, grassland and burrow habitat shifts to densely vegetated fields whose primary function is evapotranspiration of excess wastewater. This effect is akin to ceasing a regular grazing or mowing regime.

Climate Change

Climate change was not considered a threat to California tiger salamanders at the time of listing (68 **FR** 13497). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al.* 1999, Cayan *et al.* 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) by up to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan *et al.* 2008). Increased evapotranspiration may lead to shorter ponding durations, thereby reducing reproductive success in the California tiger salamander.

Because California experiences highly variable annual rainfall events and droughts, California tiger salamanders adapted a life history strategy to deal with inconsistent environmental conditions. A scenario that may operate under climate change is that different habitats may serve as population "sources" in different years, meaning these areas successfully rear juveniles to recolonize other areas, thereby buffering the metapopulation against climatic variability (Cook *et al.* 2005). However, climate change is expected to yield more erratic weather patterns. If an extended drought occurs, ponds may not persist long enough for larvae to transform and temperature extremes or fluctuations in water levels during the breeding season may kill large numbers of embryos.

The average lifespan of a California tiger salamander is 13 years (B. Shaffer, pers. comm., 2013) Thus, the longevity of adult California tiger salamanders may be sufficient to ensure population-level survival through droughts that do not persist for too many years (Barry and Shaffer 1994), presuming high reproductive success years within a single reproductive cohort (generation) also are realized during this interval. However, if long-term or more frequent and more severe droughts become the norm in the future, this will have significant implications for Sonoma County

California tiger salamanders. Further, the effect of extended and more frequent droughts in combination with other population-level stressors poses a significant risk to population viability.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial purposes was not known to be a factor in the 2003 final listing rule (68 **FR** 13497) and does not appear to be a threat at this time to the Sonoma County California tiger salamander.

FACTOR C: Disease or Predation

Disease

At the time of listing, the impact of disease on the Sonoma County California tiger salamander (if any) was not known (68 **FR** 13497). To date, pathogen outbreaks remain undocumented in Sonoma County California tiger salamander. Ranaviruses are emerging pathogens that are known to infect amphibians, reptiles, and fishes, and have caused tiger salamander die-offs throughout western North America (Jancovich *et al.* 2005). *Ambystoma tigrinum* Virus (ATV) is lethal to California tiger salamanders in experimental conditions (Picco *et al.* 2007). Regina ranavirus may pose a threat to California tiger salamanders since it has exhibited both direct and indirect negative effects on other *Ambystoma* species (Jancovich *et al.* 2003). It is suspected that iridoviruses in Arizona have infected native salamanders via introduced sport fish or bait salamanders (Jancovich *et al.* 2005).

A chytrid fungus (*Batrachochytrium dedrobatidis*) has been linked to native amphibian declines in California, as well as many amphibian species worldwide (Fellers *et al.* 2001; Garner *et al.* 2006), and has been found in California tiger salamanders in Santa Clara County (Padgett-Flohr and Longcore 2005). Because chytrid fungus is widespread throughout the species' range, it is likely that California tiger salamanders are widely exposed. Padgett-Flohr (2008) found that California tiger salamanders are susceptible to infection by chytrid fungus under lab conditions, but infection did not result in mortality (although no individuals were able to rid themselves of the fungus for the duration of the study—18 months). Although chytrid fungus has not been found responsible for California tiger salamander mortality in the laboratory conditions or the field, its potential to cause mortality or reduced fitness cannot be ruled out (CDFG 2010).

Disease must be considered a potential population threat in the foreseeable future because of the relatively small number of extant breeding sites within Sonoma County and the intensely fragmented nature of the habitat. In North American locations where ATV has been documented, high mortality rates illustrate the possibility that recurrent epidemics might increase local extinctions and hamper the ability of larger metapopulations to recover (Picco *et al.* 2007).

Predation

Bullfrogs were considered a threat to California tiger salamanders at the time of listing, and presently remain a threat. Bullfrogs and California tiger salamander tend to not co-occur in the same wetlands (Fisher and Shaffer 1996; Shaffer *et al.* 1993), suggesting exclusion of the native species via predation. Although bullfrogs are unable to establish permanent breeding populations in unaltered vernal pools and seasonal ponds (they take greater than a year to metamorphose (Degraaf and Yamasaki, 2001)), dispersing immature bullfrogs take up residence in these habitats during winter and spring (Seymour and Westphal 1994) and therefore may prey on California tiger salamander larvae and migrating adults. Bullfrogs have eliminated some California tiger salamander populations through over-predation (Shaffer *et al.* 1993).

At the time of listing, western mosquitofish (*Gambusia affinis*) were deemed a threat to California tiger salamander. The introduction of western mosquitofish to a breeding pond can eliminate an entire population (Jennings and Hayes 1994). Leyse and Lawler (2000) observed that mosquitofish did not have detectable effects on survival of California tiger salamander larvae in experimental ponds with simulated vernal pool hydrology (i.e., ephemeral ponding). However, mosquitofish reduced survival of salamander larvae in simulated perennial ponds, likely because permanent ponds allow mosquitofish populations to build from one season to the next. Furthermore, salamander larvae that did survive were smaller, took longer to reach metamorphosis, and had injuries such as shortened tails (Leyse and Lawler 2000).

Other fish species also threaten the California tiger salamander (Shaffer and Stanley 1991; Shaffer *et al.* 1993). Many non-native fish species are introduced by landowners to perennial wetland features for sport fishing or other reasons. The introduction of fish species such as largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) into ponds that may have been breeding habitat for California tiger salamander has likely eliminated salamanders from those sites (Shaffer *et al.* 1993). Other non-native predators cited in the final listing as threats to California tiger salamander include native and non-native crayfish species (*Pacifastacus*, *Orconectes*, and *Procambarus* spp.) (68 **FR** 13497). Crayfish also prey on California tiger salamanders (Shaffer *et al.* 1993), and are thought to have eliminated some populations (Jennings and Hayes 1994).

California tiger salamander eggs, larvae, and adults are also prey for many native species. In healthy salamander populations, this is not known to be a substantial threat (68 **FR** 13497). However, when combined with other impacts, such as predation by non-native species, contaminants, or habitat alteration, the collective result may be a substantial decrease in population abundance and viability. Native predators include the great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), western pond turtle (*Clemmys marmorata*), garter snakes (*Thamnophis* spp.), larger California tiger salamander larvae, larger western spadefoot (*Spea hammondii*) larvae, California red-legged frogs (*Rana draytonii*), and raccoons (*Procyon lotor*) (Hansen and Tremper 1993). Raccoons are highly effective predators on California tiger salamanders both during migration and when in the breeding ponds (CDFG 2010).

Shore birds, such as American avocet (*Recurvirostra americana*) and Forster's tern (*Sterna forsteri*) have been observed preying on California tiger salamander larvae (Allaback *et al.* 2005). Various gull species (*Larus* spp.) were observed preying on California tiger salamander larvae at Frick Lake and Brushy Peak Regional Preserve in Alameda County (S. Bobzien, *in litt*, 2003).

Predacious hexapods (a group of arthropods that includes insects), including giant water bugs (*Belostomatidae*), predacious diving beetles (*Dytiscidae*), waterscorpions (*Nepidae*), and dragonfly nymphs (*Anisoptera*) are known to prey on California tiger salamander larvae—the presence of predacious hexapods within a wetland may actually prevent California tiger salamanders from successfully breeding in the wetland (Bobzien and DiDonato 2007). California tiger salamander larvae and predatory aquatic insects will each prey on the other, and high densities of one can suppress the other. Ponding duration plays a role in determining which species will have the advantage in a particular wetland. Newly-hatched California tiger salamander larvae in permanent ponds will face a higher density of mature predatory insects that will prey on the salamander larvae. Seasonal ponds, on the other hand, are more likely to be initially free of these insects. Immigrating insects would enter seasonal ponds at low densities, and newly hatched insects are generally smaller than the California tiger salamander larvae present (Bobzien and DiDonato 2007).

Introductions of non-native tiger salamanders to Sonoma County would threaten the native California tiger salamanders for a variety of reasons, including the potential for the larger non-native and hybrid salamanders to prey on the smaller California tiger salamanders. Within a population of the Santa Barbara DPS of the California tiger salamander, hybrid tiger salamanders were observed preying on native California tiger salamanders and all cannibalism observed was unidirectional, with hybrids always preying on native California tiger salamanders (Ryan *et al.* 2009). The non-native tiger salamander has kin recognition, and is more likely to preferentially consume less-related individuals (Pfennig *et al.* 1999). Therefore, non-native and hybrid tiger salamanders may be more likely to cannibalize pure California tiger salamanders than more closely related hybrid salamanders.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

In the final rule to list the Sonoma County California tiger salamander as endangered (68 **FR** 13497), we concluded that Federal, State, and local laws have not been sufficient to prevent past and ongoing losses of the California tiger salamander and its habitat. The regulatory mechanisms that protect the Sonoma County California tiger salamander are largely enumerated above in *Factor D: Inadequacy of Existing Regulatory Mechanisms* for the three listed plants, above. These include Federal protections such as NEPA, CWA, and ESA, and State laws such as CESA, CEQA, and the NCCP. Information specific to the Sonoma County California tiger salamander is presented below.

California Endangered Species Act (CESA): The California tiger salamander was listed by the State of California as threatened under CESA in 2010 (see the plant threats section for complete discussion of protection of this regulation).

Other California Regulations: As of December 2000, it is illegal to use non-native salamanders (commonly referred to as "waterdogs") as bait or possess any member of the genus *Ambystoma* in California without a special permit from the CDFW (CCR, Title 14, §4.00 and §671). This regulation change was made to protect California tiger salamanders from hybridization with non-native tiger salamanders by further spread of the non-native species via deliberate or accidental release into State waters (CDFG 2010). Although possession and use for bait are now prohibited, a relict regulation still allows sale of non-native tiger salamanders as bait (Title 14 §200.31(c). This oversight will be eliminated in the next appropriate Department regulation change cycle (D. Steele, *in litt*, 2012).

Federal Protections

Endangered Species Act: Section 9 prohibits the taking of any federally listed endangered or threatened species. Section 3(18) defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. We define harassment as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally endangered and threatened wildlife.

On August 31, 2011, we revised the designation of critical habitat for the Sonoma County DPS of the California tiger salamander (76 **FR** 54346). The approximately 47,383 acres designated as critical habitat for the Sonoma County DPS provide needed aquatic and upland refugia habitats for adult salamanders to maintain and sustain extant occurrences of the species throughout their geographic and genetic ranges and provide those habitat components essential for the conservation of the species. (See the plant threats section for a complete discussion of other protections of this regulation).

The Lacey Act: The Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371, makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any United States or Indian tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquisition or purchasing of any wild animal, alive or dead. The designation of "wild animal" includes parts, products, eggs, or offspring.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

In the final rule to list the Sonoma County California tiger salamander as endangered (68 **FR** 13497), we concluded that mortality from road crossings, contaminants, mosquito abatement, hybridization with non-native tiger salamanders, and small population size are threats to the species. A discussion of these threats follows.

Mortality from Road Crossings

At the time of listing, mortality from road crossings was deemed a threat to the Sonoma County California tiger salamander (68 **FR** 13497). Mortality from road crossings has been well documented in Sonoma County (D. Cook, *in litt,* 2011; D. Cook, *in litt,* 2009). Dead California tiger salamanders have been found on over 16 roadways located from Santa Rosa to northern Petaluma (68 **FR** 13497). In particular, high numbers of California tiger salamanders have been documented killed on Stony Point Road, between Santa Rosa and Cotati. From 2000 to 2011 at total of 191 dead California tiger salamanders have been found on Stony Point Road out of 394 observations (D. Cook, *in litt*, 2011). Approximately 5-20 percent of the breeding adults are killed at this site annually (D. Cook, *in litt*, 2009). In addition, many road mortalities likely go undocumented as salamanders move at night during rain events and mortality events are difficult to document, so these estimates may be low. These loss rates suggest that roadway mortality may be a significant risk factor reducing Sonoma County California tiger salamander population viability. This especially is the case for this long-lived species that is adapted to a life history strategy of infrequent breeding (whereby the loss of adults to a population has a substantial impact).

Contaminants

Contaminants were considered a threat to California tiger salamanders at the time of listing (68 **FR** 13497). 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 (68 **FR** 13497). Sources of chemical pollution that may adversely affect California tiger salamanders include: contaminants from road runoff; agricultural and urban/suburban runoff; excess aquatic nitrate; and potential rodent and vector control programs (68 **FR** 13497). *Ambystoma* salamanders exposed to a combination of atrazine and nitrates were more susceptible to viral infections and had increased larval mortality (Forson and Storfer 2006a). Similar results were found with the effects of chlorpyrifos (an organophosphate insecticide) on the immune system of tiger salamanders (Kerby and Storfer 2009).

Atrazine (an herbicide) has been shown to both delay and reduce weight at metamorphosis for *Ambystoma* salamanders, which may reduce their chances for survival (Larson *et al.* 1998; Forson and Storfer 2006b). The insecticide methoxychlor has been shown to negatively impact the survival of long-toed salamanders at ecologically realistic concentrations, resulting in premature egg hatching and immobile larvae, with lower stimulus response making them more susceptible to predation (Ingerman *et al.* 1999; Verrell 2000). Hatch and Burton (1998) found that fluoranthene (a component of petroleum products typical in road run-off) at environmentally realistic concentrations reduced survival and resulted in growth abnormalities in spotted salamanders (*A. maculatum*). These hydrocarbon substances can also have indirect effects by disrupting the food web, such as decreased algae growth depleting the abundance of prey species, resulting in smaller salamander larvae (Lefcort *et al.* 1997).

We have not attempted to quantify exposure of Sonoma County California tiger salamanders to these specific compounds; however, they are (or are among) classes of compounds that are commonly used, or byproducts of, ubiquitous contaminants. Although little study has been published on the effects of contaminants specifically to California tiger salamanders, we believe that there is sufficient information available from other *Ambystoma* species (Larson *et al.* 1998; Forson and Storfer 2006b; Ingerman *et al.* 1999; Verrell 2000; Hatch and Burton 1998; Lefcort *et al.*1997) to conclude that contaminants likely adversely affect California tiger salamanders.

Mosquito Control (Abatement)

Mosquito control was considered a threat to California tiger salamanders at the time of listing (68 **FR** 13497) and it is still considered a threat at this time. Mosquito abatement agencies typically introduce mosquitofish to wetlands, including potential breeding habitat for California tiger salamanders. Mosquitofish will prey on California tiger salamanders (Leyse and Lawler 2000), and introductions of mosquitofish to a wetland can eliminate an entire cohort of developing California tiger salamander embryos or larvae (Jennings and Hayes 1994). In addition, both California tiger salamanders and mosquitofish feed on invertebrates and it is possible that large numbers of mosquitofish may out-compete the salamander larvae for food (Graf and Allen-Diaz 1993).

Mosquito control also includes the application of methoprene, which disrupts the molting process in insect larvae. The use of methoprene and other insecticides will likely have an indirect adverse effect on California tiger salamanders by reducing the availability of prey species. We are not aware of research on the direct effects of methoprene on California tiger salamanders; however, research has shown that methoprene appears to have both direct and indirect effects on growth, development and survival of larval amphibians (Ankley *et al.* 1998; Sparling 1998).

A bacterium, *Bacillus thuringiensis israeli* (Bti), is also commonly used for mosquito control. Bti reportedly does not affect insects other than larvae of mosquitoes and blackflies. However, the effects of Bti on the salamander prey base have not been quantified. The success of many aquatic vertebrates relies on an abundance of invertebrate prey in wetlands; therefore, the reduction in density of available prey likely affects reproductive success of California tiger salamanders (Lawrenz 1984).

Because of a lack of information regarding application rates for varied mosquito control chemicals, and a general lack of research specific to this stressor, the degree to which mosquito abatement practices affect Sonoma County California tiger salamanders cannot be determined at this time. We believe the use of these chemicals is a potentially serious threat to the species that requires further study.

Hybridization with Non-native Tiger Salamanders

Exotic species threaten native biodiversity through predation, competition, and habitat alteration, but also by hybridizing with native species. Hybridization between species can lead to genetic swamping, loss of native genetic diversity, and, in rare or endangered species, extirpation or extinction (Collins *et al.* 1988; Fitzpatrick and Shaffer 2007; Riley *et al.* 2003; Shaffer *et al.* 1993). At the time of listing, non-native tiger salamanders and hybrids were not considered a threat because non-native tiger salamanders were not known to occur within Sonoma County. The risk that non-native tiger salamanders could be introduced into Sonoma County wetlands exists, as introductions of these species have occurred in other areas of California within the range of the Central California and Santa Barbara DPSs. In these areas, it is apparent that genes from the non-native tiger salamanders (termed superinvasive alleles) are spreading over long distances and are becoming more common in the native Central California and Santa Barbara DPSs of the California tiger salamander due to hybridization (Shaffer *et al.*, 2004; Fitzpatrick *et al.* 2007, Fitzpatrick and Shaffer 2004), suggesting these genes confer a significant fitness benefit (at least in the habitat for Central California tiger salamander where they have spread), and that Central California tiger salamanders (and presumably Sonoma County California tiger salamanders alike) are capable of migration and genetic exchange across a fairly expansive area, given sufficient time and habitat connectivity. This factor increases the risk associated with genetic introgression (the movement of genes from one species to another).

Small Population Size

The low abundances within remaining populations of the Sonoma County California tiger salamander make the species vulnerable to risks associated with small, restricted populations. Risk is amplified in very small populations due to: (1) The impact of high death rates or low birth rates; (2) the effects of genetic drift (random fluctuations in gene frequencies) and inbreeding (mating among close relatives); and (3) deterioration in environmental quality (Gilpin and Soule´ 1986). Genetic drift and inbreeding may lead to reductions in the ability of individuals to survive and reproduce (*i.e.*, reductions in fitness) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Shaffer 1981, 1987).

V. Recovery Program

This section describes the Santa Rosa Plain recovery program by outlining the recovery strategy, identifying where recovery will occur, defining the recovery goal and objectives, establishing the downlisting and delisting criteria, and presenting the actions needed to meet the criteria that achieve our goals.

A. RECOVERY STRATEGY FOR SANTA ROSA PLAIN SPECIES

The species covered by this recovery plan*, Blennosperma bakeri*, *Lasthenia burkei*, *Limnanthes vinculans*, and the Sonoma County California tiger salamander have naturally limited geographic ranges, and are further constrained by inhabiting naturally rare habitat within that geographic range. Because the main cause of the decline and the main current threat to all species is the loss and degradation of habitat, our recovery strategy focuses upon this threat.

We will achieve recovery of these species by addressing the preservation of high-quality habitat that provides essential connectivity, reduces fragmentation, and sufficiently buffers against encroaching development. Management of these preserved areas will further provide protection to the habitat, and address non-habitat related threats. Surveys and habitat assessments (where data are lacking) will be conducted, as well as essential research to refine our knowledge on the recovery needs of the species. Additionally, habitat restoration to achieve proper functioning of a vernal pool ecosystem (and potentially reintroductions) is necessary to ensure stable populations and protect unique genetic diversity.

The key to the persistence and recovery of the three endangered Santa Rosa plants and the Sonoma County California tiger salamander lies in finding a combined approach of protecting sufficient habitat in the appropriate spatial arrangement, with proper management and threat amelioration to maintain suitable habitat quality to sustain survival, growth and reproduction of remnant and re-established populations. The habitat characteristics, species status, degree of threats, and needed recovery actions may vary by species within the plan boundary.

To accomplish this recovery strategy, we have defined core areas and management areas for the three endangered Santa Rosa plant species and the Sonoma County California tiger salamander. Core areas comprise the heart of the species historical (and current) range and represent central blocks of contiguously occupied habitat that function to allow for dispersal, genetic interchange between populations, and metapopulation dynamics. Management areas are occupied habitat peripheral to the species' core range (the core areas). However, the extent of the range is unknown due to poor survey coverage in peripheral areas and management areas have not been delineated on the map. The planning area covered by this plan encompasses the core areas and the management areas, both delineated and not delineated. A subsection of the planning area, the Santa Rosa Plain area, is the portion of the Plain where the bulk of recovery efforts will be focused. These areas are important, as they include geographic and ecological diversity not found within the core areas of the species' ranges. Further, the management areas often contain unique genetic diversity and local adaptations that are important to conserve for species viability rangewide. Where specific information and knowledge about genetic uniqueness and variability is lacking, protecting these ecologically and geographically diverse settings acts as a proxy to ensure protection of unique genetic and ecological traits.

The delineation of these core areas and management areas was based on known species ranges (based on CNDDB and AVP data), projections of potential species' range based on known habitat characteristics within adjacent areas (habitat in need of additional survey), or areas with the necessary conditions for potential restoration opportunities. Delineations have been made by geographic designators such as roads, creeks, or conservation area boundaries from the Strategy. With respect to plants, although these specific boundaries are not necessarily dispersal barriers to the listed species, they do correspond to areas where either 1) genetic information from available research to date exists to indicate historical isolation, or 2) soil types suggest breaks in the range (i.e., these breaks in soil layers are generally located along waterways). For purposes of recovery planning and implementation of restoration actions, these area boundaries are therefore the most practical.

Recovery criteria focus on habitat preservation within the core areas and management areas to support the necessary number of breeding populations, and address other needs to ensure recovery of each listed species. Within the recovery strategy, both core areas and management areas provide for resiliency (large enough populations to withstand stochastic events) and replication (sufficient number of populations). Because of the genetic uniqueness of some of the plants in the management areas (potentially due to low dispersal ability), the management areas also provide important representation (conservation of the breadth of genetic makeup to conserve adaptive capabilities) and therefore play a role beyond simple replication in the recovery of the plants.

The distinction between downlisting and delisting recovery criteria for all species centers on the degree of protection provided based on the number of robust populations across protected parcels within the species historic range. Criteria for downlisting require the replication of populations within all core areas based on habitat protection and occupancy. Delisting requires an overall greater level of replication of populations based on habitat protection and occupancy range-wide (across both the core and management areas) to further reduce extinction risk. Additionally, for the listed plants, delisting criteria includes replication of remnant native populations within management areas characterized by high genetic uniqueness.

Specific core and management areas are derived for each species, as follows:

1) *Blennosperma bakeri*

The Santa Rosa Plain area for *Blennosperma bakeri* was derived using soil types for which the species has a known habitat association.[16] All soil types used by the species were aggregated and circumscribed, and this is reflected by the bounded area of plant occurrences within the region of the Plain (see Figures 10-12). From this initial footprint, heavily urbanized areas were removed.

Within the *Blennosperma bakeri* recovery area there are three core areas (the Windsor Core Area, Alton Lane Core Area and *Blennosperma bakeri* Southern Core Area (BLBA Southern on the map)), one bounded management areas (*Blennosperma bakeri* Southern Management Area (BLBA Southern on the map)) (Figure 10), and two unbounded management areas (the Sonoma Valley Management Area and Sonoma Valley Regional Park Management Area). Survey coverage in the unbounded management areas is insufficient to bound likely occurrences in these areas; therefore, these areas do not appear on any maps.

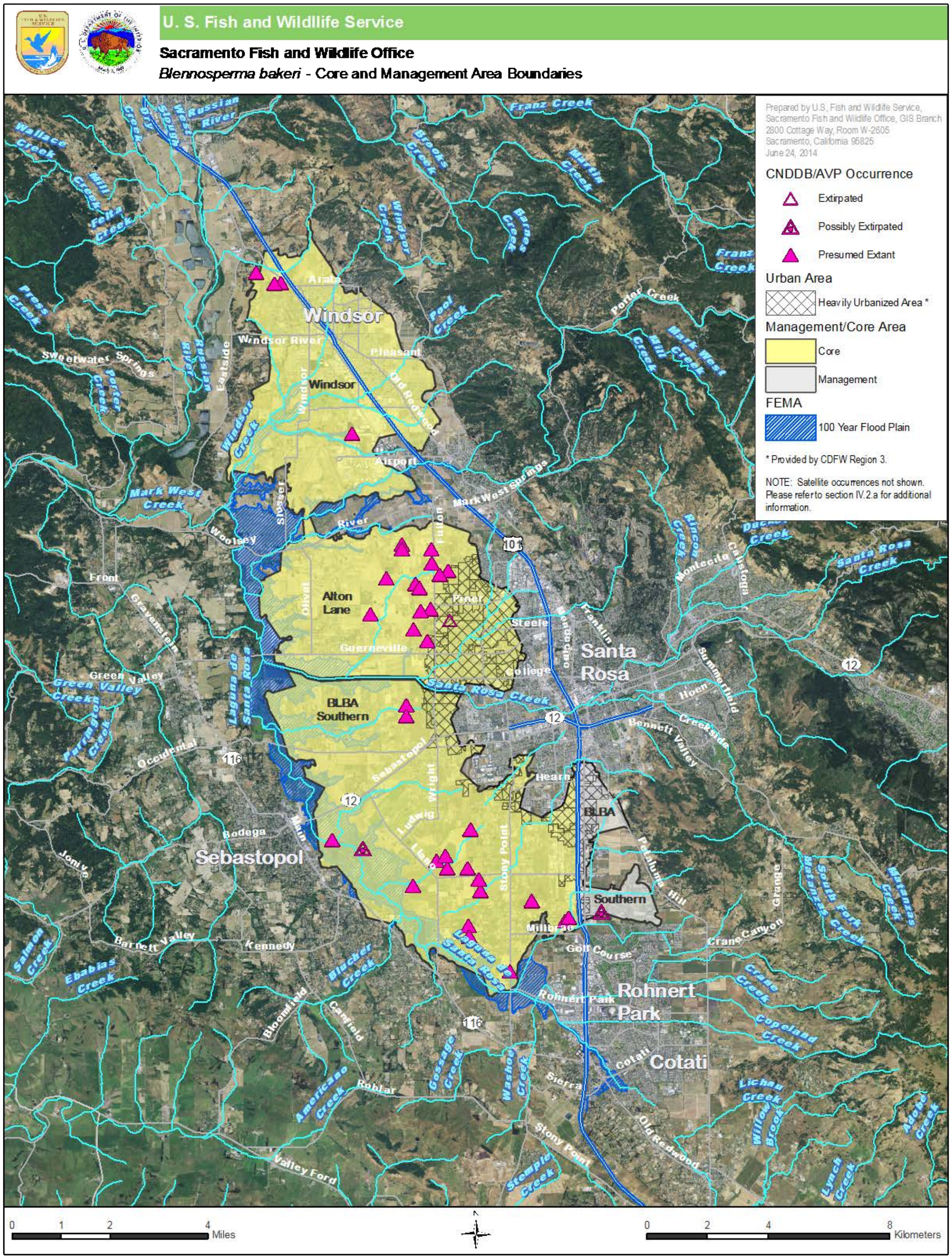
The Windsor Core Area is located in and round the Town of Windsor. The Alton Lane Core Area is south of Mark West Creek and north of Santa Rosa Creek, and the *Blennosperma bakeri* Southern Core Area is south of Santa Rosa Creek and west of Interstate Highway 101.

The *Blennosperma bakeri* Southern Management Area (is located south of the City of Santa Rosa between U.S. Highway 101 on the west and Petaluma Hill Road on the east. The *Blennosperma bakeri* Southern Management Area is adjacent to the *Blennosperma bakeri* Southern Core Area. Although this Management Area does not currently support *Blennosperma bakeri,* it does contain the appropriate soil types and suitable habitat for the species and provides opportunities for replication of the occurrences located in the *Blennosperma bakeri* Southern Core Area. Two additional unbounded management areas are located to the southeast of the *Blennosperma bakeri* Southern Management Area. One, the Sonoma Valley Management Area, encompasses two occurrences located along Highway 116 south of the Town of Sonoma. The other unbounded management area, the Sonoma Valley Regional Park Management Area, is located along Highway 12 and includes the Sonoma Valley Regional Park east of the Town of Glen Ellen. The Bouverie Preserve, adjacent to the Sonoma Valley Regional Park, may be considered as part of the Sonoma Valley Regional Park Management Area if *B. bakeri* is still found there.

Approximate acreage of *Blennosperma bakeri* suitable habitat that is currently protected in the core areas is: 50 ac in the Windsor Core Area; 80 ac in the Alton Lane Core Area; and 1,500 ac in the *Blennosperma bakeri* Southern Core Area (T. Love *in litt*., 2014). It is unknown; however, how much of this habitat is occupied by *B. bakeri.* Table 1 shows most recent occurrence baseline information.

[16] These include: Huichica loam (0 to 2 percent slope, 2 to 9 percent slope, and 0 to 5 percent slope); shallow Huichica loam (0 to 9 percent slope); shallow, ponded Huichica loam (0 to 5 percent slope) Wright loam (0 to 9 percent slope); shallow Wright loam (0 to 5 percent slope); shallow, wet Wright loam (0 to 2 percent slope); and shallow wet Wright loam (0 to 2 percent slopes) (NRCS 2009).

Figure 10. *Blennosperma bakeri* Core and Management Area Boundaries on the Santa Rosa Plain



2) *Lasthenia burkei*

The recovery area boundary for *Lasthenia burkei* was derived using a similar process to *Blennosperma bakeri*. Within the *Lasthenia burkei* recovery area there are three core areas (Windsor Core Area, Alton Lane Core Area, and *Lasthenia burkei* Southern Core Area (LABU Southern on map)) , one bounded management area (*Lasthenia burkei* Southern Management Area (LABU Southern on map)) (Figure 11), and six unbounded management areas (Clear Lake Management Area, Ukiah Management Area, Hidden Valley Lake Management Area, Healdsburg Management Area, Calistoga Management Area, and Fountaingrove Lake Management Area). Survey coverage in the unbounded management areas is insufficient to bound likely occurrences in these areas; therefore, these areas do not appear on any maps.

The Windsor Core Area is north of Mark West Creek, Alton Lane Core Area is south of Mark West Creek and north of Santa Rosa Creek, and *Lasthenia burkei* Southern Core Area is south of Santa Rosa Creek and west of Interstate Highway 101.

The *Lasthenia burkei* Southern Management Area is south of the *Lasthenia burkei* Southern Core Area. The Clear Lake Management Area is unbounded and encompasses the occurrences near Clear Lake. The Ukiah Management Area is unbounded and encompasses the occurrence(s) near the town of Ukiah. Four additional occurrences are considered unbounded management areas: Hidden Valley Lake Management Area (near Hidden Valley Lake), Healdsburg Management Area (north of Healdsburg), Calistoga Management Area (at Calistoga), and Fountaingrove Lake Management Area (near Fountaingrove Lake east of Santa Rosa). Survey coverage in these areas is insufficient to bound likely occurrences in these areas.

Approximate acreage of suitable habitat that is currently protected is: 50 ac in the Windsor Core area; 85 ac in the Alton Lane core area; 1,060 ac in the *Lasthenia burkei* Southern Core area; and 470 ac in the *Lasthenia burkei* Southern Management Area (T. Love, *in litt*. 2014). It is unknown however, how many of these acres are occupied by *L. burkei*. Table 2 shows most recent occurrence baseline information.

3) *Limnanthes vinculans*

The recovery area boundary for *Limnanthes vinculans* was derived using a similar process to *Blennosperma bakeri* and *Lasthenia burkei*. Within the *Limnanthes vinculans* recovery area there are two core areas, the *Limnanthes vinculans* Northern Core Area (LIVI Northern on the map) and *Limnanthes vinculans* Southern Core Areas (LIVI Southern on the map), one bounded management area (the Windsor Management Area) (Figure 12), and two unbounded management areas (Sonoma Valley Management Area and Knights Valley Management Area). Survey coverage in the unbounded management areas is insufficient to bound likely occurrences in these areas; therefore, these areas do not appear on any maps.

Figure 11. *Lasthenia burkei* Core and Management Area Boundaries on the Santa Rosa Plain

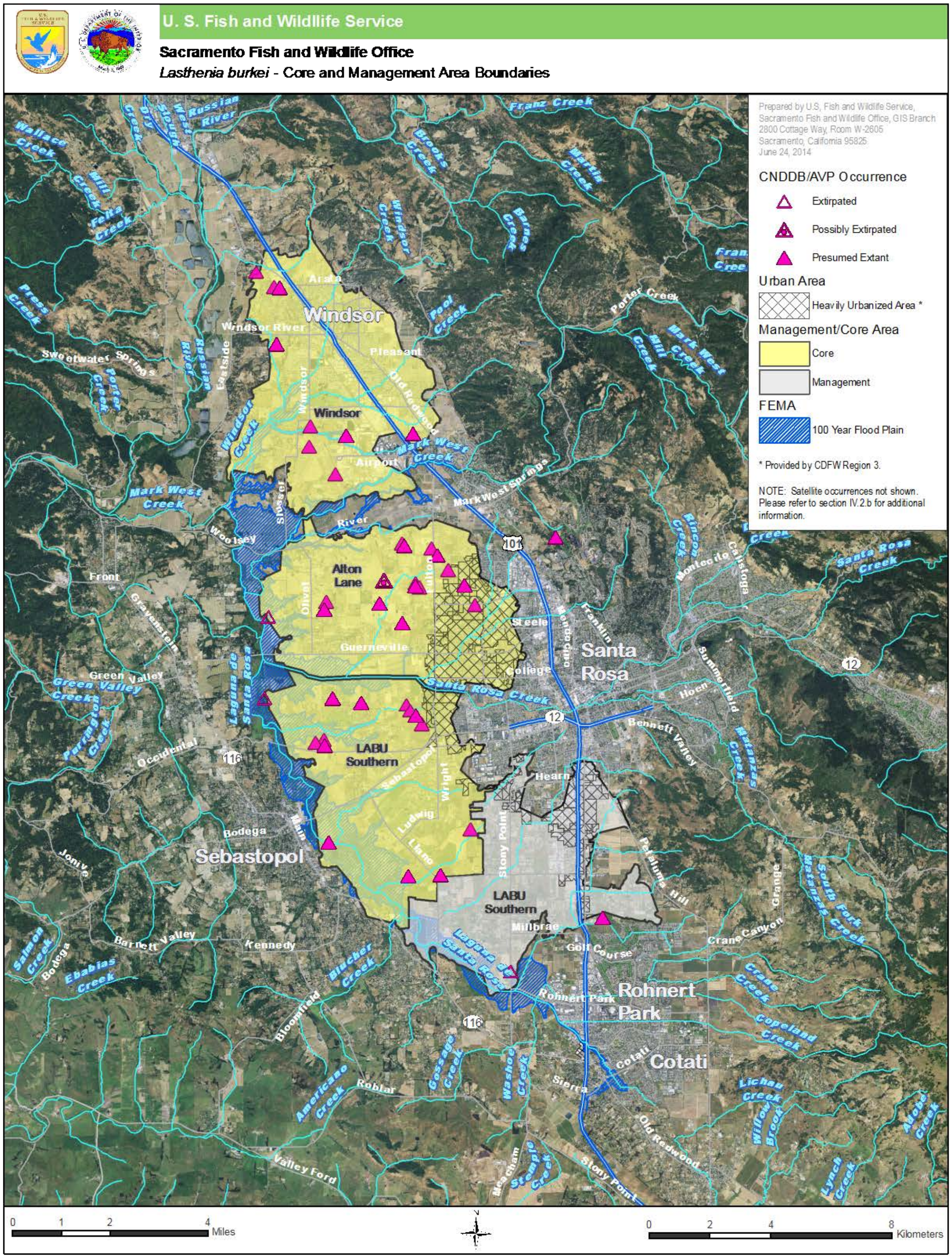
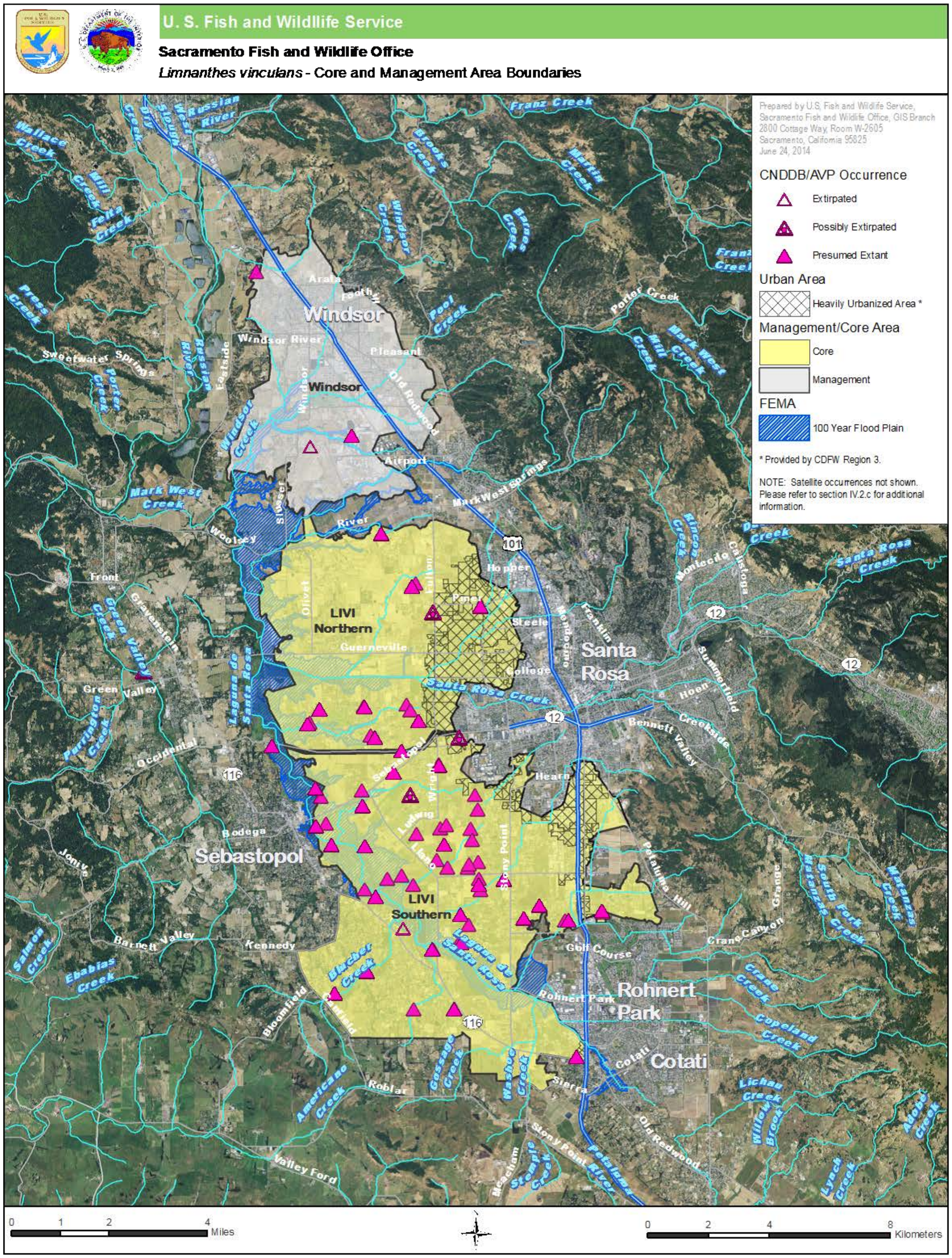


Figure 12. ***Limnanthes vinculans*** **Core and Management Area Boundaries on the Santa Rosa Plain**



The *Limnanthes vinculans* Northern Core Area is south of Mark West Creek and north of State Highway 12, and the *Limnanthes vinculans* Southern Core Area is south of State Highway 12 and crossing Interstate Highway 101 to the east.

The Windsor Management Area) is located in and around the City of Windsor north of Mark West Creek.

The Sonoma Valley Management Area) is unbounded and encompasses occurrence(s) near Sonoma. The Knights Valley Management Area is unbounded and encompasses occurrences along Highway 128 in Knights Valley. These areas have not been completely surveyed and additional occurrences may be found there.

Approximate acreage of *Limnanthes vinculans* suitable habitat that is currently protected is: 50 acres in the Windsor Management Area; 300 ac in the *Limnanthes vinculans* Northern Core Area; and 1,350 ac in the *Limnanthes vinculans* Southern Core Area (T. Love, *in litt*. 2014). It is unknown however, how much of this habitat is occupied by *L. vinculans*. Table 3 shows most recent occurrence baseline information.

4) Sonoma County California Tiger Salamander

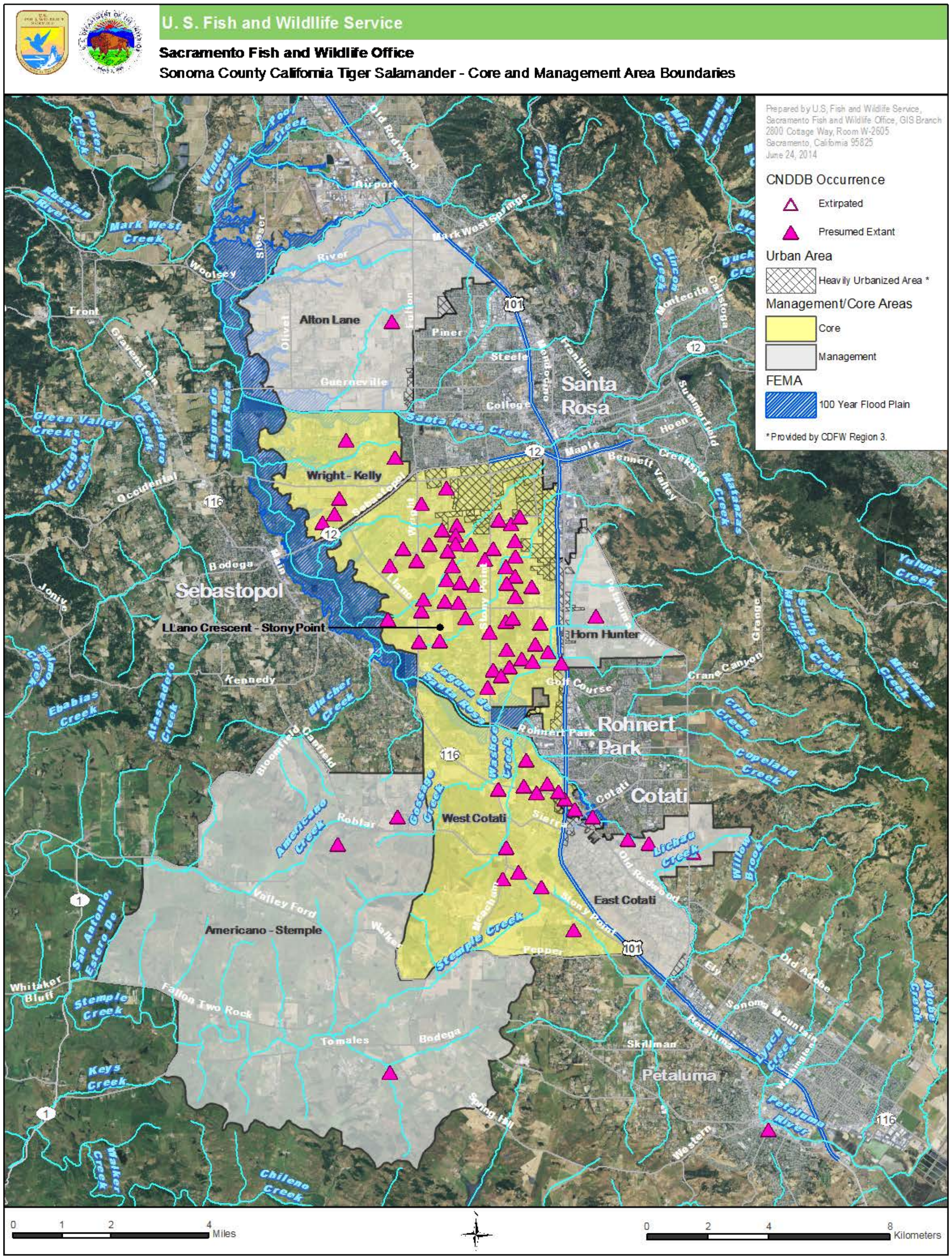
The recovery area for Sonoma County California tiger salamander comprises the heart of their range, the Plain, and also encompasses areas where they are either known to occur, or are believed to occur, based on habitat conditions and survey information available to date. This area generally constitutes the same geographic footprint reflected by the final critical habitat designation (76 **FR** 54346), but extends farther to the southwest of Cotati to include parts of the Americano Creek and the Stemple Creek watersheds, where a new occurrence of Sonoma County California tiger salamander was documented in 2013 (CNDDB 2014). This area is presented in Figure 13, below.

Within the Sonoma County California tiger salamander recovery area there are three core areas (the Wright-Kelly, Llano Crescent-Stony Point and West Cotati Core Areas), and four bounded management areas (the Alton Lane, Horn-Hunter, Americano-Stemple, and East Cotati Management Areas) that have been identified as possible areas for restoration (Figure 13).

The Wright-Kelly Core Area is bounded on the north by Santa Rosa Creek, to the west by the 100-year flood plain of the Laguna de Santa Rosa, to the east by the urbanized areas west of Fulton Road, and to the south by State Highway 12. This core area contains the Kelly (662 ac) and Wright Conservation Areas (668 ac), where 350-450 ac and 138-450 ac, respectively, are targeted for habitat acquisition in the Strategy.

The Llano Crescent-Stony Point Core Area is bounded on the north by State Highway 12, to the west by the 100-year flood plain of the Laguna de Santa Rosa, to the east by the urbanized areas of Santa Rosa, and to the south by the Laguna de

Figure 13. Sonoma County California Tiger Salamander Core and Management Area Boundaries on the Santa Rosa Plain



Santa Rosa and the urbanized area of northwest Cotati. This core area contains the Llano Crescent (1,705 ac) and Stony Point Conservation Areas (1,684 ac), where 382-900 ac and 329-750 ac, respectively, are targeted for habitat acquisition in the Strategy.

The West Cotati Core Area is bounded on the north by the Laguna de Santa Rosa, to the west by Stony Point and Meecham Roads, to the east by Highway 101, and to the south by Pepper Road. This core area contains the Northwest (1,309 ac) and Southwest Cotati Conservation Areas (1,647 ac), where 350-450 ac (in each area) are targeted for habitat acquisition in the Strategy.

The Alton Lane Management Area is bounded on the north by Mark West Creek and Highway 101, on the west by the 100-year flood plain along the Laguna de Santa Rosa, on the east by the urbanized areas of northern Santa Rosa and Fulton Road, and on the south by Santa Rosa Creek. Contained within this management area is the Alton Lane Conservation Area (905 ac) described within the Strategy (USFWS, 2005), where 294-350 acres of habitat acquisition are targeted.

The Horn-Hunter Management Area is bounded on the north by the urbanized area of southeast Santa Rosa, to the west by Highway 101, to the east by Petaluma Hill Road, and to the south by the urbanized area of northern Rohnert Park. This management area is not reflected in the Strategy, as the discovery of roughly 100 adult salamanders post-dated the conservation planning for that document.

The Americano-Stemple Management Area is comprised of the Americano Creek watershed where it is bounded on the north by Bloomfield, Canfield, and Bland Roads southeast of the town of Sebastopol, and within the Stemple Creek watershed where it is bounded to the west by Bloomfield, Gericke, and Twin Bridges Roads, to the east by Stony Point and Meecham Roads, and to the south and southeast by the Stemple Creek Watershed Boundary. This management area is not reflected in the Strategy, as the discovery of the localities that are currently occupied post-dated the conservation planning for that document.

The East Cotati Management Area is bounded on the north by the urbanized area of Rohnert Park, to the west and southwest by Highway 101, to the east by Roberts Ranch Road and Davis Lane, and to the south by Lichau Creek. Contained within this management area is the Southeast Cotati Conservation Area (1,114 ac) described within the Strategy, where 350-450 ac are targeted for habitat acquisition.

B. RECOVERY GOAL

The ultimate goal of this draft recovery plan is to sufficiently reduce the threats to *Blennosperma bakeri*, *Lasthenia burkei*, *Limnanthes vinculans*, and the Sonoma County California tiger salamander (*Ambystoma californiense*, Sonoma DPS) and ensure their long-term viability in the wild, to allow for their removal from the list of threatened and endangered species.

C. RECOVERY OBJECTIVES

To meet the recovery goal, the following objectives have been identified:

- Restore habitat conditions to sustain viable populations of all four species to support self-sufficiency in perpetuity.
- Maintain the current geographic, elevational, and ecological distribution of each listed species.
- Maintain the genetic structure and diversity of existing populations.
- Protect and manage sufficient habitat to ensure that the listed entity is able to adapt to unforeseen or unknown threats, such as climate change.
- Re-introduce individuals to successfully establish new populations in historically occupied areas within the current distribution.
- Minimize the effects of extant or potential threats.
- Monitor species population trends across multiple years (and varied climatic conditions) to determine whether populations are sustainable.
- Manage occurrences on a case-by-case basis during Section 7 consultation, with an emphasis on protections for identified core areas.

D. RECOVERY CRITERIA BY SPECIES

An endangered species is defined in the Act as a species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. When we evaluate whether or not a species warrants downlisting or delisting, we consider whether the species meets either of these definitions. A recovered species is one that no longer meets the Act's definitions of threatened or endangered due to amelioration of threats. Determining whether a species should be downlisted or delisted requires consideration of the same five categories of threats which were considered when the species was listed and which are specified in section 4(a)(1) of the Act.

Recovery criteria are conditions that, when met, indicate that a species may warrant downlisting or delisting. Thus, recovery criteria are mileposts that measure progress toward recovery. Because the appropriateness of delisting is assessed by evaluating the five threat factors identified in the Act, the recovery criteria below pertain to and are organized by these factors. These recovery criteria are our best assessment at this time of what needs to be completed so that the species may be removed from the list of threatened and endangered species. Because we cannot envision the exact course that recovery may take and because our understanding of the vulnerability of a species to threats is very likely to change as more is learned about the species and its threats, it is possible that a status review may indicate that delisting is warranted although not all recovery criteria are met. We do not yet have a complete picture of the growth rates, population dynamics, or likelihood of persistence of the three plant species into the future. The development of a population viability analysis based on updated survey data may provide this information and would assist in making our best assessment of the requirements for downlisting and delisting the species. Conversely, it is possible that the recovery criteria described below could be met and a status review may indicate that delisting is not warranted.

1. *Blennosperma bakeri*

Downlisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The reduction and fragmentation of habitat due to urban development, agriculture-land conversion, and habitat degradation as a result of modification to vernal pool hydrology, and competition with invasive plants are the primary threats to *Blennosperma bakeri*. In order to downlist *B. bakeri* to threatened status, threats to the species' habitat must be reduced. This will have been accomplished if the following have occurred:

A/1 Eighty percent[17] of extant, native occurrences, not currently protected, within each core area (Windsor Core Area Alton Lane Core Area and, *Blennosperma bakeri* Southern Core Area) are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to preserve isolated and/or genetically unique occurrences.

A/2 The following additional habitat is needed in order to downlist *B. bakeri*. New preserves protect a minimum of 50 ac in the Windsor Core Area, a minimum of 500 ac in the Alton Lane Core Area, and a minimum of 300 ac in the *Blennosperma bakeri* Southern Core Area[18]. These preserves consist of occupied habitat that is not currently protected. The ecological integrity (e.g., water quality, hydrology, uplands conditions) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to *Blennosperma bakeri*, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future.

A/3 New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with native occurrences may be less than 10 ac.[19] The preserves should be as near to new or existing preserves as possible[20].

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[17] Refer to Appendix A, 1.a.A/1.
[18] Refer to Appendix A, 1.a.A/2.
[19] Refer to Appendix A, 1.a.A/3a.
[20] Refer to Appendix A, 1.a.A/3b.

A/4 The total new preserve acreage in core area includes no less than 175 ac of vernal pools and swales in the Alton Lane Core Area, no less than 105 ac in the *Blennosperma bakeri* Southern Core Area, and no less than 18 ac in the Windsor Core Area.[21] However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages.[22]

A/5 Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented.

A/6 Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten *Blennosperma bakeri* at this time. Therefore, no recovery criteria have been developed for this factor. However, a resource agency-approved (by CDFW and USFWS), core area-specific reintroduction and genetic management plan that provides guidance for seed collection and seed use should be developed as described in 8.2 in the Stepdown Narrative.

FACTOR C: Disease or Predation

Disease and predation are not known to threaten *Blennosperma bakeri* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten *Blennosperma bakeri* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten *Blennosperma bakeri* include small, isolated populations, and climate change. To downlist *Blennosperma bakeri*, these threats must collectively be reduced. Because of past loss of habitat and occurrences of this species, robust and redundant (duplicate) occurrences are needed to ensure

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[21] Refer to Appendix A, 1.a.A/4a.
[22] Refer to Appendix A, 1.a.A/4b.

that the species persists in the event of reduced rainfall or other stochastic events. This will have been accomplished when the following have occurred:

E/1 Extant native occurrences in (a) the Windsor Core Area, and (b) the *Blennosperma bakeri* Southern Core Area are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected sites. Extant native occurrences in the Alton Lane Core Area are replicated at 1:2 (tripled) in permanently protected appropriate sites[23]. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3).

E/2 The preserves noted in Factor A are occupied by *Blennosperma bakeri* seeds at a density of 2,500 seeds per square meter[24] averaged over whole vernal pools and swales when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall.

E/3 Service-approved conservation and management plans that protect vernal pool habitat and address the effects of small occurrence size, and climate change, among other threats, are developed and are being effectively implemented. .

Delisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

In order to delist *Blennosperma bakeri*, the downlisting criteria must be met and the following criteria must also be achieved:

A/1 At least 90 percent [25]of all known native occurrences of *Blennosperma bakeri* that are extant as of December 2014, have been fully protected in perpetuity.[26]

A/2 100 ac of habitat containing *Blennosperma bakeri* is preserved and appropriately managed in the Sonoma Valley Management Area.

[23] Refer to Appendix A, 1.a.E/1.
[24] Refer to Appendix A, 1.a.E/2.
[25] Refer to Appendix A, 1.b.A/1a.
[26] Refer to Appendix A, 1.b.A/1b.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten *Blennosperma bakeri* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR C: Disease or Predation

Disease and predation are not known to threaten *Blennosperma bakeri* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten *Blennosperma bakeri* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten *Blennosperma bakeri* small, isolated populations; and climate change. To delist *Blennosperma bakeri*, these threats must collectively be reduced. Because of past loss of habitat and occurrences of this species, protected, robust and redundant (duplicate) occurrences are needed to ensure that the species persists in the event of reduced rainfall or other stochastic events. This will have been accomplished when the following have occurred:

E/1 In addition to replication noted in **E/1** of the downlisting criteria for *Blennosperma bakeri*, all occurrences in management areas have been replicated at 1:2 at appropriate locations. Bouverie Preserve, east of the Town of Glen Ellen, may be considered as part of the Sonoma Valley Regional Park Management Area and replicated at 1:2 if *Blennosperma bakeri* is still found there. This occurrence, if not already lost, could provide important genetic diversity and thus be valuable for the recovery of the species. The occurrences in the Sonoma Valley Management Area should be replicated at 1:3.

E/2 All replicate occurrences from **E/1** have achieved the same rates of seed density (2,500 seeds per square meter), as the core area occurrences.

E/3 All genetically unique and isolated unprotected sites in management areas are permanently protected *in situ* including: occurrences in Sonoma Valley Regional Park and the Wood Road area in the northern portion of the Alton Lane core area. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6.

2. *Lasthenia burkei*

Downlisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The reduction and fragmentation of habitat due to urban development, agriculture-land conversion, and habitat degradation as a result of modification to vernal pool hydrology, and competition with invasive plants are the primary threats to *Lasthenia burkei*. In order to downlist *Lasthenia burkei* to threatened status, threats to the species' habitat must be reduced. This will have been accomplished if the following have occurred:

A/1 Seventy-five percent [27] of extant, native occurrences, not currently protected, within each core area (Windsor Core Area, Alton Lane Core Area, and *Lasthenia burkei* Southern Core Area) are permanently protected and managed to maintain the habitat and the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that are isolated and /or genetically unique.

A/2 The following additional habitat is needed in order to delist or downlist *L. burkei*. New preserves consist of a minimum of 50 ac in the Windsor Core Area, a minimum 400 ac in the Alton Lane Core Area, and a minimum of 400 ac in the *Lasthenia burkei* Southern Core Area.[28] These preserves will consist of occupied habitat that is not protected as of December 2014. The ecological integrity (e.g., water quality, hydrology, uplands conditions) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to *Lasthenia burkei*, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future.

A/3 New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences or those providing protection to a large occurrence are less than 10 ac.[29] The preserves are as near to new or existing preserves as possible.[30]

A/4 New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac-

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[27] Refer to Appendix A, 2.a.A/1.
[28] Refer to Appendix A, 1.a.A/2.
[29] Refer to Appendix A, 1.a.A/3a.
[30] Refer to Appendix A, 1.a.A/3b.

preserve).[31] The total new preserve acreage in the core areas includes a minimum of 125 ac of vernal pools and swales distributed among the Alton Lane Core Area, *Lasthenia burkei* Southern Core Areas, and Windsor Core Area.[32]

A/5 Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented.

A/6 Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten *Lasthenia burkei* at this time. Therefore, no recovery criteria have been developed for this factor. However, a resource agency-approved (USFWS and CDFW), core area-specific Reintroduction and Genetic Management Plan that provides guidance for seed collection and seed use should be developed as described in 8 in the Stepdown Narrative.

FACTOR C: Disease or Predation

Disease or predation are not known to threaten *Lasthenia burkei* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten *Lasthenia burkei* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten *Lasthenia burkei* include small, isolated populations; and climate change. To downlist *L. burkei*, these threats must collectively be reduced. Because of past loss of habitat and occurrences of this species, protected robust and redundant (duplicate) occurrences are needed to ensure that the species persists in the event of reduced rainfall or other stochastic events. This will have been accomplished when the following have occurred:

E/1 All native occurrences, extant as of December 2014, are replicated at 1:2 (tripled in numbers of occurrences) in permanently protected

[31] Refer to Appendix A, 2.a.A/4a.
[32] Refer to Appendix A, 2.a.A/4b.

sites in the three core areas. Replication is accomplished as described in the **E/1** downlisting criteria for *Blennosperma bakeri*.

E/2 The preserves noted in Factor A are occupied by *Lasthenia burkei* at a density of 500 plants per square meter[33] when measured on a 25-year moving average which includes at least one above averageand one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall.

E/3 Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrence size, and climate change, among other threats, are developed and are being effectively implemented

Delisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

In order to delist *Lasthenia burkei*, the downlisting criteria must be met and the following criteria must also be achieved:

A/1 At least 90 percent[34] of native occurrences of *Lasthenia burkei*, extant as of December 2014, have been protected in perpetuity.[35]

A/2 New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac-preserve).[36]

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten *Lasthenia burkei* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR C: Disease or Predation

Disease and predation are not known to threaten *Lasthenia burkei* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

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33 Refer to Appendix A, 2.a.E/2.
34 Refer to Appendix A, 2.b.A/1.
35 Refer to Appendix A, 2.1.A/1.
36 Refer to Appendix A, 2.a.A/4a.

The inadequacy of existing regulatory mechanisms is not known to threaten *Lasthenia burkei* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten *Lasthenia burkei* include competition with nonnativeplants; small, isolated populations; and climate change. To delist *Lasthenia burkei*, these threats must collectively be reduced. Because of past loss of habitat and occurrences of this species, protected robust and redundant (duplicate) occurrences are needed to ensure that the species persists in the event of reduced rainfall or other stochastic events. This will have been accomplished when the downlisting criteria have been met and the following have occurred:

E/1 In addition to replication noted in **E/1** of the downlisting criteria for *Lasthenia burkei*, all occurrences in management areas have been replicated at 1:2 at permanently protected appropriate locations.

E/2 All replicate occurrences in management areas have achieved the same density (500 plants per square meter), as the core area occurrences.

E/3 All genetically unique and isolated unprotected sites in management areas are permanently protected *in situ*. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6.

3. *Limnanthes vinculans*

Downlisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The reduction and fragmentation of habitat due to urban development, agriculture-land conversion, and habitat degradation as a result of modification to vernal pool hydrology, and competition with invasive plants are the primary threats to *Limnanthes vinculans*. In order to downlist *L. vinculans* to threatened status, threats to the species' habitat must be reduced. This will have been accomplished if the following have occurred:

A/1 Of all extant, native occurrences in the Plain, not currently protected, 75 percent of the *Limnanthes vinculans* Northern Core Area occurrences, and 80 percent of the *Limnanthes vinculans* Southern Core Area occurrences are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species.[37] Priority should be given to occurrences that have been shown to be isolated and/or genetically unique.

A/2 New preserves protect a total of 500 ac in two general areas: 200 ac in the *Limnanthes vinculans* Northern Core Area, and 300 ac in the *Limnanthes vinculans* Southern Core Area.[38] These preserves consist of occupied habitat that was not protected as of December 2014. The ecological integrity (e.g., water quality, hydrology, uplands conditions) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses is sufficient to ensure that there are no significant adverse effects to *Limnanthes vinculans*, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future.

A/3 New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences may be less than 10 ac.[39] The preserves should be as near to new or existing preserves as possible.[40]

A/4 The total new preserve acreage among all core areas consists of a minimum of 70 ac of vernal pools and swales (40 ac in the *Limnanthes vinculans* Northern Core Area, and 30 ac in the *Limnanthes vinculans* Southern Core Area). However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages.[41]

A/5 Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented.

A/6 Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten *Limnanthes vinculans* at this time. Therefore, no recovery criteria have been developed for this factor. However,

[37] Refer to Appendix A, 3.a.A/1.
[38] Refer to Appendix A, 1.a.A/2.
[39] Refer to Appendix A, 3.a.A/3a.
[40] Refer to Appendix A, 3.a.A/3b.
[41] Refer to Appendix A, 3.a.A/4.

a resource agency-approved (USFWS and CDFW), core area-specific reintroduction and genetic management plan that provides guidance for seed collection and seed use should be developed as described in 8 in the Stepdown Narrative.

FACTOR C: Disease or Predation

Disease and predation are not known to threaten *Limnanthes vinculans* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten *Limnanthes vinculans* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten *Limnanthes vinculans* include competition with nonnativeplants; small, isolated populations; and climate change. To downlist *Limnanthes vinculans*, these threats must collectively be reduced. Because of loss of habitat and occurrences of this species, robust and redundant (duplicate) occurrences are needed to ensure that the species persists in the event of reduced rainfall or other stochastic events. This will have been accomplished when the following have occurred:

E/1 All native occurrences, extant as of December 2014, in the *Limnanthes vinculans* Northern Core Area as well as the Theiller (owned by CDFW) and Haroutounian (owned by Sonoma County Open Space) sites in the southern portion of the *Limnanthes vinculans* Southern Core Area, are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected appropriate sites[42]. The remaining occurrences in *Limnanthes vinculans* Southern Core Area are replicated at 1:1 because they are genetically similar. Replication is accomplished as described in **E/1** of *Blennosperma bakeri* downlisting criteria.

E/2 The preserves noted in Factor A are occupied by *Limnanthes vinculans* at a density of 1,500 seeds per square meter[43] when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall.

E/3 Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small

[42] Refer to Appendix A, 3.a.E/1.
[43] Refer to Appendix A, 3.a.E/2.

occurrences of the listed plants and climate change, are developed and are being effectively implemented.

Delisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

In order to delist *Limnanthes vinculans*, the downlisting criteria must be met and the following criteria must also be achieved:

A/1 At least ninety percent of all known occurrences of *Limnanthes vinculans* that are extant as of December 2014, have been protected in perpetuity.[44]

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten *Limnanthes vinculans* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR C: Disease or Predation

Disease or predation are not known to threaten *Limnanthes vinculans* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten *Limnanthes vinculans* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten *Limnanthes vinculans* include competition with nonnativeplants; small, isolated populations; and climate change. To delist *Limnanthes vinculans*, these threats must collectively be reduced. Because of loss of habitat and occurrences of this species, robust and redundant (duplicate) occurrences are needed to ensure that the species persists in the event of reduced rainfall or other stochastic events. This will have been accomplished when the downlisting criteria have been met and the following have occurred:

E/1 In addition to replication noted in **E/1** of the downlisting criteria for *Limnanthes vinculans*, all occurrences in management areas have been replicated at 1:2 at permanently protected at appropriate locations.

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[44] Refer to Appendix A, 3.b.A/1.

E/2 All replicate occurrences in management areas have achieved the same density (1,500 seeds per square meter), as the core area occurrences.

E/3 If *Limnanthes vinculans* is found at the Knights Valley site, the northernmost location, this occurrence should be replicated at 1:2 in permanently protected appropriate locations.

E/4 All genetically unique and isolated unprotected sites in management areas are permanently protected *in situ*. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6.

4. Sonoma County California Tiger Salamander

Downlisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

To downlist the Sonoma County California tiger salamander to threatened status, threats to the species' habitat must be reduced. This will have been accomplished if the following have occurred:

A/1 At least three viable metapopulations are protected within the core range of the Sonoma County California tiger salamander. This will be reflected by at least one self-sustaining metapopulation in each of the **three** core areas: the Wright-Kelly Core Area, the Llano Crescent-Stony Point Core Area, and the West Cotati Core Area.[45]

A/2 Each core area must have sufficient aquatic and upland habitat to support metapopulation dynamics by ensuring population connectivity, dispersal, and re-colonization of suitable breeding pools. This requires, at a minimum, a 308-ac centralized wetland/upland complex in fully preserved status in each of the three core areas.[46] In addition, contiguous, functional upland habitat must be present around each preserved complex, and must be substantially unfragmented (i.e., constituting no less than 50% of adjoining area extending 2.09 km (1.3 mi) from the center of the pool complex.[47]) This area may only be partially preserved.[48]

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[45] Refer to Appendix A, 4.a.A/1.
[46] Refer to Appendix A, 4.a.A/2a.
[47] Refer to Appendix A, 4.a.A/2b.
[48] Refer to Appendix A, 4.a.A/2c.

A/3 Each core area will support suitable aquatic breeding habitat to sustain the population in perpetuity (i.e., 95% probability of persistence over 100 years).[49] The hydrology of aquatic breeding habitat and the adjacent environment will be managed to sustain optimal breeding habitat conditions for Sonoma County California tiger salamander within the central breeding pool complexes. Based on best available information, we believe this requires no less than 4 ponds totaling 8 ac of breeding pool area (fewer acres would be required if more ponds are available—e.g, with 10 ponds, a total area of 2.5 ac may be sufficient)[50] with an inundation period of approximately four months.[51] To achieve the desired pooling duration, the best existing information suggests that pond areas should be no less than 0.25 ac, and pool depths ranging 40-80 cm (15.75-31.5 in).[52] Smaller pools are allowable if the local conditions are such to ensure pond duration sufficient for progeny to complete metamorphosis.

A/4 Upland habitat must be in suitable land use categories to support conditions necessary to sustain Sonoma County California tiger salamander populations in perpetuity.[53] These areas must be contiguous to the central complexes and connected by habitat corridors no less than 1,200 feet in width.[54]

Small Mammal Eradication Efforts

A/5 A Service-approved rodent management plan is implemented for preserves to ensure that small mammal eradication efforts are managed at intensities below those that may adversely affect the Sonoma County California tiger salamander populations in all preserve areas (including adjacent compatible lands counted towards recovery).[55] Limited eradication efforts in small areas (e.g., around a livestock watering trough or along a levee), may be permissible if these are determined to not directly or indirectly harm Sonoma County California tiger salamander, or determined to have an overall net benefit to the habitat.[56]

Livestock Grazing

A/6 A Service-approved management plan is implemented covering the preserves within the **three** core areas to incorporate optimum livestock grazing regimes and grazing management techniques to

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49 Refer to Appendix A, 4.a.A/3a.
50 Refer to Appendix A, 4.a.A/3b.
51 Refer to Appendix A, 4.a.A/3c.
52 Refer to Appendix A, 4.a.A/3d.
53 Refer to Appendix A, 4.a.A/4a.
54 Refer to Appendix A, 4.a.A/4b.
55 Refer to Appendix A, 4.a.A/5a.
56 Refer to Appendix A, 4.a.A/5b.

enhance habitat suitability and survival for Sonoma County California tiger salamander populations.

Climate Change

A/7 Wetland complexes within the preserves must meet or exceed the ponding criteria set out in **A/3** no less than eight times in a ten year period, when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. Preserves (natural or created) will balance availability of dry year breeding habitat against normal to wet year perennial ponding which could lead to proliferation of non-native competitors and predators.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten Sonoma County California tiger salamander at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR C: Disease or Predation

To downlist Sonoma County California tiger salamander, the threat of disease and predation must be measured and controlled to ensure that its potential impact is minimal. This will be accomplished when the following have occurred:

Disease

C/1 A Service-approved disease management plan is finalized and implemented to ensure that: 1) monitoring for early detection of ranaviruses and other pathogens is conducted within a representative sampling of sites across the three core areas, 2) infected populations are isolated should a ranavirus or other pathogen be detected, and 3) the risk of introduction of novel pathogens to Sonoma County California tiger salamander populations is reduced to a negligible level. Funding for disease monitoring and mitigation is assured in perpetuity through an endowment fund or other funding mechanism.

Predation

C/2 Predation from non-native species within all preserves contributing to recovery will be at a level that does not inhibit recruitment for the Sonoma County California tiger salamander below sustainable population growth rates.

C/3 To the maximum extent feasible, all aquatic breeding habitats should be ephemeral to ensure that fish, bullfrogs, and other non-native species cannot establish breeding populations. New preserves will be sited to minimize colonization risk posed by adjacent natural waterways or ditches.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten the Sonoma County California tiger salamander at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors that threaten the Sonoma County California tiger salamander include: road mortality, direct and indirect effects from contaminants, mosquito abatement efforts, possibility of hybridization with introduced non-native salamanders, overgrazing by cattle, small population size, and climate change. To downlist the Sonoma County California tiger salamander, these threats must collectively be reduced. This will have been accomplished when the following have occurred:

Exposure to Contaminants

E/1 A Service-approved contaminants management plan is implemented at preserves to assure that any detected contaminants at concentrations that may be harmful to Sonoma County California tiger salamander at the population level are reduced to tolerable thresholds (e.g., no greater than an effective concentration to reduce survival in adult lifestage greater than 1 percent [EC_{01}][57]).

E/2 Sufficient habitat is protected to ensure that all populations within the **three** core areas are adequately buffered from contaminant effects due to adjacent incompatible land uses.[58]

Mosquito Abatement Efforts

E/3 A Service-approved management plan is adopted in coordination with the local mosquito abatement district to implement specific mosquito control techniques at intensities compatible with Sonoma County California tiger salamander reproduction (including survival, growth and maturation of larvae).

57 Refer to Appendix A, 4.a.E/1.
58 Refer to Appendix A, 4.a.E/2.

Mortality from Road Crossings

E/4 All roads within protected core areas are assessed for road crossing issues (either as a barrier to dispersal or as an area where high levels of mortality from vehicle strikes occur). A Service-approved management plan is implemented to reduce roadway mortality by providing means for effective dispersal in a roadway impacted landscape. To the maximum extent practical, preserves should be located at least a mile from major road crossings.

Introduction of Non-native Salamander Genes

E/5 A Service-approved management plan to reduce the risk of hybridization with non-native salamanders with Sonoma County California tiger salamander is implemented. The plan should include management contingencies for reducing the degree of hybridization should non-native genes be introduced.[59]

Small Population Size

E/6 Each of the **three** core areas must support a minimum viable population of interbreeding individuals, at an estimated abundance of 5,409 individuals.[60]

Delisting Criteria

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

To delist the Sonoma County California tiger salamander, threats to the species' habitat must be reduced or removed. This will have been accomplished when the downlisting criteria have been met and when the following additional conditions have occurred:

A/1 Sufficient habitat to support viable metapopulations is protected in **two** management areas of the four that have been identified as suitable for restoration: the Alton Lane Management Area, the Horn/Hunter management area, the Americano/Stemple Management Area, and the Southeast Cotati Management Area.

A/2 Habitat criteria for management area preserves (308-ac central wetland complexes with 50% of land within 1.3 mi in compatible land use management) are identical to the ones defined in **A/2-A/7** of the downlisting criteria, with the exception that *all* habitat counted toward the recovery criteria in both core and management areas will be fully

[59] Refer to Appendix A, 4.a.E/5.
[60] Refer to Appendix A, 4.a.E/6.

preserved by public ownership or private easement, endowment, etc. to meet the delisting standard.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for any purpose is not known to threaten Sonoma County California tiger salamander at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR C: Disease or Predation

To delist Sonoma County California tiger salamander, the threat of disease and predation must be measured and controlled to ensure that its potential impact is minimal. This will be accomplished through the same management plans enumerated for downlisting for disease and predation (**C/1-C/3**, above), with the additional provision that funding to cover the geographic area encompassed within the incremental additional habitat preserves is available.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten the Sonoma County California tiger salamander at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

To delist the Sonoma County California tiger salamander, factor E threats must collectively be reduced. This will be accomplished via the same management plans enumerated for downlisting for contaminants, mosquito abatement, road mortality, and genetic integrity (**E/1-E/5**, above), with the provision that funding to cover the geographic area encompassed within the incremental additional habitat preserves is available. Downlisting criteria (**E/6**) to mitigate the threats of small population size will also apply in these two additional management areas for purposes of delisting the Sonoma County California tiger salamander.

E. RECOVERY ACTIONS STEPDOWN NARRATIVE

The actions identified below are those that, in our opinion, are necessary to bring about the recovery of *Blennosperma bakeri*, *Lasthenia burkei*, *Limnanthes vinculans*, and the Sonoma County California tiger salamander, and ensure the long-term conservation of these species. However, these actions are subject to modification as dictated by new findings, changes in species status, and the completion of other recovery actions. Each action has been assigned a priority according to our determination of what is most important for the recovery of these species based on the life history, ecology, and threats (see the **Background** section of this document) and the following definitions of the priorities:

Priority 1: An action that must be taken to prevent extinction or to prevent a species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline of the species population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

The following Recovery Actions Stepdown Narrative provides detail of the actions necessary to achieve full recovery. The priority assigned to each action is specified within parentheses at the end of the description.

1.0 Protect extant occurrences and potential habitat for *Blennosperma bakeri*, *Lasthenia burkei*, and *Limnanthes vinculans*.

Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. [61]

1.1 Identify and protect areas via land acquisition or conservation easement (from willing sellers),, or other methods, in core areas and management areas that support extant occurrences.

Private lands should be protected in perpetuity through easements, fee-simple acquisition by conservation agencies, or other mechanisms and managed to support the listed species. The protection of each occurrence should be prioritized based on its size, genetic uniqueness, landscape context, and current knowledge of the occurrence's status.

1.1.1 Identify and protect habitat for *Blennosperma bakeri*: Acquire habitat to contribute to *Blennosperma bakeri* downlisting criterion A/2-A/4. (Priority 1)

[61] Vernal pool creation is considered an experimental science because the extent to which entire vernal pool plant and invertebrate communities can be successfully recreated is still unknown (M. Showers, CDFW, *in litt*, 2005).

1.1.2 Identify and protect habitat for *Lasthenia burkei*: Acquire habitat to contribute to *Lasthenia burkei* downlisting criterion A/2-A/4. (Priority 1)

1.1.3 Identify and protect habitat for *Limnanthes vinculans*: Acquire habitat to contribute to *Limnanthes vinculans* downlisting criterion A/2-A/4. (Priority 1)

1.2 Identify and protect areas in core areas and management areas with potential to support reintroduced occurrences of the three plants species covered in this recovery plan.

Potential habitat should be protected in perpetuity through conservation management agreements, easements, fee-simple acquisition by conservation agencies, or other mechanisms and managed to support listed species.

1.2.1. Identify and protect habitat for reintroduction for *Blennosperma bakeri*. (Priority 2)

1.2.2. Identify and protect habitat for reintroduction for *Lasthenia burkei*. (Priority 2)

1.2.3. Identify and protect habitat for reintroduction for *Limnanthes vinculans*. (Priority 2)

1.3 Identify and protect areas in core areas and management areas with potential to support created vernal pool and swale complexes for species covered in this recovery plan. (Priority 2)

Potential habitat should be protected in perpetuity through easements and fee-simple acquisition by conservation agencies and managed to support listed species.

1.3.1. Identify and protect areas for creation of *Blennosperma bakeri* habitat. (Priority 2)

1.3.2. Identify and protect areas for creation of *Lasthenia burkei* habitat. (Priority 2)

1.3.3. Identify and protect areas for creation of *Limnanthes vinculans* habitat. (Priority 2)

2.0 Develop a central database for survey data from all natural and created occurrences of the three plant species including information on protection status.

Data should include numbers of plants, area occupied by the species, presence of invasive species, site condition, land ownership, level of management, disturbance, whether the site is natural, restored, or created, and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be noted. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies.

2.1 Collect and enter data for *Blennosperma bakeri* occurrences. (Priority 1)

2.2 Collect and enter data for *Lasthenia burkei* occurrences. (Priority 1)

2.3 Collect and enter data for *Limnanthes vinculans* occurrences. (Priority 1)

3.0 Collect and store seed from all occurrences of all three plant species covered in this recovery plan.

Seed collections for each plant taxa should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent[62] of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable.

3.1 Collect and store seeds of *Blennosperma bakeri*. (Priority 1)

3.2 Collect and store seeds of *Lasthenia burkei*. (Priority 1)

3.3 Collect and store seeds of *Limnanthes vinculans*. (Priority 1)

4.0 Survey historical locations and other potential habitat (not previously surveyed) where the three plant species covered in this plan may occur.

4.1 Survey unprotected historical occurrences. (Priority 1)

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[62] The Center for Plant Conservation (1991) guidelines are general guidelines. Until species-specific data are available, the special terms and conditions of section 10(a)(1)(A) permits for collection of seed of these species specify that no more than 5 percent of the projected annual seed production of any individual plant or discrete population of plants shall be collected. This limitation ensures that the volume of seed removed from the site will not appreciably reduce the size of the population.

Unprotected occurrences that are not confirmed as having been extirpated should be surveyed at least once every 3 years if landowner permission has been obtained. To increase efficiency and reduce costs, integrated survey programs involving several species in the same geographic area should be implemented where possible. Rediscovered populations should become candidates for protection efforts.

4.2 Survey potential habitat for new populations. (Priority 2)

Survey potential vernal pool habitat (habitat not previously surveyed, but that could support the listed species) throughout the range of each species, as feasible and if landowner permission has been obtained. Incorporate any newly discovered populations into all aspects of the recovery process.

5.0 Conduct research necessary to develop a population viability analysis for the three plants.

Table 2 lists research tasks needed for the development of a population viability analysis for the three plant species. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment.

Table 5. Needed Research Tasks for Developing a Population Viability Analysis for *Blennosperma bakeri, Lasthenia burkei, Limnanthes vinculans*

Task #	Research Task	Priority
5.1	Determine amount of seed set	1
5.2	Determine seed viability	1
5.3	Determine recruitment of plants from seed bank	1
5.4	Determine seedling survival	1
5.5	Determine likelihood of population persistence	1
5.6	Determine population growth rate	1
5.7	Determine what factors influence population viability	1
5.8	Determine what life stage is most critical for population viability	1
5.9	Determine what other factors limit the establishment of populations	1

6.0 Conduct necessary biological research on three listed plants and use results to guide recovery efforts.

Table 6 lists the needed research tasks for the recovery of *Blennosperma bakeri*, *Lasthenia burkei*, and *Limnanthes vinculans*. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment.

Table 6. Needed Research Tasks to Guide Recovery of *Blennosperma bakeri, Lasthenia burkei, Limnanthes vinculans*

Task #	Research Task	Priority
6.1	Collect occurrence size estimates (number of plants and area occupied) using methods consistent between sites and years for all listed plant species	1
6.2	Study effects of wastewater application on listed plants	1
6.3	Develop criteria for determining the maximum acceptable distance that seed or soil inoculum can be moved from original vernal pool donor site to introduction or restoration site.	1
6.4	Determine seed germination requirements	1
6.5	Determine seed viability	1
6.6	Determine upland habitat needs of pollinators	1
6.7	Determine effects of grazing including timing, intensity, and impacts of different types of grazing animals	1
6.8	Determine population genetics of all occurrences	2
6.9	Conduct research to determine methods of establishing occurrences of the three plant species in appropriate habitat	2
6.10	Determine density and movement of seeds within soil seed bank	2
6.11	Determine effects of loss of pollinators on listed plants	2
6.12	Determine mechanisms of seed dispersal	2
6.13	Determine seedling growth rates??	2
6.14	Compare effectiveness of invasive plant control treatments including mowing and mulching, mowing and phytomass removal, and no mowing. Study should also evaluate the effects of these treatments on the listed plants.	2
6.15	Determine if selective herbicides can be used to safely improve habitat for the three listed species without harming the listed plants or their pollinators	2

7.0 Habitat management for three listed plant species.

7.1 Develop adaptive management plans and implement appropriate management actions for all protected sites for all 3 plant species. (Priority 1)

Management plans that address recovery of the listed species should be developed and implemented to the extent possible for protected areas that are inhabited by listed species, and for protected areas that are potential sites for introduction of listed species. Management plans should include adaptive strategies to abate threats to listed species and to identify new threats as they appear. If new threats are identified or other new information about threats becomes available, management plans should be re-evaluated and revised to address abatement of those threats. Management activities should be evaluated periodically and adjusted to maximize the potential for survival, conservation, and recovery of listed species (i.e. adaptive management). Results of new biological research should also be considered in adaptive management schemes.

7.2 Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. (Priority 1)

Standards should address loss of vernal pool habitat and impacts to the listed plants from use of pesticides and herbicides.

7.3 Decrease acreage of vernal pool habitat within priority preservation and restoration areas that is sprayed with treated wastewater. (Priority 1)

The three plants will be aided if the City of Santa Rosa decreases the area of its land in the Santa Rosa Plain that is being sprayed with treated wastewater. Cessation of spraying wastewater on historically vernal wetland habitat will permit these lands to be dry in summer, as is natural for vernal wetlands, and would improve the ability of the endangered plants in these wetlands to survive and withstand competition from non-native vegetation.

7.4 Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (Priority 2)

Protection of the vernal pool habitat supporting the listed plants and California tiger salamander, particularly in the wet season, from the creation of tire ruts and crushing of plants will help prevent further loss of occupied habitat.

8.0 Restore or create vernal wetlands, followed by reintroduction of three listed plants per a restoration techniques white paper and a Reintroduction and Genetic Management Plan.

As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed.

8.1 Develop a white paper on what is currently known about techniques and success of restoration and creation of habitat for the three listed plants to identify relevant future research topics. (Priority 2)

8.2 Develop a resource agency-approved (USFWS and CDFW), core area-specific Reintroduction and Genetic Management Plan for each of the three plant species. The Reintroduction and Genetic Management Plan should provide guidance for seed collection, determining suitability of reintroduction and introduction sites, and protection of genetically unique occurrences. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. (Priority 2)

8.3 Restore or create habitat for *Blennosperma bakeri*, followed by reintroduction or introduction. (Priority 2)

8.4 Restore or create habitat for *Lasthenia burkei*, followed by reintroduction or introduction. (Priority 2)

8.5 Restore or create habitat for *Limnanthes vinculans*, followed by reintroduction or introduction. (Priority 2)

9.0 Monitor all protected occurrences.

Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. *Blennosperma bakeri* and *Limnanthes vinculans* at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (Priority 2)

10.0 Engage and educate the public about *Blennosperma bakeri, Lasthenia burkei, Limnanthes vinculans* recovery.

Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence.

Education and outreach activities should include (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land,. (Priority 3)

11.0 Maintain current geographic, elevational, and ecological distribution of Sonoma County California Tiger Salamander.

The following Recovery Actions will assist in the recovery of the Sonoma County California tiger salamander by protecting habitat and restoring or enhancing habitat, where necessary. This will ensure that self-sustaining populations of Sonoma County California tiger salamander are protected throughout the species range.

11.1 Acquire habitat within three centralized wetland/upland complexes, one within each core area.[63] (Priority 1)

11.2 Acquire centralized wetland/upland habitat within two additional management areas. [29] (Priority 2)

11.3 Acquire upland habitat adjacent to preserves within three core areas.[64] (Priority 1)

[63] Area will be owned in fee title by a government agency or other organization and managed in a manner that promotes Sonoma California tiger salamander conservation. All acreages for action 1 are derived from the downlisting and delisting (**A/1-A/2**) criteria, above.

[64] Peripheral upland habitat is grassland areas with burrows required for salamander growth and survival within dispersal distance from the network of breeding pools. It should be either: (1) owned in fee title by a government agency or conservation organization and managed for the benefit of the Sonoma California tiger salamander; or, (2), privately-owned lands that are protected in perpetuity with conservation easements and managed in a manner that promotes Sonoma California tiger salamander conservation.

11.4 Acquire upland habitat adjacent to preserves in two additional management areas.[30] (Priority 2)

12.0 Siting, Design, and Construction of Sonoma County California Tiger Salamander Breeding Habitat

12.1 Restore sites, or design and create preserve pools within three core area wetland/upland complexes to meet downlisting criteria specified in **A/2**-**A/4** and **A/7**, above. (Priority 1)

12.2 Restore sites, or design and create preserve pools within two management area wetland/upland complexes to meet delisting criteria specified in **A/2**-**A/4** and **A/7**, above. (Priority 2)

13.0 Agency Coordination

13.1 Partner with California Department of Fish and Wildlife, Army Corp of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with treated wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. (Priority 1)

14.0 Adaptive Management of Sonoma County California Tiger Salamander Recovery

14.1 Conduct necessary surveys and studies.

14.1.1 Monitor breeding sites to detect disease outbreaks. (Priority 3)

14.1.2 Assess non-native predator risk at breeding sites, and mitigate where necessary. (Priority 2)

14.1.3 Assess contaminant risks at breeding sites and mitigate where necessary. (Priority 2)

14.1.4 Assess contaminant risks at upland sites and mitigate where necessary. (Priority 3)

14.1.5 Assess mosquito abatement risks at breeding sites and mitigate where necessary. (Priority 2)

14.1.6 Assess road mortality risk to migrating adults and juvenile salamanders and develop conservation measures. (Priority 2)

14.1.7 Survey Americano/Stemple Management Area to determine population status. (Priority 2)

14.1.8 Survey Southeast Cotati Management Area to determine population status. (Priority 2)

14.1.9 Monitor population trends in the Horn/Hunter Management Area. (Priority 2)

14.2 Population Viability Analysis

14.2.1 Conduct research to determine current metapopulation abundances across the range of Sonoma County California tiger salamander. (Priority 1)

14.2.2 Monitor status and trend in all protected populations counted towards recovery. (Priority 1)

14.2.3 Determine Sonoma County California tiger salamander habitat use and movements (using telemetry or other appropriate methods) to determine their ability to navigate and sustain viable populations in fragmented habitat.[65] (Priority 1)

14.2.4 Conduct research to determine vital rates in Sonoma County California tiger salamander populations, including: survival of all life stages, recruitment, and adult fertility. (Priority 1)

14.2.5 Conduct population viability analyses specific to Sonoma County California tiger salamander metapopulations throughout the range. The analysis should focus on probability of persistence and using growth rate metrics, including other information available via actions 4.2.1-4.2.4. The specific benchmarks for recovery based on the population metric in this Recovery Plan would be revised, as needed, based on the results of this analysis. (Priority 1)

14.3 Other Sonoma County California Tiger Salamander Research

14.3.1 Conduct research to optimize non-native predator control. (Priority 3)

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[65] The habitat acreage metric (among others) would be revised, as needed, based on results from this research.

14.3.2 Conduct contaminants research following site assessments to ascertain risk from discovered compounds. (Priority 3)

14.3.3 Conduct research to identify and quantify specific threats from ongoing mosquito abatement efforts (specific methods of control used) and adverse effects (if any) to Sonoma County California tiger salamander at the population level. If effects are identified, also determine the most effective methods for mosquito control consistent with successful Sonoma County California tiger salamander breeding. (Priority 2)

14.3.4 Conduct research to determine required burrow densities and small mammal populations required to sustain viable metapopulations of Sonoma County California tiger salamanders. (Priority 3)

14.3.5 Conduct research to determine mortality rates associated with road crossings and identify best strategies to eliminate or reduce roadway mortality. (Priority 1)

14.3.6 Conduct research to determine optimal grazing strategies for habitats supporting Sonoma County California tiger salamander populations. (Priority 2)

14.3.7 Conduct research to determine reproductive success as a function of breeding pool design and management. (Priority 2)

14.3.8 Conduct research to determine the efficacy and utility of genetic information as an assessment tool to estimate population abundance and trend. (Priority 2)

15.0 Reporting and Planning: Sonoma County California Tiger Salamander

15.1 Develop and implement a Sonoma County California tiger salamander management plan to maintain habitat suitability in perpetuity. (Priority 2)

The management plan(s) will address: maintenance of adequate hydrology (**A/3, A/7**); burrowing mammal management (**A/5**); grazing management (**A/6**); disease detection, prevention, and mitigation measures (**C/1**); predator control (**C/2-C/3**); contaminants mitigation (**E/1-E/2**); mosquito abatement activities (**E/3**); road mortality mitigation (**E/4**); and protection of native alleles (**E/5**); The development and implementation of the management plans must occur on all protected habitat counted towards the recovery of the species.

V. IMPLEMENTATION SCHEDULE

The following implementation schedule outlines actions and estimated costs for this recovery plan. It is a guide for meeting the objectives discussed in Chapter II. This schedule prioritizes actions, provides an estimated timetable for performance of actions, indicates the responsible parties, and estimates costs of performing actions. These actions, when accomplished, should further the recovery and conservation of the listed species.

<u>Key to terms and acronyms used in the Implementation Schedule</u>:

Responsible Parties:

ALL - All Responsible Parties
CDFW - California Department of Fish and Wildlife
RWQCB - San Francisco Regional Water Quality Control Board
SSF - Contracted Seed Storage Facility
USFWS - U.S. Fish and Wildlife Service
USACE - US Army Corp of Engineers
County - Sonoma County agencies (Fire, Water, Sanitation)
VCD - Marin/Sonoma Mosquito and Vector Control District
City - Jurisdictional City Departments for Santa Rosa, Cotati, Rohnert Park, and Windsor
G – Grantee (e.g., contract biologist, organization, or University researcher)

Responsible parties are those agencies who may voluntarily participate in any aspect of implementation of particular tasks listed within this recovery plan. Responsible parties may willingly participate in project planning, provide funding, provide staff time, or contribute to other means of implementation. The most likely lead responsible party appears in bolded text in the table below.

Definition of action durations:

Continual (C): An action that will be implemented on a routine basis once begun.

Ongoing (O): An action that is currently being implemented and will continue until action is no longer necessary.

Unknown (U): Either action duration or associated costs are not known at this time.

Number: The predicted duration of the action in years.

To Be Determined (TBD): To Be Determined.

Table 7: Implementation Schedule for the Santa Rosa Plain Recovery Plan

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
Blennosperma bakeri						
1.1.1	1	Identify and protect habitat for *Blennosperma bakeri*. .	O	CDFW, USFWS	64,333	Total 850 acres. 75 % (638 ac) estimated as fee for title. 25% (212 ac) estimated as easement. 638 * $55,200 = $35,217,600. 212 * $7,150 = $1,515,800. For replicate sites, assumed 20 sites range wide, acquire 25 ac total for each: 500 ac * $55,200 = $27,600,000. Cost estimate includes actions 1.2.1 and 1.3.1.
1.2.1	2	Identify and protect habitat for reintroduction for *Blennosperma bakeri*.	C	CDFW, USFWS	U	Costs for this action are factored in to new preserve acquisition in 1.1.1 above, as occupancy in all areas is uncertain at this time.
1.3.1	2	Identify and protect areas for creation of *Blennosperma bakeri* habitat.	O	CDFW, USFWS	U	Costs for this action are factored in to new preserve acquisition in 1.1.1 above, as occupancy in all areas is uncertain at this time.
2.1	1	Collect and enter data for *Blennosperma bakeri* occurrences.	C	CDFW, USFWS	20	
3.1	1	Collect and store seeds of *Blennosperma bakeri*.	5	G	7	Estimated $2,500 + $150 per population (assumed 30).
8.3	2	Restore or create habitat for *Blennosperma bakeri*, followed by reintroduction or introduction.	C	G, CDFW, USFWS,	19,101	Restoration cost at new preserves 638 ac * $8,738 = $5,574,844. Creation (Siting/design/construction) cost: 212 * $34,950 = $7,409,400. For replicate sites: assumed 20 sites range wide, restore (75%) or construct (25%) 20 new acres each: 300 ac * $8,738 = $2,621,400. Creation cost: 100 ac * $34,950 = $3,495,000.
				Subtotal	**83,461**	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
Lasthenia burkei						
1.1.2	1	Identify and protect habitat for *Lasthenia burkei*.	O	CDFW, USFWS	78,133	Total 850 acres. 75% (638 ac) estimated as fee for title. 25% (212 ac) estimated as easement. 638 * $55,200 = $35,217,600. 212 * $7,150 = $1,515,800. For replicate sites, assumed 30 sites to acquire and replicate range wide. Acquire 25 ac total for each of 30: 750 ac * $55,200 = $41,400,000. Cost estimate includes actions 1.2.2 and 1.3.2.
1.2.2	2	Identify and protect areas for reintroduction of *Lasthenia burkei* habitat.	C	CDFW, USFWS	U	Costs for this action are factored in to new preserve acquisition in 1.1.2 above, as occupancy in all areas is uncertain at this time.
1.3.2	2	Identify and protect areas for creation of *Lasthenia burkei* habitat.	C	CDFW, USFWS	U	Costs for this action are factored in to new preserve acquisition in 1.1.2 above, as occupancy in all areas is uncertain at this time.
2.2	1	Collect and enter data for *Lasthenia burkei* occurrences.	C	CDFW, USFWS	20	
3.2	1	Collect and store seeds of *Lasthenia burkei*.	5	G	7	Estimated $2,500 + $150 per population (assumed 30 populations).
8.4	2	Restore or create habitat for *Lasthenia burkei*, followed by reintroduction or introduction.	O	G, CDFW, USFWS	24,470	Restoration cost at new preserves 638 ac * $8,738 = $5,570,844. Creation (siting/design/construction) cost: 212 * $34,950 = $7,409,400. For replicate sites, restore or construct 20 new acres each. Restoration cost 563 ac * $8,738 = $4,919,494. Siting/design/construction cost: 188 ac * $34,950 = $6,570,600.
				Subtotal	**102,630**	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
Limnanthes vinculans						
1.1.3	1	Identify and protect habitat for *Limnanthes vinculans*:	O	CDFW, USFWS	76,794	Total 500 acres. 75% (375 ac) estimated as fee for title. 25% (125 ac) estimated as easement. 375 * $55,200 = $20,700,000. 125 * $7,150 = $893,750. For replicate sites, assumed 40 sites to acquire and replicate range wide. Acquire 25 ac total for each: 1000 ac * $55,200 = $55,200,000. Cost estimate includes actions 1.2.3 and 1.3.3.
1.2.3	2	Identify and protect areas for reintroduction of *Limnanthes vinculans*.	C	CDFW, USFWS	U	Costs for this action are factored in to new preserve acquisition in 1.1.3 above, as occupancy in all areas is uncertain at this time.
1.3.3	2	Identify and protect areas for creation of *Limnanthes vinculans* habitat.	C	CDFW, USFWS	U	Costs for this action are factored in to new preserve acquisition in 1.1.3 above, as occupancy in all areas is uncertain at this time..
2.3	1	Collect and enter data for *Limnanthes vinculans* occurrences.	C	CDFW, USFWS G	20	
3.3	1	Collect and store seeds of *Limnanthes vinculans*.	5	G	7	Estimated $2,500 + $150 per population (assumed 30).
8.5	2	Restore or create habitat for *Limnanthes vinculans*, followed by reintroduction or introduction.	C	G CDFW, USFWS	22,937	Restoration cost at new preserves 375 ac * $8,738 = $3,276,750. Creation (siting/design/construction) cost: 125 * $34,950 = $4,368,750. For replicate sites, restore or construct 20 new acres each. Restoration cost: 750 ac * $8,738 = $6,553,500. Siting/design/construction cost: 250 ac * $34,950 = $8,737,500.
				Subtotal	**99,758**	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
All 3 Santa Rosa Plants						
4.1	1	Survey unprotected occurrences using methods consistent between sites and years for all listed plant species	5	G, CDFW, USFWS	90	15 d/ yr @ $400/d for 3 species (5 yrs)
4.2	2	Survey potential habitat for new populations using methods consistent between sites and years for all listed plant species.	5	G, CDFW, USFWS	90	15 d/ yr @ $400/d for 3 species (5 yrs)
5.1	1	Determine amount of seed set	5	G, CDFW, USFWS	10	
5.2	1	Determine seed viability	5	SSF, CDFW, USFWS	20	
5.3	1	Determine recruitment of plants from seed bank	5	CDFW, USFWS, G	100	
5.4	1	Determine seedling survival	5	CDFW, USFWS, G	10	
5.5	1	Determine likelihood of population persistence	3	CDFW, USFWS, G	50	
5.6	1	Determine population growth rate	5	G, CDFW, USFWS	10	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
5.7	1	Determine what factors influence population viability.	1	G, CDFW, USFWS	1,000	
5.8	1	Determine what life stage is most critical for population viability	1	G, CDFW, USFWS	100	
5.9	1	Determine what other factors limit the establishment of populations	1	CDFW, USFWS G	500	
6.1	1	Collect occurrence size estimates (number of plants and area occupied) using methods consistent between sites and years for all listed plant species	TBD	G, CDFW, USFWS	1,800	15 d/ yr @ $800/d for 3 species (50 yrs)
6.2	1	Study effects of wastewater application on listed plants.	TBD	G CDFW, USFWS	100	
6.3	1	Develop criteria for determining the maximum acceptable distance that seed or soil inoculum can be moved from original vernal pool donor site to introduction or restoration site.	TBD	CDFW, USFWS, G	20	
6.4	1	Study seed germination requirements.	TBD	SSF, G, CDFW, USFWS	40	
6.5	1	Study seed viability.	TBD	SSF, G, CDFW, USFWS	10	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
6.6	1	Determine upland habitat needs of pollinators.	TBD	G, CDFW, USFWS	100	
6.7	1	Study effects of grazing including timing, intensity, and impacts of different types of grazing animals.	TBD	G, CDFW, USFWS	100	
6.8	2	Study population genetics of all occurrences.	TBD	G, CDFW, USFWS	100	
6.9	2	Conduct research to determine methods of establishing occurrences of the three plant species in appropriate habitat.	TBD	G, CDFW, USFWS	100	
6.10	2	Study density and movement of seeds within soil seed bank.	TBD	G, CDFW, USFWS	200	
6.11	2	Study effects of loss of pollinators on listed plants.	TBD	G, CDFW, USFWS	100	
6.12	2	Study mechanisms of seed dispersal.	TBD	G, CDFW, USFWS	50	
6.13	2	Study seedling growth.	TBD	G, CDFW, USFWS	20	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
6.14	2	Compare impacts of different mowing treatments (mowing and mulching, mowing and phytomass removal, and no mowing) to control invasive plants.	TBD	G, CDFW, USFWS	50	
6.15	2	Determine if selective herbicides can be used to safely improve habitat for the three listed species without harming the listed plants or their pollinators.	TBD	G, CDFW, USFWS	100	
7.1	1	Develop adaptive habitat management plan for all protected sites for all 3 species.	5	CDFW, USFWS	TBD	
7.2	1	Work with local agricultural districts to develop standards for vineyard conversion.	TBD	CDFW, USFWS	TBD	
7.3	1	Decrease acreage of land sprayed with treated wastewater.	TBD	CDFW, USFWS RWQCB, County	U	
7.4	2	Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat.	TBD	CDFW, USFWS VCD	TBD	
8.1	2	Develop white paper on techniques of restoration and creation of habitat of the 3 plants.	5	CDFW, USFWS, G	50	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
8.2	2	Develop a core area-specific Reintroduction and Genetic Management Plan for the 3 plants	TBD	CDFW, USFWS, G	30	
9.0	2	Develop monitoring plans and monitor all protected natural and replicated occurrences for the 3 plants.	O	All	20	Monitoring activity costs are included in actions 4.1, 4.2, and 6.1, above. This is for the report generation and design.
10.0	3	Engage and educate the public about *Blennosperma bakeri, Lasthenia burkei, Limnanthes vinculans* recovery.	TBD	CDFW, USFWS	30	
				Subtotal	**5,000**	

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
Sonoma County California tiger salamander (*Ambystoma californiense*, Sonoma Distinct Population Segment)						
11.1	1	Acquire habitat within three core centralized wetland/upland complexes	O	CDFW, USFWS	51,005	Purchase cost estimate of $55,200 fee for title. 924 ac * $55,200 = $51,004,800
11.2	2	Acquire centralized wetland -upland habitat within two management areas	O	CDFW, USFWS	34,003	616 ac * $55,200/ac = $34,003,200
11.3	1	Acquire upland habitat within three core areas	O	CDFW, USFWS	169,251	Assuming 75% fee for title acquisition ($55,200 per ac) and 25% estimated as easement (cost estimate used is average of $9,100 per acre for open pasture and $5,200 for vernal pool rangeland = $7,150/ac)
11.4	2	Acquire upland habitat in two management areas	O	CDFW, USFWS	112,834	Assumptions as above.
12.1	1	Restore breeding habitat in three core areas	2	CDFW, USFWS	2,100	Includes all siting, design, construction, permitting/compliance costs.
12.2	2	Restore breeding habitat in two management areas	2	CDFW, USFWS	1,340	Includes all siting, design, construction, permitting/compliance costs.
13.1	1	Work with partnership and funding programs to manage/restore/enhance habitat for the Sonoma County California tiger salamander	O	CDFW, USFWS	TBD	Costs are incidental to normal operating budget for ongoing coordination and conservation implementation.
13.2	2	Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit	C	CDFW, USFWS	TBD	Cost rationale, as above
14.1.1	3	Monitor breeding sites to detect disease outbreaks.	C	CDFW, USFWS	0	Costs folded into ongoing population surveys, in 4.1.10 below
14.1.2	2	Assess and mitigate non-native predator risks	C	CDFW, USFWS	0	Costs folded into ongoing population surveys, in 4.1.10 below

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
14.1.3	2	Assess and mitigate contaminant risks in breeding habitat	3	CDFW, USFWS	300	Final cost determed by initial screening in affected habitats.
14.1.4	3	Assess and mitigate contaminant risks in upland habitat	3	CDFW, USFWS	500	Final cost determined by initial screening in affected habitats.
14.1.5	2	Assess and mitigate threat posed by mosquito abatement activities	2	All	200	
14.1.6	2	Assess and mitigate road mortality risk factor	3	All	1000	
14.1.7	2	Survey Stemple Creek Management Area	5	CDFW, USFWS	30	Survey timing contingent on private property access.
14.1.8	2	Survey SE Cotati Management Area	2	CDFW, USFWS	15	Survey timing contingent on private property access.
14.1.9	2	Monitor population trends in Horn/Hunter management area	10	CDFW, USFWS	50	
14.2.1	1	Research to determine current metapopulation abundances	10	CDFW, USFWS	2,000	
14.2.2	1	Monitor status and trend in all protected populations counted towards recovery	C	CDFW, USFWS	1,250	Final estimate of cost assumes cohort over cohort estimates spanning two full lifespans (~26 years). 250,000/5 yr * 5 yr = $1,250,000
14.2.3	1	Research to determine habitat use and movements	5	CDFW, USFW	1,000	
14.2.4	1	Research to determine population vital rates	10	CDFW, USFWS	0	Can be attained through Action 4.2.1-4.2.2, above.
14.2.5	1	Determine minimum viable population sizes	10	USFWS	TBD	Largely achieved through modeling using data from 4.2.1-4.2.4.
14.3.1	3	Research to optimize non-native predator control methods	5	CDFW, USFWS	100	
14.3.2	3	Conduct contaminants research to	3	CDFW,	200	Final cost dependent on suite of compounds

Action Number	Priority	Description	Duration (Years)	Responsible Parties	Cost Estimate (in $1,000 Units)	Comments
		determine sensitivity and risk to environmentally relevant compounds		USFWS		detected at concentrations of concern to amphibians through initial screening per 4.1.3 and 4.1.4, above.
14.3.3	3	Research to find compatible mosquito abatement technologies	2	All	100	
14.3.4	3	Research to determine optimal burrow densities	3	CDFW, USFWS	300	Cost savings likely if paired with other relevant studies (information from 4.2 actions.
14.3.5	1	Research techniques for minimizing roadway mortality	5	CDFW, USFWS	500	
14.3.6	2	Research to determine optimal grazing strategies	5	CDFW, USFW	500	
14.3.7	2	Research to determine optimal breeding pond criteria	5	CDFW, USFWS	500	
14.3.8	2	Research to determine efficacy of genetic markers as index of abundance	5	CDFW, USFWS	500	
15.1	1	Finalize management plan	2	CDFW, USFWS	30	
				Subtotal	**379,608**	
				Total Cost	**463,081**	A portion of the subtotal costs for individual species will be reduced due to co-existence of species on preserves. Therefore, the full value is not carried over this "total cost." Assumes economy from preserve co-management as follows: 1) 80 percent of plant habitat will be sited within habitat preserves also acquired for Sonoma County California tiger salamander; 2) cost efficiencies from siting and construction etc. of multi-species plant pool/swales will approximate a calculation where *Lasthenia burkei* and *Blennosperma bakeri* will be calculated as fully redundant (i.e., total cost for *L. burkei* covers both), while the entire cost for *Limnanthes vinculans* will be added to total (i.e., assume no cost savings from colocation).

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Appendix A: Justification and Technical Information for Recovery Criteria

Following are more detailed explanations for the rationale behind the various criteria presented herein.

Blennosperma bakeri

1.a.A/1: The rate of 80 percent was selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Blennosperma bakeri* and how these factors contribute to potential extinction risk for the species.

1.a.A/2: The acreages of the additional habitat for each core area were determined by the Service with input from the species experts to be suitable in size for their respective core areas and to provide adequate habitat for the species (S. Talley, pers. comm., 2013).

1.a.A/3a: The Strategy recommends that preserves be no less than 10 ac and states that preserves should include the entire watershed of the pool(s) and swale(s) being protected, and the ratio of perimeter to area should be minimized. Although 10 ac is not an optimal size, it has been important in achieving the goal of maintaining existing plant populations throughout the range of the listed plants (Conservation Strategy Team 2005). Ten ac was also recommended as the minimum preserve size by species experts (S. Talley pers. comm., 2013).

1.a.A/3b: The location of preserves will be determined with guidance from a Reintroduction and Genetic Management Plan to be developed.

1.a.A/4a: Preserve acreages in the downlisting criterion A/4 represent 35 percent of the minimum preserve acreages noted in delisting criterion A/2 Therefore, for Alton Lane core area, 35 percent of 500 ac = 175 ac of vernal pools and swales; for *Blennosperma bakeri* southern core area, 35 percent of 300 ac = 105 acres; and for Windsor core area, 35 percent of 50 ac = 18 ac.

1.a.A/4b: Vernal pool preserves that provide suitable habitat for the listed plants were sampled by vernal pool experts and were found to consist of no more that 35 percent wetted acreage (L. Stromberg pers. comm. 2013). This value was determined by the species experts to be the standard for the purposes of the 2007 Programmatic Biological Opinion (Service 2007).

1.a.E/1: The Service after consultation with the species experts determined that the occurrences in these two areas (a and b) have higher genetic diversity than the remaining occurrences and should be replicated at a higher ratio because of their higher likelihood of being extirpated. The occurrences in the Alton Lane Core Area, which would be replicated at 1:2, have lower genetic diversity and may be at lower risk of extirpation.

1.a.E/2: The density value of 2,500 seeds per m^2 was derived by the species experts from the estimated number of flowers that bloom in a 1 m^2 plot (1,000 flowers bloom), in which each flower produces an average of 5 seeds; therefore, with 50 percent plant cover, 1 m^2 will produce 2,500 *Blennosperma bakeri* seeds.

1.b.A/1a: The rate of 90 percent was selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Blennosperma bakeri* and how these factors contribute to potential extinction risk for the species.

1.b.A/1b: *Blennosperma bakeri* is not currently present in the *Blennosperma bakeri* Southern Management Area; therefore, this recovery criterion does not currently apply to this Area. However, this Management Area provides the opportunity and location for replication of occurrences from the adjacent *Blennosperma bakeri* Southern Core Area.

Lasthenia burkei

2.a.A/1: The rate of 75 percent was selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Lasthenia burkei* and how these factors contribute to potential extinction risk for the species.

2.a.A/3a: The Conservation Strategy recommends that preserves be no less than 10 ac and states that preserves should include the entire watershed of the pool(s) and swale(s) being protected, and the ratio of perimeter to area should be minimized. Although 10 ac is not an optimal size, it has been important in achieving the goal of maintaining existing plant populations throughout the range of the listed plants (Conservation Strategy Team 2005).   Ten acres was also recommended as the minimum preserve size by species experts (S. Talley pers. comm., 2013).

2.a.A/3b: The location of preserves will be determined with guidance from a Reintroduction and Genetic Management Plan to be developed.

2.a.A/4a: Drier conditions are permissible for *Lasthenia burkei* because the habitat for this species is slightly drier than that of *Blennosperma bakeri* or *Limnanthes vinculans.*

2.a.A/4b: The acreage of vernal pools and swales in the new preserves in downlisting criterion A/4, 125 ac distributed among the three core areas, represents the best realistic estimate determined by the Service and the species experts (L. Stromberg, pers. comm., 2013).

2.a.E/2: The density value of 500 plants per m^2 was derived by the species experts based on estimates from empirical data for a floral abundance representing a “good” site.

2.b.A/1: The rate of 90 percent was selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Lasthenia burkei* and how these factors contribute to potential extinction risk for the species.

2.b.A/1: The rate of 90 percent was selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Lasthenia burkei* and how these factors contribute to potential extinction risk for the species.

Limnanthes vinculans

3.a.A/1: The rates of 75 and 80 percent were selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Blennosperma bakeri* and how these factors contribute to potential extinction risk for the species.

3.a.A/3a: The Conservation Strategy recommends that preserves be no less than 10 ac and states that preserves should include the entire watershed of the pool(s) and swale(s) being protected, and the ratio of perimeter to area should be minimized. Although 10 ac is not an optimal size, it has been important in achieving the goal of maintaining existing plant populations throughout the range of the listed plants (Conservation Strategy Team 2005). Ten ac was also recommended as the minimum preserve size by species experts (S. Talley pers. comm., 2013).

3.a.A/3b: The location of preserves will be determined with guidance from a Reintroduction and Genetic Management Plan to be developed.

3.a.A/4: Vernal pool preserves that provide suitable habitat for the listed plants were sampled by vernal pool experts and were found to consist of no more that 35 percent wetted acreage (L. Stromberg pers. comm. 2013). This value was determined by the species experts to be the standard for the purposes of the 2007 Programmatic Biological Opinion (Service 2007).

3.a.E/1: The Theiller site (owned by CDFW) and the Haroutounian site (owned by Sonoma County Agricultural Preservation and Open Space District) have been determined by the species experts to be important to the recovery of *Limnanthes vinculans* (M. Halbur, pers. comm., 2013). The replication rate is higher for these sites because they are more isolated and may be genetically distinct.

3.a.E/2: Plant surveys measure flowers per area. Number of seeds per square meter are calculated using data from the species experts (C. Sloop, pers. comm., 2013). Currently, each *Limnanthes vinculans* flower is estimated to yield one to two viable seeds.

3.b.A/1: The rate of 90 percent was selected by the Service based on input received from species experts on the current distribution, abundance, and ecology of *Limnanthes vinculans* and how these factors contribute to potential extinction risk for the species.

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4.a.A/1: To protect genetic, ecological, and geographic diversity of the species and to provide for viability via replication, across the range of the species, multiple viable metapopulations must be present. Maintaining genetic variability and populations within a diversity of ecological settings confers adaptability (e.g., potential rangewide shifts in habitat quality due to climate change). Preservation of ecological conditions conducive to natural adaptation and maintenance of genetic uniqueness is important for species viability. Providing habitat capable of supporting multiple metapopulations across the range of the species further protects the species from catastrophic events (e.g., wildfires within the core areas of the species, hybrid introductions, and novel invasive predators or pathogens). This scenario also preserves habitats which are then available for future translocations to augment populations, thereby reducing the collective threat to the species.

4.a.A/2a: The area of this centralized complex is derived from the early estimates to support 95% of Sonoma County California tiger salamander populations with a dispersal distance of 630 m from the breeding pool (Trenham and Shaffer 2005). We did not use the 1.65 km (1.02 mi) (C. Searcy, *in litt,* 2013b) 95% population usage estimate under this approach, because: although it is the recent estimate available (from seven years of data), it is nevertheless limited to a population of Central California tiger salamander from xeric grassland habitat that may not be representative of the mesic conditions found on the Santa Rosa Plain. We use the 630 m estimate in conjunction with the 2.09 km estimate (Orloff 2007) to establish a two-phase process, whereby some habitat fragmentation is allowed in outer upland areas (630 m to 2.09 km) in exchange for full protections around smaller central preserve areas (within 630 m). In our opinion, expanding the footprint of managed lands (2.09 km instead of 1.65 km) available for upland growth and survival is compensatory for allowing some degree of habitat fragmentation within the preserve area. Fully preserved habitat is either: (1) owned in fee title by a government agency or conservation organization and managed for the benefit of the Sonoma County California tiger salamander; or, (2), privately-owned lands that are protected in perpetuity with conservation easements and managed in a manner that promotes Sonoma County California tiger salamander conservation. In all instances, funding in perpetuity is secured for management and monitoring, either through endowment fund or other mechanism.

4.a.A/2b: This is the area estimated to contain the bulk of Sonoma County California tiger salamander populations (following Orloff 2007) and follows the estimates used to derive migration distances under the final critical habitat designation (76 **FR** 54346). The estimation of the 50% threshold is to allow some degree of habitat fragmentation given the reality of the current developed landscape. If Sonoma County California tiger salamander can select or be directed to specific functional habitat, or areas with high burrow density (i.e., productive upland habitat), then this level of fragmentation may be tolerable to a viable metapopulation. Further research (reflected in other criteria) is needed to determine the efficacy of this model (and adjust it up or down, accordingly).

4.a.A/2c: Partially preserved lands means that lands surrounding the centralized wetland/upland complexes have uses that are compatible with successful growth and survival of juveniles and adults, but may not necessarily be fully protected. For example, these may be secured via easement, to maintain compatible land uses such as grazing, while such private lands are not necessarily actively managed beyond stipulations within the easement language (e.g., the easement may include limited rodent control).

4.a.A/3a: From Traill *et al.* (2007), a minimum viable population for amphibians is 5,409 individuals. This may be translated to an effective population size of 153 (C. Searcy, *in litt,* 2013b).

4.a.A/3b: C. Searcy (*in litt,* 2013b) further derived an estimate that 8 ponds measuring 661 square meters (0.163 ac) each are needed to achieve this effective population size utilizing a regression equation from Wang *et al.* (2011). This value is comparable to the conditions at Jepson Prairie for Central California tiger salamander. The equation in Wang *et al.* (2011) is based on a small number of natural pools (n = 5), and it is most likely the case that the confidence intervals at the extremes of this regression line (i.e. for numerous smaller ponds or single larger ponds) would render an inaccurate estimate when applied to sites with fewer ponds or with a high number of smaller ponds. Cook (2005) recommended 3-9 pools per preserve based on empirical data from the Plain. We combine both approaches, and using the Wang *et al.* (2011) equation nearer to the central regression points, propose a total of 4 to 9+ ponds per preserve ranging from 2 ac each (for only 4 larger ponds) to at least $1/8^{th}$ ac each (if spread amongst 9 or more ponds). Additional ponds or pools from these may be warranted, provided the landscape (sufficient upland habitat to wetland) is available and accessible such that possible density-dependent mortality does not prevail at any lifestage. There is flexibility in application of pool numbers and sizes, and final requirements should be resolved through the adaptive management process with site-specific data and using effective population size (or appropriate abundance metrics) as the guiding principle and metric.

4.a.A/3c: Typical breeding times run from mid-December with peak metamorphosis in mid-April. Maturing larvae need a warmer phase within this general time span (P. Trenham, pers. comm., 2013).

4.a.A/3d: Pool depth should be 40-80 cm (15.75-31.5 in) (Cook 2005) (shallower if the pool is inundated longer, deeper if predators controlled).

4.a.A/4a: Compatible land uses (e.g., ranchlands) are those which support sufficient densities of burrowing animals to provide shelter and foraging area for oversummering adults and rearing juveniles which also do not present other threats to population viability (see *Reasons for Listing and Current Threats*, above).

4.a.A/4b: D. Cook, Sonoma County Water Agency (pers. comm., October 24, 2013). Figure was based on empirical data from road undercrossing study (unpubl.).

4.a.A/5a: Compatible lands counting towards recovery include lands that are sufficiently connected and unfragmented (per criteria A/2 through A/4, above), in land use types that support small mammal colonies per criteria A/5, provided such lands are not presenting other population threats (see criteria under Factor E). Pasture grazed at appropriate intensity (see criteria A/6) is an ideal example of such land uses.

4.a.A/5b: Small mammal colonies (such as pocket gophers) must be present in sufficient numbers to create and/or maintain sufficient underground habitat for the salamander to maintain self-sustaining populations.

4.a.E/1:   A conservative toxicity benchmark is proposed herein to reflect the demographic value of adult salamanders to the overall population give the life history strategy of the Sonoma County California tiger salamander (long lived, infrequent breeders).

4.a.E/2: A court injunction (Center for Biological Diversity v. USEPA 5/17/10) includes 11 species and 43 chemicals and covers nine bay counties including Sonoma, Napa, and Solano. Buffers for California tiger salamanders are 200 ft for ground application and 400 ft for aerial applications from the aquatic habitat (does not define or describe upland habitat). For the time being, the current injunction for certain compounds and breeding habitat, in tandem with the buffer provided by the preserve design prescribed by the criteria herein (i.e., several hundred meters to a mile or more upland habitat surrounding centralized breeding pools) is presumed to provide sufficient protection for all life stages. However, the required distance depends on the specific compounds applied, application methods, site-specific hydrology, and season of application, among other factors.

4.a.E/5: Pending genetic analysis, the degree of genetic introgression of a given population will remain 'undetermined.' If the breeding habitat where hybrid or non-native individuals are found is adjacent to, or within, a region deemed necessary for meeting recovery criteria (i.e., core and management areas), then the breeding habitat must be maintained in a manner consistent with CTS life cycle (e.g., hydrology and absence of non-native predators left intact), except as a means of temporary eradication efforts. Population-wide eradication or management activities will be coordinated on a case-by-case basis in consultation with Service staff through the 10(a)(1)(A) process.

4.a.E/6: From Traill *et al.* (2007), this number for amphibians is 5,409 individuals. This may be translated to an effective population size of 153 (C. Searcy, *in litt,* 2013b). A minimum viable population assumes connectivity within the metapopulation, which is presumed achieved through Factor A criteria, above.