Appendix 2.A
Covered Species Accounts

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Acronyms and Abbreviations

AB	Assembly Bill
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin River Delta
BiOp	biological opinion
BLM	Bureau of Land Management
CALFED	California Bay Delta Authority
Caltrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Regional Water Quality Control Board
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
Delta	Sacramento–San Joaquin River Delta
DO	dissolved oxygen
DPR	California Department of Parks and Recreation
DPS	distinct population segment
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
DWR	California Department of Water Resources
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESRP	Endangered Species Recovery Program
ESU	evolutionarily significant unit
FR	*Federal Register*
G	globally
GIS	geographic information systems
HCP	habitat conservation plans
HSU	habitat suitability unit
I-205	Interstate 205
I-5	Interstate 5
I-580	Interstate 580
I-680	Interstate 680
I-80	Interstate 80
LSZ	low-salinity zone

mg/L	milligrams per liter
NAVD88	North American Vertical Datum 1988
NFD	not formally defined
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWR	National Wildlife Refuge
PCBs	polychlorinated biphenyls
PCE	primary constituent elements
POD	pelagic organism decline
ppb	parts per billion
ppt	parts per thousand
psu	practical salinity units
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
ROA	Restoration Opportunity Area
S	state
SAV	submerged aquatic vegetation
SR	State Route
SSURGO	Soil Survey Geographic Database
State Water Baord	State Water Resources Control Board
SWP	State Water Project
T	variety
TMDL	total maximum daily load
Upland Recovery Plan	*Recovery Plan for the Upland Species of the San Joaquin Valley, California*
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Program
Vernal Pool Recovery Plan	*Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon*
X2	2 ppt isohaline

Appendix 2A.22
Swainson's Hawk (*Buteo swainsoni*)

2A.22.1 Legal Status

The Swainson's hawk (*Buteo swainsoni*) is listed as a threatened species under the California Endangered Species Act (California Fish and Game Code, Sections 2050 *et seq*.). The species was listed by the California Fish and Game Commission in 1983.

The Swainson's hawk has no federal regulatory status. However, the species is included on the U.S. Fish and Wildlife Service (USFWS) list of Birds of Conservation Concern for Region 1 (U.S. Fish and Wildlife Service 2008). USFWS considers these species potential candidates for federal listing. Critical habitat has not been designated for this species.

2A.22.2 Species Distribution and Status

2A.22.2.1 Range and Status

Swainson's hawks nest in the grassland plains and agricultural regions of western North America from southern Canada (and possibly in the northern provinces and territories, and Alaska) to northern Mexico. Other than a few documented small wintering populations in the United States (Herzog 1996; England et al. 1997), the majority of the species winters primarily in the Pampas region of Argentina. The Central Valley population winters mainly between Mexico and central South America (Bradbury et al. in preparation).

Early accounts described the Swainson's hawk as one of the most common raptors in California, occurring throughout much of lowland California (Figure 2A.22-1), including the Central Valley, coastal valleys, southern California deserts, and Great Basin deserts east of the Sierra Nevada (Sharp 1902). Since the mid-1800s, native grassland foraging habitats and woodland nesting habitats that supported the species have undergone a gradual conversion to agricultural uses and urban uses. Today, native grassland habitats are virtually nonexistent in the state, and only remnants of the once vast riparian forests and oak woodlands still exist (Katibah 1983). While the species has successfully adapted to certain agricultural landscapes, this habitat loss has caused a substantial reduction in the breeding range and in the size of the breeding population in California (Bloom 1980; England et al. 1997). Current breeding populations occur primarily in the Central Valley, but also in the Klamath Basin, the northeastern plateau, Owen's Valley, and rarely in the Antelope Valley (Grinnell and Miller 1944; Bloom 1980; Garrett and Dunn 1981; Anderson et al. 2007).

Swainson's hawk populations have declined in California, Utah, Nevada, and Oregon (England et al. 1997). Populations in other western states are considered stable. Bloom (1980) reported a statewide estimate of 375 breeding pairs.

This was followed by estimates of 550 breeding pairs in the late 1980s (California Department of Fish and Game 1988), and 800 to 1,000 breeding pairs in the late 1990s (Swainson's Hawk Technical Advisory Committee in Yolo County Habitat Conservation Plan/Natural Community Conservation

Plan Joint Powers Agency 2011). However, none of these estimates were generated using a statistically based statewide survey effort and would be considered less credible than the results of a more statistically valid approach. The most recent statewide population estimate for California is 2,081 breeding pairs (Anderson et al. 2007) and is based on a statistically valid statewide survey conducted in 2005 and 2006. While this estimate is higher than the original statewide estimate that led to the state listing of the species (Bloom 1980) and subsequent estimates through the 1980s and 1990s, it cannot be reliably used to measure trends. It does, however, represent a substantial decline (50 to 90%) of the historical statewide breeding population in California (Bloom 1980). Nearly 94% of nesting Swainson's hawks in California are found in the Central Valley (an estimated 1,948 nesting pairs) (Anderson et al. 2007) from Tehama County south to Kern County. The majority of these are found in the middle section of the Central Valley between Butte County in the north to Merced County in the south, where foraging and nesting habitat conditions are optimized. Over 60% of the statewide population occurs within Yolo, Sacramento, Solano, and San Joaquin Counties (Anderson et al. 2007). Surveys conducted in Butte to San Joaquin Counties between 2002 and 2009 showed numbers of breeding pairs of Swainson's hawks at 593 in 2002; 1008 in 2003; and 941 in 2009 (California Department of Fish and Game 2010). While intensively farmed for over 100 years, much of this area retains a relative abundance of nesting habitat—narrow riparian corridors along rivers and streams, remnant oak groves and trees, roadside trees—and an agricultural pattern that is conducive to Swainson's hawk foraging (Estep 2007, 2008; Anderson et al. 2007).

2A.22.2.2 Distribution and Status in the Plan Area

Figure 2A.22-2 illustrates the nesting distribution of Swainson's hawk in the Plan Area. These data are from surveys conducted in the Yolo and Sacramento County portions of the Plan Area (Estep 2007, 2008), surveys conducted by the California Department of Water Resources (DWR) from 2009 to 2011 (Delta Habitat Conservation and Conveyance Program 2011), and information from the California Natural Diversity Database (CNDDB) (California Department of Fish and Game 2011).

There are over 400 reported nesting records in the Plan Area (Figure 2A.22-2). At least 300 of the records are considered independent nesting territories that are potentially active in any given year. This represents about 14% of the statewide population (Anderson et al. 2007).

In the northern portion of the Plan Area, nest sites are distributed mainly east of the Deep Water Ship Channel and along the western edge of the Plan Area. These are areas that support mainly annually rotated, irrigated agricultural, hayfield, and pasturelands, and an abundance of potential nesting habitat, including riparian woodlands, roadside trees, tree rows, and isolated trees.

The area immediately west of the Deep Water Ship Channel (with the exception of the northern Yolo Bypass Wildlife Refuge) and the area immediately north of State Route (SR) 12 support few potential nest trees and thus fewer known nest sites. However, a very dense nesting population occurs immediately west of the Plan Area boundary in Yolo and Solano Counties. These birds likely forage throughout much of the northern Plan Area.

Similarly, the area south of SR 4 supports a dense nesting population. The agricultural landscape in this area includes an abundance of alfalfa hay and annually rotated irrigated cropland and many potential nest trees, mostly along riparian corridors and roadside tree rows. Areas that lack nest sites, particularly the southernmost portion of the Plan Area south of Interstate 205 (I-205), also lack sufficient nest trees to support many nesting pairs.

The central Sacramento–San Joaquin River Delta (Delta), the region between SR 12 and SR 4, supports fewer Swainson's hawk nests compared with the northern and southern regions (Figure 2A.22-2). The agricultural landscape in the central Delta provides generally suitable foraging habitat for Swainson's hawks, although probably less high-value cover types; the lack of nest sites is likely primarily associated with the lack of suitable nest trees in this area. However, the survey effort in the central Delta has not been as extensive as elsewhere in the Plan Area, and this may contribute in part to the lack of reported nesting territories in that area. Survey data from 2009 to 2011 add numerous active nest sites, primarily in the eastern and southern Plan Area, but also several in the central Delta (Delta Habitat Conservation and Conveyance Program 2011).

The surveys conducted in 2009, 2010, and 2011 collected information about environmental resources in the area where conceptual conveyance options were proposed (the Conveyance Planning Area). In 2009, surveyors collected 130 Swainson's hawk data points, which represented at least 85 individual nests. Nests were close to cultivated agricultural lands and most nest sites found were along the eastern and central portion of the Conveyance Planning Area. However, that may be a function of a greater survey effort in those areas (Delta Habitat Conservation and Conveyance Program 2011).

In 2010, surveyors collected seven Swainson's hawk data points, which represented seven individual nests. All of these nests were near areas where Swainson's hawk nests had been observed during 2009 surveys. Therefore, they may represent duplicate data points. In 2011, surveyors collected 54 Swainson's hawk data points throughout the Delta, which represent a minimum of 50 individual nests. Many of the 2011 nests were found in areas previously not surveyed, but several nests were likely observed in previous years. Although the central Delta had previously been characterized as a low-density nesting area, the 2011 data indicate it is actually a high-density nesting area.

For all 3 years of surveys, surveyors collected 192 Swainson's hawks nest data points, which represents approximately 175 nesting pairs.

2A.22.3 Habitat Requirements and Special Considerations

2A.22.3.1 Nesting

Throughout much of its range, both in North and South America, the Swainson's hawk inhabits grasslands, prairies, shrub-steppes, and agricultural landscapes, including dry and irrigated row crops, alfalfa and hay fields, pastures, and rangelands. They nest in trees most often in riparian woodlands and farm shelterbelts (England et al. 1997), as well as in urban/suburban areas with large trees adjacent to suitable foraging habitat (James 1992; England et al. 1995). Suitable nest trees are usually deciduous and tall (up to 100 feet [30 meters]); however, in urban/suburban areas, most nest trees are conifers (England et al. 1995, 1997). Nests are built of sticks and are sometimes several feet in diameter. They are generally placed in the uppermost and outermost branches that will support the nest, often in mistletoe clumps (England et al. 1997).

In the Central Valley, Swainson's hawks usually nest in large native trees such as valley oak (*Quercus lobata*), Fremont cottonwood (*Populus fremontii*), Hinds' walnut (*Juglans hindsii*), and willows (*Salix*

spp.), and occasionally in nonnative trees, such as eucalyptus (*Eucalyptus* spp.). Nests occur in riparian woodlands, roadside trees, trees along field borders, isolated trees, small groves, and on the edges of remnant oak woodlands. Stringers of remnant riparian forest along drainages contain the majority of known nests in the Central Valley (Estep 1984; Schlorff and Bloom 1984; England et al. 1997). However, this appears to be a function of nest tree availability rather than dependence on riparian forest. Nests are usually constructed as high as possible in the tree, providing protection to the nest as well as better visibility from it.

Nesting pairs are highly traditional in their use of nesting territories and nesting trees. Many nest sites in the Central Valley are known to have been occupied annually since 1979 and banding studies conducted since 1986 confirm a high degree of nest and mate fidelity (Estep in preparation).

Nesting habitat results from the 2006 and 2007 baseline surveys of South Sacramento County and Yolo County (Estep 2007, 2008) indicate that riparian habitat was the most frequently used nesting habitat type. Isolated trees, roadside trees, tree rows, farmyard trees, and rural residential trees were also frequently used. Valley oak and Fremont cottonwood were the most frequently used nest trees, followed by walnut, willow, and eucalyptus trees.

2A.22.3.2 Foraging

Swainson's hawks are essentially plains or open-country hunters, requiring large areas of open landscape for foraging. Historically, the species used the grasslands of the Central Valley and other inland valleys. With substantial conversion of these grasslands to farming operations, Swainson's hawks have shifted their nesting and foraging into those agricultural lands that provide low, open vegetation for hunting and large rodent prey populations. Foraging habitat value is a function of the following elements:

- Patch size: sensitivity to fragmented landscapes; use will decline as suitable patch size decreases.
- Prey accessibility: the ability of hawks to access prey depends on vegetation structure and management activities.
- Prey availability: the abundance of prey populations in a field.

Data on minimum foraging patch size are largely anecdotal, but are generally thought to be between 2 and 10 hectares (5 and 25 acres) (Estep and Teresa 1992; California Department of Fish and Game 1994). In the Central Valley, agricultural land use or specific crop type determine the foraging value of a field at any given time. Cover types were evaluated by Estep (1989) and ranked based on these factors. However, suitability ranking is based on a variety of site-specific issues and at a landscape level should be characterized only on a general basis. On a site-specific level—important for land management purposes to maximize foraging value—individual cover types can be assessed based on site-specific and management conditions.

Important land cover or agricultural crops for foraging are alfalfa and other hay, grain and row crops, bare fallow fields, dryland pasture, and annual grasslands (Estep 1989; Babcock 1995; Swolgaard 2003; Anderson et al. in preparation). The matrix of these cover types across a large area creates a dynamic foraging landscape as temporal changes in vegetation results in changing foraging patterns and foraging ranges.

Hay crops, particularly alfalfa, provide the highest value because of the low vegetation structure (high prey accessibility), relatively large prey populations (high prey availability), and because farming operations (e.g., weekly irrigation and monthly mowing during the growing season) enhances prey accessibility. Most row and grain crops are planted in winter or spring and have foraging value while the vegetation remains low, but become less suitable as vegetation cover and density increases. During harvest, vegetation cover is eliminated while prey populations are highest, significantly enhancing their suitability during this period. Some crop types, such as rice, orchards, and vineyards, provide little to no value because of reduced accessibility and relatively small prey populations (Estep 1989; Babcock 1995; Swolgaard 2003; Anderson et al. in preparation).

2A.22.4 Life History

2A.22.4.1 Description

The Swainson's hawk is a long-winged, medium-sized (19- to 22-inch [48- to 56-centimeter] and 1.5- to 3- pound [0.7- to 1.4-kilogram]) soaring raptor that nests and roosts in large trees in flat, open grassland or agricultural landscapes. Females, on average, are larger than males, but there are no distinguishing plumage characteristics between the sexes.

The Swainson's hawk is characterized by its long, narrow, and tapered wings held in flight in a slight dihedral shape. The body size is somewhat smaller, thinner, and less robust than other buteos (broad-winged soaring hawks), although the wings are at least as long as other buteos. This body and wing shape allows for efficient soaring flight and aerial maneuverability. This is important for foraging, which Swainson's hawks do primarily from the wing, and during courtship and inter-specific territorial interactions.

There are three definitive plumage morphs: light, rufous, and dark. However, there are numerous intermediate variations between these plumage morphs. The two most distinguishing plumage characteristics are a dark breast band and the contrasting darker flight feathers and lighter wing linings on the underwings, giving most individuals a distinctive bicolored underwing pattern. These characteristics are most pronounced in lighter morph birds and become less so as the plumage darkens, and are indistinguishable in the definitive dark morph, which is completely melanistic. All three definitive plumage morphs are present in the Central Valley with a relatively large proportion of the population categorized as intermediate morph, with varying amounts of streaking or coloration in the belly and wing linings.

2A.22.4.2 Seasonal Patterns

Swainson's hawks arrive on their breeding grounds in the Central Valley from early March to early April. The breeding season extends through mid-to late August, when most young have fledged and breeding territories are no longer defended. By late August,premigratory groups begin to form. The fall migration begins in early to mid-September. By early October, most Swainson's hawks have migrated out of the Central Valley. Central Valley Swainson's hawks winter from central Mexico to northern South America (Bradbury et al. in preparation). This differs from what is known about the migratory pattern and wintering grounds of Swainson's hawk populations outside of the Central Valley, most of which take a different migratory route and winter entirely in southern South

America, with the largest wintering populations known to occur in northern Argentina (England et al. 1997).

2A.22.4.3 Reproduction

Swainson's hawks exhibit a high degree of nest site fidelity, using the same nests, nest trees, or nesting stands for many years (England et al. 1997). Pairs are monogamous and may maintain bonds for many years (England et al. 1997). Immediately upon arrival onto breeding territories, breeding pairs begin constructing new nests or repairing old ones. One to four eggs are laid in mid- to late April followed by a 30- to 34-day incubation period. Nestlings begin to hatch by mid-May followed by an approximately 20-day brooding period. The young remain in the nest until they fledge in 38 to 42 days after hatching (England et al. 1997). Studies conducted in the Sacramento Valley indicate that one or two—and occasionally three—young typically fledge from successful nests (Estep in preparation). The rate of young fledged per nest in the Central Valley is among the lowest recorded in the entire species range. This geographic difference in reproductive success may be related to the reliance on small voles that may not meet the high energetic demands of breeding adults and developing young compared to the diets that include a higher proportion of gophers, rabbits, ground squirrels, and other larger mammals consumed in other locations. It may also be due to the energetic demands of foraging in a dynamic agricultural landscape that causes birds to travel long distances to forage during times when vegetation growth in agricultural fields reduces available foraging habitat near the nest. In Yolo County, fledging rates ranged from 1.15 to 1.96 young per successful nest from 1988 to 2000 (Estep in preparation).

After fledging, young remain near the nest and are dependent on the adults for about 4 weeks, after which they permanently leave the breeding territory (Anderson et al. in preparation).

2A.22.4.4 Home Range and Territory Size

Home ranges are highly variable depending on cover type, and fluctuate seasonally and annually with changes in vegetation structure (e.g., growth and harvest) (Estep 1989; Woodbridge 1991; Babcock 1995). Smaller home ranges consist of high percentages of alfalfa, fallow fields, and dry pastures (Estep 1989; Woodbridge 1991; Babcock 1995). Larger home ranges were associated with higher proportions of cover types with reduced prey accessibility, such as orchards and vineyards, or reduced prey abundance, such as flooded rice fields. Swainson's hawks regularly forage across a very large landscape compared with most raptor species. Data from Estep (1989) and England et al. (1995) indicate that it remains energetically feasible for Swainson's hawks to successfully reproduce when food resources are limited around the nest and large foraging ranges are required. Radio-telemetry studies indicate that breeding adults in the Central Valley routinely forage as far as 18.6 miles from the nest (Estep 1989; Babcock 1995).

Home ranges (calculated as minimum convex polygons) for 12 Swainson's hawks in the Central Valley averaged 10.7 square miles (range: 1.3 to 33.7 square miles) (27.7 square kilometers [range: 3.4 to 87.3 square kilometers]) (Estep 1989). Using similar methods, four Swainson's hawks in West Sacramento ranges averaged 15.6 square miles (range: 2.8 to 29.6 square miles) (40.4 square kilometers [range: 7.3 to 76.7 square kilometers]), and included fields planted in grain, alfalfa, tomatoes, and safflower, as well as fallow fields (Babcock 1995).

Swainson's hawks in the central region of the Central Valley had the shortest distances between nests of those reported in England et al. (1997); on average, nests were 0.7 mile (1.1 kilometers)

apart (Estep 1989). Results from a 2006 baseline survey of South Sacramento County indicate a nesting density of 37 pairs per 100 square miles (259 square kilometers); and from a 2007 baseline survey of nesting Swainson's hawks in Yolo County, a nesting density within the survey area of 38 pairs per 100 square miles, the highest nesting density reported for this species (Estep 2008). This high nest density was attributed to widely available, uniformly distributed optimal foraging habitat and relatively abundant nesting sites along narrow riparian corridors, farm shelterbelts, roadside trees, remnant groves, and isolated trees.

2A.22.4.5 Foraging Behavior and Diet

Swainson's hawks hunt primarily from the wing, searching for prey from a low-altitude soaring flight, 98 to 295 feet (30 to 90 meters) above the ground and attack prey by stooping toward the ground (Estep 1989). This species is also highly responsive to farming and seasonal wetland management activities that expose and concentrate prey, such as cultivating, harvesting, and disking. During these activities, particularly late in the season, Swainson's hawks will hunt behind tractors searching for exposed prey. Other activities, such as flood irrigation and burning, also expose prey and attract foraging Swainson's hawks.

In the Central Valley, Swainson's hawks feed primarily on small rodents, usually in large fields that support low vegetation cover (to provide access to the ground) and high densities of prey (Bechard 1982; Estep 1989). These habitats include hay fields, grain crops, certain row crops, and lightly grazed pasturelands. Fields lacking adequate prey populations (e.g., flooded rice fields) or those that are inaccessible to foraging birds (e.g., vineyards and orchards) are rarely used (Estep 1989; Babcock 1995; Swolgaard 2003, Anderson et al. in preparation).

Meadow vole (*Microtus californicus*) is the principal prey item taken by Swainson's hawks in the Central Valley (Estep 1989). Pocket gopher (*Thomomys bottae*) is also an important prey item. Other small rodents, including deer mouse (*Peromyscus californicus*) and house mouse (*Mus musculus*), are taken, along with a variety of small birds, reptiles, and insects.

2A.22.5 Threats and Stressors

Swainson's hawks face different threats in different portions of their range. In California, causes of population decline are thought to be loss of nesting habitat (Schlorff and Bloom 1984) and loss of foraging habitat to urban development and to conversion to unsuitable agriculture, such as orchards and vineyards (England et al. 1995, 1997).

Conversion of agricultural lands to urban uses continues at a high rate throughout the range of the Swainson's hawk. Urbanization results in permanent loss of habitat and fragmentation of landscapes, which both result in a reduction of available foraging habitat for the Swainson's hawk.

Conversion from compatible to incompatible crop patterns also reduces available foraging habitat and influences the distribution of nesting Swainson's hawks. Large regions of the Central Valley that have been converted to rice, vineyards, orchards, cotton, and other incompatible crop types support few nesting Swainson's hawks. The continued conversion of suitable agricultural landscapes (e.g., annually rotated irrigated cropland, hayfields, and pasturelands) to vineyards and other unsuitable cover types continues to reduce available foraging habitat on a local and regional basis. Spring and

summer inundation of agricultural lands or seasonal wetland habitats also reduces available foraging habitat.

Loss of riparian and other nesting habitat continues throughout the Central Valley from levee projects, agricultural practices, and local development along watercourses. A related issue is the loss and lack of regeneration of valley oak and other native trees. This is an ongoing problem in areas that have continued to support remnant valley oaks and oak groves. Nesting habitat continues to decline as these trees and small groves die off or are removed and are not replaced through natural regeneration or replanting.

Nestlings are vulnerable to starvation and fratricide (i.e., the larger nestling killing the smaller nestling in times of food stress), and predation from crows, ravens, and other raptors. Natural population cycles of voles in central California may be a major factor in reproductive success where vole population crashes suppress Swainson's hawk reproduction or lead to increased starvation rates of nestlings. In addition, insecticides and rodenticides may contribute to food scarcity by reducing prey abundance. There is little evidence that adult Swainson's hawks are killed by natural predators, but collisions with moving vehicles and illegal shooting and trapping have been identified as sources of mortality (England et al. 1997).

Well-documented mass poisoning of hundreds or thousands of Swainson's hawks wintering in Argentina (Woodbridge et al. 1995; Goldstein et al. 1996) have led to that country's ban of an insecticide (organophosphate monocrotophos) used on alfalfa and sunflower fields to control grasshopper populations. Levels of dichlorodiphenyldichloroethylene (DDE) (a toxic degradation product of dichlorodiphenyltrichloroethane [DDT], a pesticide used extensively until 1972 when it was banned in the U.S.) in Swainson's hawks from the Central Valley may have been high enough to negatively affect reproductive success during the decades when DDT was used extensively in the United States. However, levels of DDE measured in eggs collected in 1982 and 1983 were not considered high enough to indicate a health threat (Risebrough et al. 1989).

2A.22.6 Relevant Conservation Efforts

Conservation efforts have focused on the development and implementation of habitat conservation plans/natural community conservation plans. These regional conservation approaches can be an effective tool to managing and sustaining Swainson's hawk populations if sufficient suitable landscape is preserved (Estep and Teresa 1992). Much of the Plan Area overlaps with or is near other conservation planning efforts that are either currently being implemented or are in development. Swainson's hawk is a covered species under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County 2006), and the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003). It is also proposed for coverage under the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County 2011), and the *Butte Regional Habitat Conservation Plan and Natural Community Conservation Plan* (Butte County Association of Governments 2011).

The California Department of Fish and Wildlife (CDFW) is finalizing a management strategy for the Swainson's hawk that is designed to coordinate conservation planning efforts to facilitate a comprehensive and consistent approach to managing landscapes to sustain Swainson's hawk populations in the Central Valley (California Department of Fish and Game in preparation).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the Swainson's hawk as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions under its control and within its scope that are necessary in order to contribute to the recovery of the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

2A.22.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods.*

2A.22.7.1 GIS Model Data Sources

The Swainson's hawk model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture 2005, 2010), Farmland Mapping and Monitoring Program (California Department of Conservation 2004), and land use survey of the Delta and Suisun Marsh area-version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable Swainson's hawk habitat in the Plan Area according to the species' two primary life requisite parameters, nesting habitat and foraging habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.22.7.2 Habitat Model Description

Modeled nesting habitat in the Delta includes the following types from the BDCP composite vegetation layer:

- White alder (*Alnus rhombifolia*)
- *Alnus rhombifolia*/*Salix exigua*
- *Alnus rhombifolia*/*Cornus sericea*
- Oregon ash (*Fraxinus latifolia*)
- Box elder (*Acer negundo*)
- *Acer negundo*–*Salix gooddingii*
- Hinds' walnut (*Juglans hindsii*)
- Fremont cottonwood (*Populus fremontii*)
- Black willow (*Salix gooddingii*)
- *Salix gooddingii*/wetland herbs

- *Salix gooddingii–Populus fremontii* (*Quercus lobata–Salix exigua–Rubus discolor*)
- *Salix gooddingii–Quercus lobata*/wetland herbs
- *Salix gooddingii*/*Rubus discolor*
- Coast live oak (*Quercus agrifolia*)
- Valley oak (*Quercus lobata*)
- *Quercus lobata*/*Rosa californica* (*Rubus discolor–Salix lasiolepis*/*Carex* spp.)
- *Quercus lobata–Acer negundo*
- *Quercus lobata–Alnus rhombifolia* (*Salix lasiolepis–Populus fremontii–Quercus agrifolia*)
- *Quercus lobata–Fraxinus latifolia*
- Black willow (*Salix gooddingii*) –valley oak (*Quercus lobata*) restoration
- Valley oak (*Quercus lobata*) restoration
- White alder (*Alnus rhombifolia*) arroyo willow (*Salix lasiolepis*) restoration
- Eucalyptus
- Eucalyptus globulus
- *Fraxinus latifolia*
- Fremont cottonwood–valley oak–willow riparian forest
- Landscape trees
- Mixed Fremont cottonwood–willow spp. not formally defined (NFD) alliance
- Mixed willow super alliance
- Oaks
- *Salix lasiolepis*/*Quercus agrifolia*
- Valley oak alliance–riparian
- Willow trees

While valley oak and/or cottonwood-dominated riparian forests are considered optimal nesting habitat for this species, the model does not distinguish habitat value according to overstory composition, tree density, structure, or patch size. For purposes of this model, all overstory riparian and other mature trees are considered potential Swainson's hawk nesting habitat. Natural vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP composite vegetation data layer.

Foraging habitat includes the following types from the BDCP composite vegetation layer using a 5-acre minimum patch size:

- Grasslands
    - Ruderal herbaceous grasses and forbs
    - California annual grasslands–herbaceous
    - *Bromus diandrus–Bromus hordeaceus*

- Italian ryegrass (*Lolium multiflorum*)
- *Lolium multiflorum–Convolvulus arvensis*
- *Suaeda moquinii* (*Lasthenia californica*)
- Degraded vernal pool complex–California annual grasslands
- Degraded vernal pool complex–ruderal herbaceous grasses and forbs
- Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)

- Managed Wetlands
  - Rabbitsfoot grass (*Polypogon monspeliensis*)
  - Intermittently flooded perennial forbs
  - Managed annual wetland vegetation (nonspecific grasses and forbs)
  - Shallow flooding with minimal vegetation
  - Seasonally flooded undifferentiated annual grasses and forbs
  - Managed alkali wetland (*Crypsis*)
  - Intermittently or temporarily flooded undifferentiated annual grasses and forbs
- Alkali seasonal wetland complex and other natural seasonal wetlands
  - *Distichlis spicata*–annual grasses
  - Seasonally flooded grasslands
  - Vernal pools
  - Degraded vernal pool complex–vernal pools
  - Degraded vernal pool complex–rabbitsfoot grass
  - Temporarily flooded perennial forbs
  - Alkaline vegetation mapping unit
  - *Allenrolfea occidentalis* mapping unit
  - *Suaeda moquinii* mapping unit
  - Salt scalds and associated sparse vegetation
- Vernal pool complex
  - Annual grasses generic
  - Annual grasses/weeds
  - California annual grasslands–herbaceous
  - *Distichlis*/annual grasses
  - *Distichlis spicata*–annual grasses
  - Italian ryegrass (*Lolium multiflorum*)
  - Ruderal herbaceous grasses and forbs

    - Salt scalds and associated sparse vegetation
    - Vernal pools
- Annual grasses generic
- Annual grasses/weeds
- *Baccharis*/annual grasses
- *Bromus* spp./*Hordeum*
- *Crypsis schoenoides*
- *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
- Cultivated annual graminoid
- *Cynodon dactylon*
- *Distichlis*/annual grasses
- Fallow disced field
- Field crops
- *Hordeum*/*Lolium*
- *Lolium* (generic)
- *Lolium*/*Rumex*
- *Lotus corniculatus*
- Medium upland herbs
- Medium wetland graminoids
- Medium wetland herbs
- Pasture
- Perennial grass
- Short upland graminoids
- Short wetland graminoids
- Tall wetland graminoids
- Truck/nursery/berry crops
- Upland annual grasslands and forbs formation
- Upland herbs
- Agriculture

The following DWR 2007 Land Use survey types are included as suitable agricultural foraging habitats for Swainson's hawk. These types represent the typical agricultural cover types in the Plan Area that are included in the DWR 2007 land use survey. Rotational crop types that are not common to the Plan Area are not included here. Pasture types are mostly perennial; alfalfa is semi-perennial

(3 to 7 years); and all other types are annually or seasonally rotated irrigated crops, only some of which provide suitable foraging habitat for Swainson's hawks.

- Grain and hay crops
  - Wheat
  - Oats
  - Miscellaneous grain and hay
  - Nonirrigated miscellaneous grain and hay
  - Mixed grain and hay
  - Nonirrigated mixed grain and hay
- Field crops
  - Safflower
  - Sugar beets
  - Corn
  - Grain sorghum
  - Sudan
  - Beans
  - Miscellaneous field
  - Sunflowers
- Pasture
  - Alfalfa and alfalfa mixtures
  - Clover
  - Mixed pasture
  - Nonirrigated mixed pasture
  - Native pasture
  - Nonirrigated native pasture
  - Miscellaneous grasses
- Truck, nursery and berry crops
  - Asparagus
  - Green beans
  - Carrots
  - Lettuce (all types)
  - Melons, squash and cucumbers (all types)
  - Onions and garlic

  - Mixed berry crops
  - Tomatoes
  - Peppers
  - Broccoli
- Idle
  - Land not cropped the current or previous crop season, but cropped within the past three years
  - New lands being prepped for crop production

The model includes all grassland types, many managed and natural seasonal wetland types, all irrigated pastures and hays, and all seasonally rotated croplands. The model excludes suitable habitat fragments less than 40 acres in size if they are completely within urbanized areas. Suitable habitat fragmented by unsuitable agricultural crop types is not excluded. Agricultural crop types designated as species habitat correspond to DWR 2007 land use database categories.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Additional detail regarding crop types was available for cultivated lands and was incorporated into the mapping. In the new analysis areas, the following natural communities and crop types were assumed to provide the listed habitat type (i.e., nesting, foraging) for Swainson's hawk.

Additional areas mapped as nesting habitat include the following natural community types:

- Valley/foothill riparian
  - Fremont cottonwood–valley oak–willow (ash–sycamore) riparian forest NFD alliance
  - Mixed Fremont cottonwood–willow species, NFD alliance
  - Mixed willow super alliance
  - Valley oak (*Quercus lobata*)
  - Valley oak alliance–riparian

Additional areas mapped as foraging habitat include the following natural community types when the 5-acre minimum patch size was met:

- Agricultural
  - Grain/hay crops
  - Alfalfa
  - Pasture
- Alkali seasonal wetland complex

- Grassland
  - Upland annual grassland and forbs formation
- Vernal pool complex

2A.22.7.3 Assumptions

- **Assumption:** Swainson's hawk use nesting sites indicated on Figure 2A.22-2.

  Rationale: In the Central Valley, Swainson's hawks typically nest in large native trees such as cottonwood, valley oak, walnut, and black willow (Figure 2A.22-2). These trees (and thus most nest sites) are most often found along stringers of valley riparian forest (Estep 1984; Schlorff and Bloom 1984; England et al. 1997). Because the age or structure of the overstory trees is not considered here, this model may overestimate the extent of suitable riparian nesting habitat. However, Swainson's hawks also nest in a variety of other native (e.g., Oregon ash, box elder, white alder) and nonnative trees (e.g., eucalyptus) and habitats such as roadside trees, windbreaks, oak groves, isolated trees, and trees around rural residences. These nesting habitat types are not sufficiently captured by this model primarily due to the small mapping units that would be required, and thus potential nonriparian nesting habitat is underestimated here (Figure 2A.22-2). While the model focuses on riparian habitats, to address this issue, impact assessments will include all potential nesting habitat types where they occur in association with suitable foraging habitat.

- **Assumption:** Swainson's hawk foraging habitat is restricted to the vegetation types described in Section 2A.22.7.2, *Habitat Model Description*.

  Rationale: In the Central Valley, foraging habitat consists primarily of irrigated croplands and pasturelands. Swainson's hawks also forage in annual grasslands and during the summer will use noninundated seasonal wetlands. Swainson's hawks feed primarily on small rodents, usually in large fields that support low vegetation cover (to provide access to the ground) and high densities of prey (Bechard 1982; Estep 1989). These habitats include hay fields, grain crops, certain row crops, and lightly grazed pasturelands. Because foraging Swainson's hawks must have access to the ground, vegetation structure influences foraging use, which varies according to the crop type and seasonal planting and harvesting regime (Estep 2009). However, because the grain and hay, field, and truck, nursery and berry crop types listed above are seasonally rotated, the value of individual fields changes each year. Therefore, these crop types are not differentiated based on their seasonal value and are instead combined into a category of seasonally rotated croplands. As a result, this model overestimates the extent of available agricultural foraging habitat in any given year. Foraging use is also a function of patch size. Foraging use generally decreases as suitable foraging patch size decreases below approximately 40 acres. However, this is usually based on fragmentation of foraging habitat due to urbanization, and not necessarily by unsuitable crop types. To maintain consistency with CDFW guidance, a minimum foraging patch size of 5 acres is used.

2A.22.7.4 Habitat Value Categories

As described, the Swainson's hawk is closely associated with agricultural lands. Most of the Plan Area consists of agricultural land and most is considered to have some value as foraging habitat for Swainson's hawks. However, the value of crop types differ widely due to their growth and structure, which influences accessibility by foraging hawks, and in prey abundance, which influences the

availability of prey to foraging hawks. Because of the dynamic nature of the agricultural landscape and the variability of crop patterns and conditions seasonally and annually, only a proportion of the agricultural landscape is suitable or available for foraging in any given season or year.

Sufficient information is available on the growth and structure of different agricultural crops (Estep 1989, 2009) and the prey abundance and use of different crop types to generally categorize crops based on their value as foraging habitat. Table 2A.22-1 categorizes modeled cover types according to five relative value classes, very high, high, moderate, low, and marginal. These value classes correspond to the conservation objectives for the Swainson's hawk with regard to sustaining maintaining moderate to very high-value types on protected conservation lands. Table 2A.22-1 provides the rationale for assigning crop types and other agricultural land uses to habitat value categories. Figure 2A.22-3 displays the distribution of foraging habitat and the assigned habitat values within the Plan Area.

Table 2A.22-1. Swainson's Hawk Agricultural Foraging Habitat Value Classes

Foraging Habitat Value Class	Assigned Agricultural Crops/ Habitats	Rationale for Assignment of Agricultural Crop Class	Information Sources
Very High	Alfalfa	Alfalfa has the highest value because it is semi-perennial (up to 5 years before rotation), which increases prey abundance; has a relatively low profile such that prey are accessible season-long; and has a management regime (mowing and irrigation) which further increases prey accessibility.	Estep 1989, 2009; Swolgaard et al. 2008; Anderson et al. in preparation
High	Native pasture, mixed pasture, clover, miscellaneous grasses, non-irrigated native pasture and pasture, native vegetation[a]	These pasture types provide a relatively consistent vegetation structure and rodent prey populations. There is less seasonal variability with respect to prey abundance and accessibility compared with grain and vegetable crops, but they lack the management practices that enhance prey accessibility found in alfalfa.	Estep 1989, 2009; Swolgaard et al. 2008; Anderson et al. in preparation
Medium	Grasslands, managed wetlands, alkali seasonal wetlands, Vernal pool complex, tomatoes, beets, wheat, oats, miscellaneous grain and hay, nonirrigated miscellaneous grain and hay, mixed grain and hay, non-irrigated mixed grain and hay	Certain row crops, such as beets and tomatoes have a relatively high value because they support large rodent prey populations, are accessible season-long because of their relatively low vegetation profile, and they are harvested prior to migration, when an abundance of prey becomes available. Most grain crops (primarily wheat in Yolo County) provide value during and following harvesting, when prey become accessible. Grasslands are generally available season-long but provide lower prey abundance compared with higher value agricultural habitats, don't provide a peak period of high-value abundance and accessibility like some agricultural crops (e.g., tomatoes), and in some cases grass height reduces prey accessibility during a portion of the breeding season.	Estep 1989, 2009; Swolgaard et al. 2008; Anderson et al. in preparation

Foraging Habitat Value Class	Assigned Agricultural Crops/ Habitats	Rationale for Assignment of Agricultural Crop Class	Information Sources
Low	Broccoli, sudan, dry beans, field crops, asparagus, green beans, carrots, melons/squash/ cucumbers, onions/garlic, peppers, lettuce truck/nursery/ berry crops, miscellaneous field	The truck and berry/field crop agriculture types are suitable for a portion of the breeding season depending on their structure and planting/harvesting regime. In general, they produce less prey abundance and less prey availability than the other agriculture types listed above.	Estep 1989, 2008; Swolgaard et al. 2008; Anderson et al. in preparation
Marginal	Safflower, corn, grain sorghum, sunflower	These types are available for a brief time during the breeding season and have particularly low prey accessibility.	Estep 1989, 2009; Swolgaard et al. 2008; Anderson et al. in preparation
[a] Native vegetation is a land use designation within the California Department of Water Resources crop type dataset (2007). For the purposes of incorporating native vegetation classes into the correct species models, and, when applicable, assigning habitat foraging values, the management on these lands most resembles that of native pasture, an irrigated pasture type.			

2A.22.8 Recovery Goals

A USFWS recovery plan has not been prepared for this species and no recovery goals have been established; however, the CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the Swainson's hawk as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions under its control and within its scope that are necessary in order to contribute to the recovery of the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

2A.22.9 References Cited

2A.22.9.1 Literature Cited

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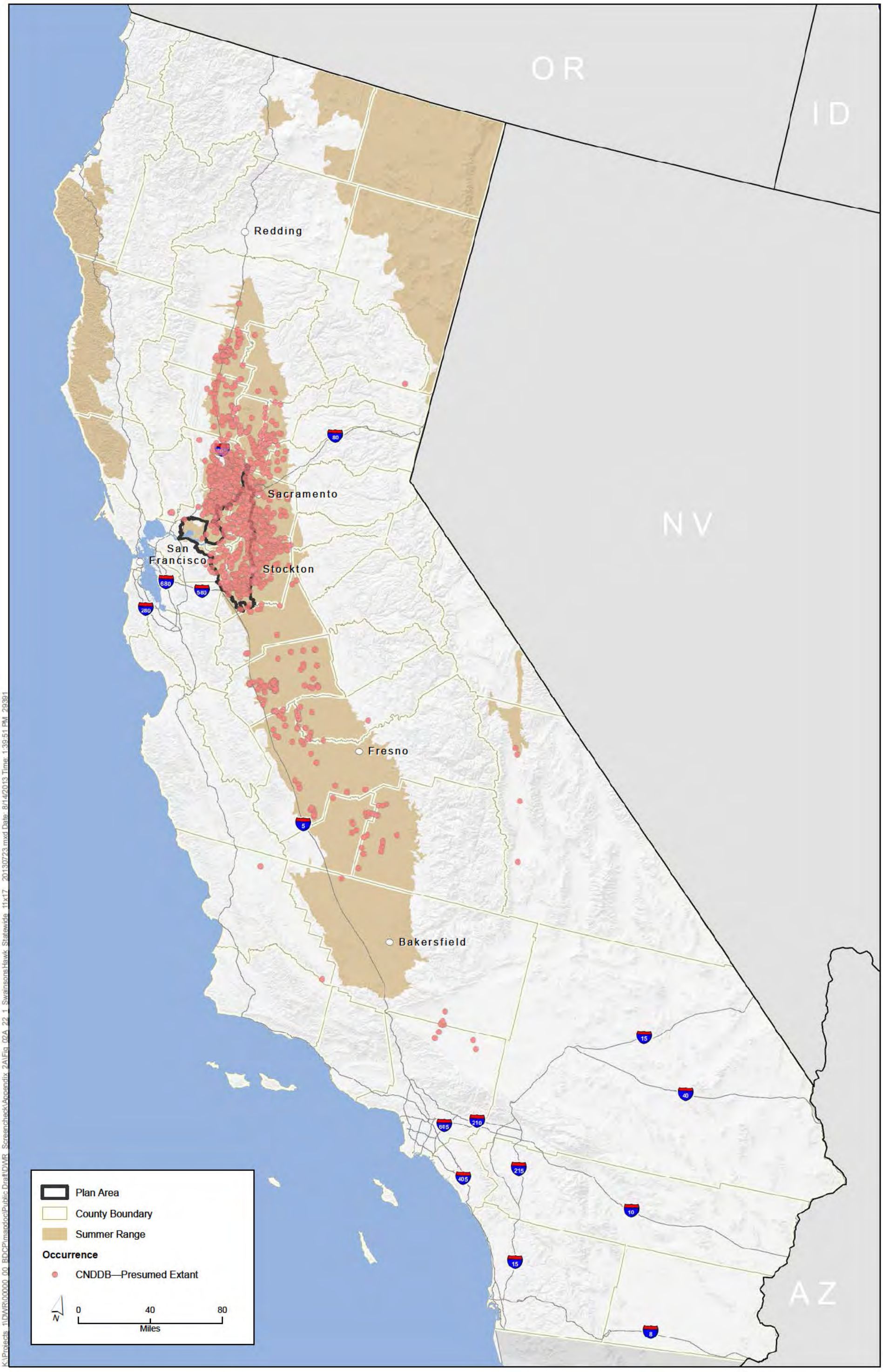
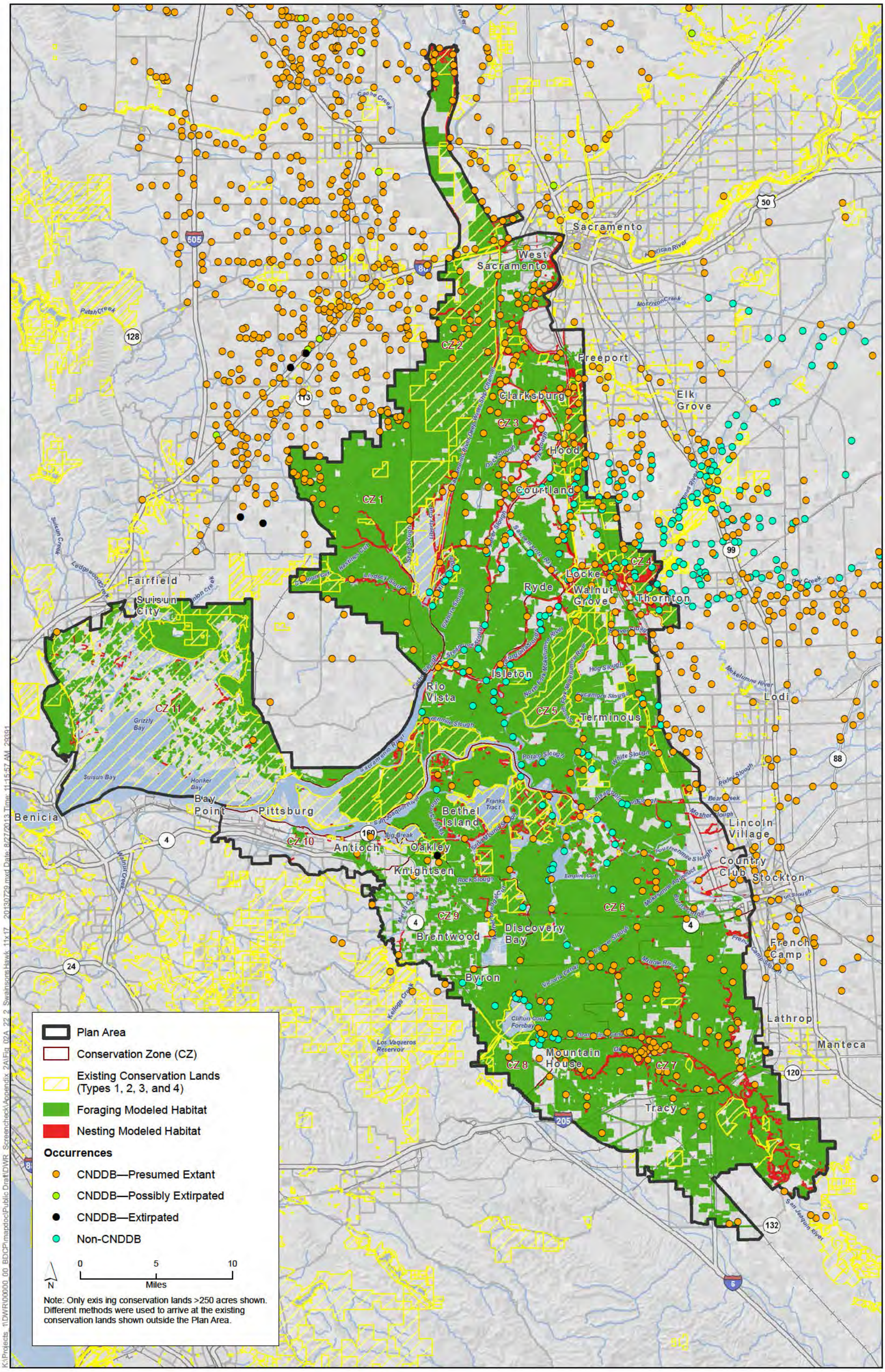


GIS Data Sources: Occurrences, CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.22-1
Swainson's Hawk Statewide Range and Recorded Occurrences



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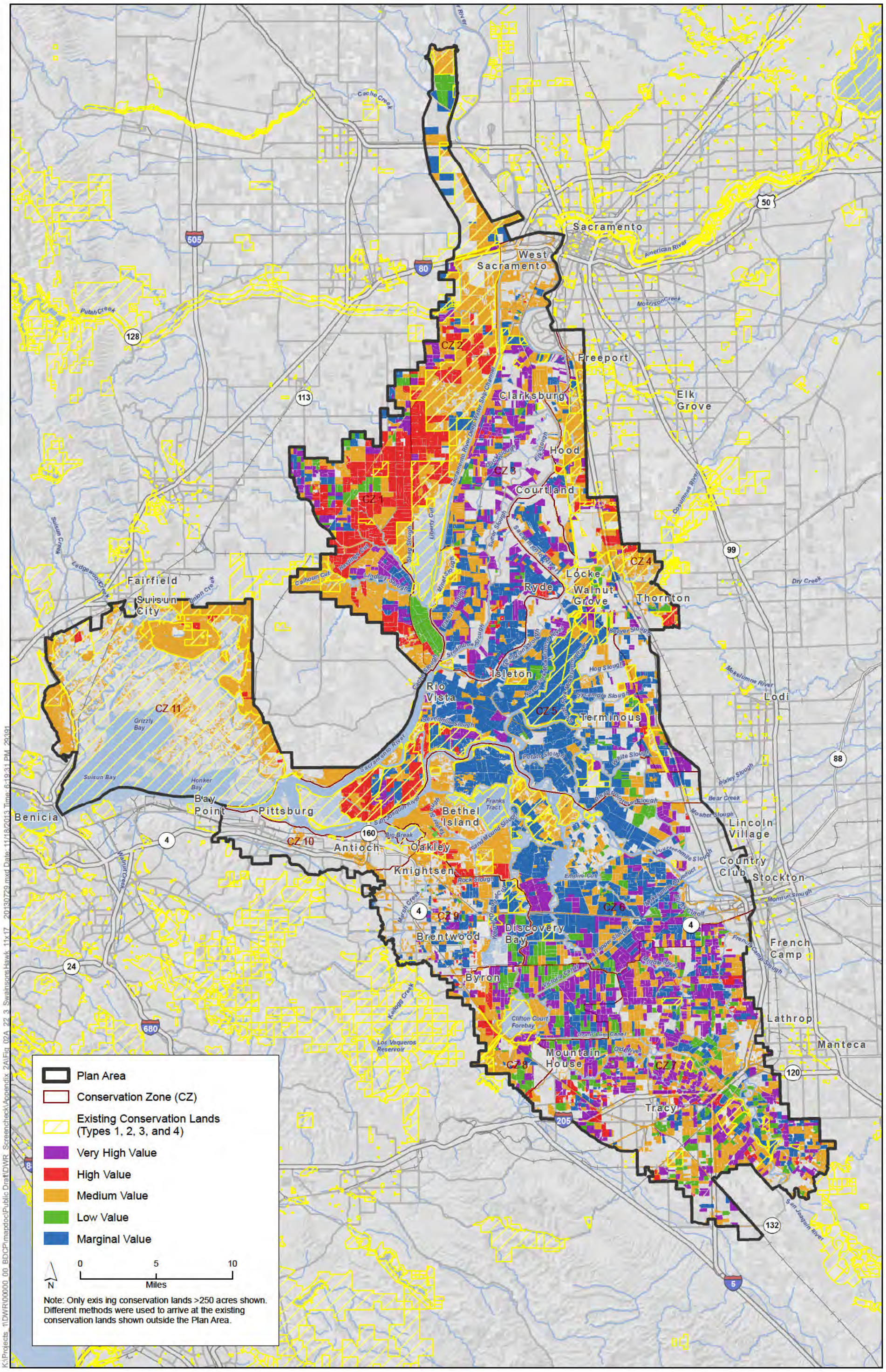
GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013, DHCCP 2009-2001, Estep 2006.

Figure 2A.22-2
Swainson's Hawk Habitat Model and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011.

Figure 2A.22-3
Swainson's Hawk Foraging Habitat Model and Associated Value Rankings

Appendix 2A.23
Tricolored Blackbird (*Agelaius tricolor*)

2A.23.1 Legal Status

The tricolored blackbird (*Agelaius tricolor*) is designated as a state Bird Species of Special Concern by the California Department of Fish and Wildlife (CDFW) (Shuford and Gardali 2008). Nests are protected in California under Fish and Game Code, Section 3503.

The tricolored blackbird has no federal regulatory status; however, the species is protected under the federal Migratory Bird Treaty Act and is designated as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS) (U.S. Fish and Wildlife Service 2002). A petition for federal listing submitted to USFWS in 2004 was denied in 2006, based on insufficient scientific evidence to warrant listing the species under the federal Endangered Species Act.

2A.23.2 Species Distribution and Status

2A.23.2.1 Range and Status

The tricolored blackbird is a colonial nesting passerine bird that is largely restricted to California. The species forms some of the largest colonies of any North American passerine bird, which may number in the tens of thousands of breeding pairs (Beedy and Hamilton 1999). More than 95% of the California breeding population of tricolored blackbird occurs in the Central Valley (Kyle and Kelsey 2011). Approximately 98% of adult tricolored blackbirds occur north of the Tehachapi Mountains and the remaining 2% occur south of the Tehachapi Mountains (Meese pers. comm.). Breeding also occurs in the foothills of the Sierra Nevada south to Kern County, the coastal slopes from Sonoma County to the Mexican border, and sporadically in the Modoc Plateau (Figure 2A.23-1). However, very few locations in the range of the tricolored blackbird provide the landscape characteristics required for successful breeding by colonies of tens of thousands of breeding pairs (Meese pers. comm.). Wintering tricolored blackbirds often form huge, mixed species flocks that forage across the landscape. The Sacramento–San Joaquin River Delta (Delta) and central coast are recognized as major wintering areas for tricolored blackbirds (Hamilton 2004; Beedy 2008). Tricolored blackbirds may make extensive movements during the breeding season and during winter (Beedy 2008). While the overall range of the tricolored blackbird has been largely unchanged since the 1930s (Neff 1937; DeHaven et al. 1975; Beedy et al. 1991; Hamilton 1998), large gaps now exist in the species' former range.

Historical population sizes of tricolored blackbirds are unknown, but by the mid-1930s, following the removal of most major wetland areas in the state, populations still likely exceeded 1.1 million adult birds (Hamilton 1998). In the first systematically conducted range-wide surveys, Neff (1937) documented 252 colonies of tricolored blackbirds in 26 California counties, including over 700,000 adults in just eight Central Valley counties. Surveys conducted in the 1960s and 1970s indicated that range-wide populations declined by more than 50% during the 30- to 35-year period following Neff's surveys in the 1930s (Orians 1961; Payne 1969; DeHaven et al. 1975).

More recently in the 1990s and 2000s, USFWS, CDFW, and California Audubon have cosponsored systematic tricolored blackbird surveys throughout California. Surveys during the 1990s (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000) confirmed the significant declining trend in California populations since the 1930s, with a particularly dramatic decline noted after 1994. A population low of 94,269 adult birds was documented during the 1999 survey. Statewide surveys conducted during the 2000s indicate some recovery from the 1999 low; however, the population increases have primarily been limited to the San Joaquin Valley and the Tulare Basin (Kyle and Kelsey 2011). A total of 259,322 adults were counted during the most recent (2011) statewide survey, with Kern, Tulare, and Merced Counties in the San Joaquin Valley accounting for about 88% of the total population in early spring (Kyle and Kelsey 2011). The 2011 count represents a population decline of about 35% from the previous statewide count of 394,848 birds in 2008. The 2011 data represent the least productive breeding season ever recorded during the statewide surveys (Meese pers. comm.).

Breeding surveys conducted over the last 15 years have documented wide fluctuations in tricolored blackbird populations, with populations stabilizing between 250,000 and 400,000 over the last 6 years (Kyle and Kelsey 2011). The data also indicate that populations continue to decline in several areas of the state where the species was formerly common, particularly in Southern California and several Central Valley counties, including San Joaquin County, where no active colonies have been documented since 2004, and in Sacramento and Fresno Counties. No active colonies have been observed in San Bernardino County since 1994. However, colonies continue to persist in Riverside County and a single colony has been documented in Kings County at LeMoore Naval Air Station (Information Center for the Environment 2011). Thus, while population numbers statewide may have stabilized, tricolored blackbirds appear to have concentrated into a significantly smaller effective range (Kyle and Kelsey 2011).

2A.23.2.2 Distribution and Status in the Plan Area

There are few reported historical occurrences of tricolored blackbird breeding colonies from the Plan Area (Figure 2A.23-2). Beedy et al. (1991 cited in Neff 1937) reported historical occurrences at Stone Lakes and at sites near Tracy, near Durham Ferry, and at Birds Landing. The California Natural Diversity Database (CNDDB) (California Department of Fish and Game 2011) reported occurrences in and near the Yolo Bypass; near Stockton, Manteca, and Tracy in the southeastern corner of the Plan Area; and along the eastern edge of Suisun Marsh; however, few of these are recent reports.

More recent surveys have documented occasional breeding sites generally along the fringe of Suisun Marsh, in the Yolo Bypass, and along the southwestern perimeter of the Plan Area. The tricolored blackbird portal contains records for 19 breeding sites in the Plan Area since 1996, ranging from as few as 3 to as many as 2,000 breeding adults per site (Kyle pers. comm.). A single nesting colony of about 1,000 breeding adults was recorded during the 2011 statewide survey along the northern edge of Suisun Marsh (Kyle pers. comm.). Several thousand acres of potentially suitable tricolored blackbird nesting habitat were surveyed in the Plan Area between 2009 and 2011 by the California Department of Water Resources (DWR) (California Department of Water Resources et al. 2012). Fourteen detections were recorded in 2009, representing ten likely nest sites. However, these surveys were completed before the optimal nesting period for tricolored blackbirds in the Delta. Additional surveys conducted during the optimal breeding period detected five tricolored blackbirds in 2010 and one in 2011. All observations appeared to be foraging birds; no nesting by tricolored blackbirds was confirmed. Based upon recent survey results, the tricolored blackbird

appears to be an uncommon breeder in the Plan Area. Historical nesting activity was generally restricted to the northern and southern ends of the Plan Area.

Although recent nesting colonies in the Plan Area have generally been small (comprising less than 2,000 breeding adults), several large colonies have been reported near the Plan Area. Colonies of 35,000, 57,000 and 18,900 breeding adults were documented on the Conaway Ranch in the Yolo Bypass north of Interstate 80 (I-80) in 2007, 2009, and 2010 (Meese 2007, 2009, 2010). The 2007 colony bred in a milk thistle stand adjacent to a recently renovated marsh used by tricolored blackbirds in the past, and was one of only three documented colonies statewide that were large and successful. This colony was estimated to have produced about 30,000 young (Meese 2007). The 2009 colony, which returned to nest in the recently renovated bulrush/cattail marsh, produced the largest number of young in the Central Valley (estimated 30,000) in that year (Meese 2009). The Hay Road Landfill site in Solano County is just outside of the Plan Area south of Dixon. Colonies of 1,000 and 4,000 breeding adults were documented at this site in 2005 and 2011, respectively (Information Center for the Environment 2011).

The Delta is also recognized as a major wintering area for tricolored blackbirds (Hamilton 2004; Beedy 2008). Large, mixed wintering flocks of tricolored blackbirds and other species numbering in the hundreds of thousands have been reported to roost on Sherman Island, but the actual roost location has not been precisely identified (Meese pers. comm.). Wintering tricolored blackbirds are often associated with open rangelands and dairies (University of California Davis no date).

2A.23.3 Habitat Requirements and Special Considerations

Tricolored blackbirds are among the most colonial of North American passerine birds (Bent 1958; Orians 1961; Payne 1969; Beedy and Hamilton 1999). The species' highly synchronized and colonial breeding system may have adapted to exploit a rapidly changing environment in which the locations of secure nesting habitat and rich insect food supplies were ephemeral and likely to change each year (Orians 1961; Collier 1968; Payne 1969).

2A.23.3.1 Nesting

There are few reported historical occurrences of tricolored blackbird breeding colonies in the Plan Area (Neff 1937; Beedy et al. 1991; California Department of Fish and Game 2011). More recent surveys, however, have documented occasional nesting colonies in and around the Plan Area. Colonies identified since 1996 have generally been located along the fringe of the Suisun Marsh, in the Yolo Bypass, and along the southwestern perimeter of the Plan Area (University of California Davis no date). Nesting by tricolored blackbirds in the Plan Area is currently limited by the availability of high-value breeding habitat.

Tricolored blackbirds have three basic requirements for selecting their breeding colony sites:

- Open, accessible water.
- A protected nesting substrate, including flooded, thorny, or spiny vegetation.

- A suitable foraging space providing adequate insect prey within five miles of the nesting colony (Hamilton et al. 1995; Beedy and Hamilton 1999; University of California Davis no date). This requirement places an intense demand on the landscape during breeding (Meese pers. comm.).

The species typically nests in large, dense colonies twice per season, with the second attempt often in a different, more northerly location (Hamilton 1998). Tricolored blackbirds will return to breed year after year in the same locations if suitable landscape conditions persist (University of California Davis no date).

Males initially select breeding sites and establish nesting territories. If the site is determined suitable, females will select the nest site location. The first nests in a colony generally occur in the densest vegetation, usually in the interior of the nesting habitat. As the colony forms, nests are added in concentric circles gradually or in synchronous pulses (Collier 1968). As many as 30,000 nests have been recorded in cattail (*Typha* spp.) marshes of 10 acres or less, with individual nests less than 0.5 meter from each other (Neff 1937; DeHaven et al. 1975). However, typical nest densities in cattail and tule breeding sites generally range from 1,200 to 1,500 nests per acre (Meese pers. comm.). Nest heights range from a few centimeters to about 1.5 meters above water or ground at colony sites in freshwater marshes (Neff 1937), and up to 3 meters in the canopies of willows (*Salix* spp.) and other riparian trees; nests are rarely built on the ground.

Over time, the selection of nesting habitat has changed dramatically as freshwater marsh habitat has been removed. Almost 93% of the 252 breeding colonies reported by Neff (1937) were in freshwater marshes dominated by tules (*Schoenoplectus*, formerly *Scirpus* spp.) and cattails (*Typha* spp.). The remaining colonies in Neff's study were in willows (*Salix* spp.), blackberries (*Rubus* spp.), thistles (*Cirsium* and *Centaurea* spp.), or nettles (*Urtica* spp.). In contrast, only 53% of the colonies reported during the 1970s were in cattails and tules (DeHaven et al. 1975). The 2011 statewide survey documented only 33.6% of colony sites in tule/cattail wetlands, all of which were small colonies that represented only 4.9% of the total breeding population census (Kyle and Kelsey 2011). Tricolored blackbirds are highly dependent on disturbance events to maintain nesting sites. Older stands of bulrush and cattail with many senescent stems and horizontal dead stems become unattractive to the species for nesting.

An increasing percentage of colonies in the 1980s and 1990s were reported in Himalayan blackberry (*Rubus armeniacus*, formerly *R. discolor*) (Beedy et al. 1991). Some of the largest recent colonies are in silage and grain fields (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000), particularly triticale (a wheat–rye hybrid) fields in the San Joaquin Valley (Kyle and Kelsey 2011; University of California Davis no date). Other substrates where tricolored blackbirds have been observed nesting include giant cane (*Arundo donax*), safflower (*Carthamus tinctorius*), milk thistle (*Silybum marianum*), mustards (*Brassica* spp.), mallows (*Malva* spp.), tamarisk trees (*Tamarix* spp.), elderberry and poison-oak (*Sambucus* spp. and *Toxicodendron diversilobum*), and riparian scrublands and forests (DeHaven et al. 1975; Kyle and Kelsey 2011; University of California Davis no date).

2A.23.3.2 Foraging

Proximity of nesting colonies to suitable foraging habitat appears to be a key factor for high reproductive success by tricolored blackbirds. Breeding birds prefer to forage in areas that provide abundant insect prey, including pastures, grasslands, agricultural fields planted with crops such as alfalfa and sunflower, feedlots, and dairies. With the loss of the natural flooding cycle and most

native wetland and upland habitats in the Central Valley, breeding tricolored blackbirds now forage primarily in anthropogenic habitats. However, this is highly variable and site-specific. Tricolored blackbirds have been able to exploit foraging conditions created when shallow flood irrigation, mowing, or grazing keeps the vegetation at an optimal height (less than 15 centimeters). Preferred foraging habitats include crops such as alfalfa, sunflowers, and irrigated and dry pastures, as well as annual grasslands and shrub lands. The application of insecticides to preferred croplands will greatly diminish their foraging value to breeding tricolored blackbirds.

In recent years, an increasing percentage and now large majority of nonbreeding adults forage on grains provided to livestock; for example, in cattle feedlots and dairies. Tricolored blackbirds also forage in remnant native habitats, including wet and dry vernal pools and other seasonal wetlands, riparian scrub habitats, and open marsh borders. Vineyards, orchards, and most row crops (e.g., sugar beets, corn, peas, beets, onions) do not provide suitable nesting substrates or foraging habitats for tricolored blackbirds (Beedy and Hamilton 1999). Both adults feed the nestlings; adults feeding young typically forage within 5 miles of the colony(Beedy and Hamilton 1999). Females forming eggs and adults feeding nestlings forage exclusively on insects, with foraging typically concentrated on highly productive habitats (University of California Davis no date).

Some small breeding colonies may occur at private and public lakes, reservoirs, and parks, provided that suitable foraging habitat is nearby. Many of these colonies are surrounded by shopping centers, subdivisions, and other urban development; adults from such colonies forage in undeveloped uplands nearby.

During the nonbreeding season, tricolored blackbirds are primarily granivores that forage opportunistically in grasslands, pasturelands, and croplands (Hamilton 2004; University of California Davis no date). Large numbers of tricolored blackbirds are attracted to grains associated with livestock feed lots and dairies. Wintering populations concentrate in the Delta, the San Joaquin Valley, and at some central coast locations (e.g., Point Reyes National Seashore).

2A.23.4 Life History

2A.23.4.1 Description

The tricolored blackbird is a medium-sized passerine (8.8 inches [22 centimeters] in length with 14-inch [36 centimeter] wingspan) that closely resembles the red-winged blackbird (*Agelaius phoeniceus*), with subtle differences in coloration, bill shape, and overall morphology (Beedy and Hamilton 1999). The adult male is black, with shades of glossy blue, and has a bright red patch on the wing (an epaulet), similar to that of a red-winged blackbird. However, the epaulet of tricolored blackbirds is a deeper red with a white lower border, as opposed to an orange-red patch with a yellowish border or no border at all. The adult females are brownish and black, streaked with gray, with small reddish epaulets (rarely visible in the field) and a pale gray or whitish chin and throat. Tricolored blackbirds have longer, slightly narrower wingtips and thinner bills than red-winged blackbirds (Beedy and Hamilton 1999).

2A.23.4.2 Seasonal Patterns

Many tricolored blackbirds reside throughout the year in the Central Valley of California. However, local populations can move considerable distances, and some are migratory and move from inland

breeding locations to wintering habitats in the Delta and coastal areas. During the first breeding effort of the season, most birds nest in the San Joaquin Valley. Most later move northward throughout the Sacramento Valley, northeast California, and southern Oregon to nest again (Hamilton 1998). Thus, individual tricolored blackbirds may occupy and breed at several sites, or renest at the same site, during a given breeding season, depending on environmental conditions and their previous nesting success (Hamilton 1998; Beedy and Hamilton 1999; Meese 2006). In the fall, after the nesting season, large roosts form at managed wildlife refuges and other marshes near abundant food supplies such as cultivated rice (*Oryza sativa*) and water grass (*Echinochloa crus-galli*) (Beedy and Hamilton 1997). During winter, many tricolored blackbirds move out of the Sacramento Valley to the Delta. Large flocks also winter in the central and southern San Joaquin Valley and at the dairy farms in coastal areas such as Point Reyes and Monterey County (Beedy and Hamilton 1997). Roosting by tricolored blackbirds during the fall and winter generally occurs in emergent wetlands and shrub stands (Kyle pers. comm.). Winter foraging habitat primarily consists of livestock pens and recently cultivated fields, supplemented by grassland (Meese pers. comm.). From early March to early April, tricolored blackbird flocks move from wintering areas to their breeding colonies in the San Joaquin Valley (Beedy and Hamilton 1997).

2A.23.4.3 Reproduction

Tricolored blackbirds nest colonially, enabling them to synchronize their timing of nest building and egg laying (Beedy and Hamilton 1999). A few breeding colonies documented during fall months (September to November) had more protracted nest-building periods that led to asynchronous egg laying and fledging of young (Orians 1960). In the Central Valley, adults typically arrive on the breeding grounds from early March to early April (Hamilton 2004). Females usually breed in their first year, but most males apparently defer breeding until they are at least 2 years old (Payne 1969). Females typically lay three to four eggs and incubate them for 11 to 14 days (Emlen 1941; Orians 1961); then both parents feed young until they fledge 9 to 14 days after hatching (Beedy and Hamilton 1999).

Tricolored blackbird young transition from hatchlings to fledglings in approximately 24 days. Thus, a successful nesting effort requires approximately 45 days from nest initiation to independence of young (Hamilton et al. 1995). However, because birds may continue to be recruited into the nesting colony following the initial nest establishment, the colony itself remains active and in various stages of the breeding cycle for an extended period. This period may sometimes last more than 90 days, but generally requires a minimum of 50 days for a complete breeding cycle of a less asynchronous colony (Beedy and Hamilton 1997).

2A.23.4.4 Foraging Behavior and Diet

Like other blackbirds, tricolored blackbirds often forage in flocks. They usually forage on the ground by walking, hopping, or taking short flights. Most forage within 3 miles of their colony sites (Orians 1961) but may forage up to 5.5 miles away (Meese pers. comm.).

Diets of adult tricolored blackbirds are dependent on geographic location and the availability of local insect foods. Among the most important prey for adults provisioning nestlings include Coleopterans (beetles), Orthopterans (grasshoppers, locusts), Hemipterans (true bugs), other larval insects, and Arachnids (spiders and allies) (Crase and DeHaven 1977; Beedy and Hamilton 1999). The primary diet of a colony depends on the local food availability (large hatches of dragonflies [Odonata] are especially favorable to this species (Meese pers. comm. as cited in Yolo County Habitat Conservation

Plan/Natural Community Conservation Plan Joint Powers Agency 2011). Individuals are also attracted to large outbreaks of grasshoppers (Orians 1961). Adult females require insects to form eggs, and nestlings are fed almost exclusively insects until they are at least 9 days old, after which a mixture of both plant and animal foods are provided (Crase and DeHaven 1977; Skorupa et al. 1980; Meese pers. comm.). During the nonbreeding season, tricolored blackbirds often congregate at dairy feedlots to consume grains and other livestock feed, while others forage on insects, grains, and other plant material in grasslands and agricultural fields (Skorupa et al. 1980; Beedy and Hamilton 1999).

2A.23.5 Threats and Stressors

2A.23.5.1 Habitat Loss and Alteration

The most significant historical and ongoing threat to the tricolored blackbird is habitat loss and alteration. The initial conversion from native landscapes to agriculture removed vast wetland areas in the state and caused initial declines in populations. The more recent conversion of suitable agricultural lands to urban areas has permanently removed historical breeding and foraging habitat for this species.

In urbanizing areas, habitat fragmentation and proximity to human disturbances has also led to abandonment of large historical colonies (Beedy and Hamilton 1999).

In Sacramento County, a historical breeding center of this species, the conversion of grassland and pastures to vineyards expanded from 7,537 acres in 1996, to 13,171 acres in 1998 (DeHaven 2000), to 16,709 acres in 2003 (U.S. Department of Agriculture 2012). Conversions of pastures and grasslands to vineyards in Sacramento County and elsewhere in the species' range in the Central Valley have resulted in the recent loss of several large colonies and the elimination of extensive areas of suitable foraging habitat for this species (Cook 1999; DeHaven 2000; Hamilton 2004; Yolo County 2008).

2A.23.5.2 Mortality during Crop Harvest

Entire colonies (up to tens of thousands of nests) in cereal crops and silage are often destroyed by harvesting and plowing of agricultural lands (Beedy and Hamilton 1999; Hamilton 2004; Cook and Toft 2005). While adult birds can fly away, eggs and fledglings cannot. The concentrations of a high proportion of the known population in a few breeding colonies increases the risk of major reproductive failures, especially in vulnerable habitats such as active agricultural fields (Yolo County 2008).

2A.23.5.3 Predation

Historical accounts documented the destruction of nesting colonies by a diversity of avian, mammalian, and reptilian predators (Beedy and Hamilton 1999). Recently, especially in perennial freshwater marshes of the Central Valley, entire colonies have been lost to black-crowned night-herons (*Nycticorax nycticorax*) and common ravens (*Corvus corax*). Since 2006, cattle egrets (*Bubulcus ibis*) have been observed preying on tricolored blackbird nests in Tulare County. Predation by cattle egrets has become so severe that complete reproductive failure has occurred in at least one large colony for 5 consecutive years (Meese 2011). Some large colonies (up to 100,000

adults) may lose greater than 50% of nests to coyotes (*Canis latrans*), especially in silage fields, but also in freshwater marshes when water is withdrawn (Hamilton et al. 1995). Thus, water management by humans often has the effect of increasing predator access to active colonies (Yolo County 2008).

2A.23.5.4 Human Disturbances

Tricolored blackbird colonies are highly sensitive to human disturbances. Proximity to urbanizing areas can cause colonies to be permanently abandoned. Increases in noise, loose pets, and human presence can cause nest abandonment. Even entry into colonies for management or scientific purposes can cause disturbances and should be avoided (Beedy and Hamilton 1999).

2A.23.5.5 Poisoning and Contamination

Various poisons and contaminants have caused mass mortality of tricolored blackbirds. McCabe (1932) described the strychnine poisoning of 30,000 breeding adults as part of an agricultural experiment. Neff (1942) considered poisoning to regulate numbers of blackbirds preying upon crops (especially rice) to be a major source of mortality. This practice continued until the 1960s, and thousands of tricolored blackbirds and other blackbirds were exterminated to control damage to rice crops in the Central Valley. Beedy and Hayworth (1992) observed a complete nesting failure of a large colony (about 47,000 breeding adults) at Kesterson Reservoir in Merced County; selenium toxicosis was diagnosed as the primary cause of death. At a colony in Kern County, all eggs sprayed by mosquito abatement oil failed to hatch (Beedy and Hamilton 1999). Hosea (1986) attributed the loss of at least two colonies to aerial herbicide applications (Yolo County 2008).

2A.23.5.6 Other Conservation Issues

Important information gaps in the ecology of the species include the effects of land use changes on the reproductive success of colonies and on the distribution of wintering birds; the relationship of invertebrate prey abundance and brood size; winter distribution, diet, and survival rates; and measures of suitable foraging habitat (Beedy and Hamilton 1999; Meese 2007).

Tricolored blackbirds have been the focus of recent management concern due to population decline, very limited global range, and vulnerability of large breeding colonies to habitat losses, predation, and human-induced impacts.

2A.23.6 Relevant Conservation Efforts

The Tricolored Blackbird Working Group was established specifically to address the conservation of the tricolored blackbird across the state. In 2007, the group prepared a conservation strategy for this species (Tricolored Blackbird Working Group 2007). Recommendations for the species conservation include frequent monitoring of breeding and wintering population sizes, colony locations, and reproductive success; protecting colony locations and foraging habitats; protecting colonies on farmland by avoiding harvesting and tilling until young have fledged; providing adequate protection in Habitat Conservation Plans; focusing on dairy dependence for breeding and wintering populations; developing or restoring breeding habitat near reservoirs, rice fields, alfalfa fields, and other optimal foraging habitats; and managing major predators in or near breeding

colonies, including common ravens, black-crowned night-herons, cattle egrets, and coyotes when feasible (Beedy and Hamilton 1999; Hamilton 2004) .

The tricolored blackbird is also a covered species in other neighboring regional conservation plans, including the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County 2006), and the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003). It is proposed for coverage in the in-progress *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.23.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.23.7.1 GIS Model Data Sources

The tricolored blackbird model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]); aerial photography (U.S. Department of Agriculture 2005), and land use survey of the Delta area-version 3, land use survey of the Delta and Suisun Marsh area - version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable tricolored blackbird habitat in the Plan Area according to the species' two primary life requisites, breeding habitat and nonbreeding habitat. Vegetation types were assigned to a suitability category based on the species requirements, as described above, and the assumptions described below.

2A.23.7.2 Habitat Model Description

Modeled breeding habitat is represented by suitable nesting substrate, including cattail/bulrush emergent wetlands and riparian shrub strands, in close association with highly productive foraging areas that support abundant insect prey, such as grasslands (including vernal pool complex and alkali seasonal wetland complex), irrigated and nonirrigated pasture, alfalfa, unsprayed sunflowers, and possibly fallow rice.

Modeled breeding habitat consists of all bulrush, cattail, and blackberry communities, and adjacent high-quality foraging areas located within 5 miles of nesting colonies documented in the Plan Area over the last 15 years. Breeding season foraging habitat in the Plan Area encompasses grassland (including vernal pool complex and alkali seasonal wetland complex), irrigated and nonirrigated pasture (including alfalfa), and sunflower croplands, all habitats known to support abundant insects.

The nesting component of breeding habitat in the Delta consists of the following types from the BDCP composite vegetation layer that occur within 5 miles of breeding colonies documented between 1998 and 2012.

- Nontidal freshwater perennial emergent
  - American bulrush (*Schoenoplectus americanus*)
  - Hard-stem bulrush (*Schoenoplectus acutus*)
  - Mixed *Schoenoplectus*/floating aquatics (*Hydrocotyle–Eichhornia*) complex
  - Mixed *Schoenoplectus*/submerged aquatics (*Egeria–Cabomba–Myriophyllum* spp.) complex
  - Mixed *Schoenoplectus* mapping unit
  - Broad-leaf cattail (*Typha latifolia*)
  - Narrow-leaf cattail (*Typha angustifolia*)
  - *Schoenoplectus acutus*–(*Typha latifolia*)–*Phragmites australis*
  - *Schoenoplectus acutus–Typha angustifolia*
  - *Schoenoplectus acutus* pure
  - *Schoenoplectus acutus–Typha latifolia*
- Valley/foothill riparian
  - Blackberry (*Rubus discolor*)
  - Mexican elderberry (*Sambucus mexicana*)
  - *Salix lasiolepis*–Mixed brambles (*Rosa californica–Vitis californica–Rubus discolor*)
  - *Salix exigua*–(*Salix lasiolepis*)–*Rubus discolor–Rosa californica*
  - *Salix gooddingii/Rubus discolor*
  - Black willow (*Salix gooddingii*)
  - Narrow-leaf willow (*Salix exigua*)
  - *Rubus discolor*

The foraging component of breeding habitat includes both uncultivated (i.e., natural) and cultivated lands. The following noncultivated types from the BDCP composite vegetation layer provide foraging habitat for tricolored blackbirds in the Delta:

- Grassland
  - All types
- Alkali seasonal wetlands complex
  - All types
- Other natural seasonal wetlands
  - All types
- Vernal pool complex
  - Annual grasses generic
  - Annual grasses/weeds
  - California annual grasslands

- *Distichlis* (generic)
- *Distichlis spicata*
- *Distichlis spicata*–annual grasses
- *Distichlis*/annual grasses
- *Distichlis*/*S. maritimus*
- Ruderal herbaceous grasses and forbs
- Italian ryegrass (*Lolium multiflorum*)
- *Salicornia virginica*
- *Salicornia*/annual grasses

Noncultivated types from the BDCP composite vegetation layer that provide breeding season foraging habitat for tricolored blackbirds in the in the Suisun Marsh and Yolo Basin include:

- *Bromus* spp./Hordeum
- *Crypsis schoenoides*
- *Crypsis* spp.–wetland grasses–wetland forbs
- Cultivated annual graminoid
- *Cynodon dactylon*
- *Distichlis*/annual grasses
- *Distichlis* (generic)
- *Distichlis spicata*
- *Distichlis*/*Cotula*
- *Distichlis*/*Juncus*
- *Distichlis*/*Lotus*
- *Distichlis*/*S. americanus*
- *Distichlis*/*S. maritimus*
- *Distichlis*/*Salicornia*
- *Distichlis–Juncus–Triglochin–Glaux*
- *Hordeum*/*Lolium*
- *Lotus corniculatus*
- Medium upland herbs
- Medium wetland graminoids
- Medium wetland herbs
- Pasture
- Perennial grass

- Short upland graminoids
- Short wetland graminoids
- Tall wetland graminoids
- Upland annual grasslands and forbs formation
- Upland herbs

The following crop types from the DWR 2007 land use survey types represent potentially suitable foraging habitats for tricolored blackbirds during the breeding season, as based upon input provided by species experts (Meese pers. comm.; Kyle pers. comm. 2011). Pasture types are mostly perennial; alfalfa is semi-perennial (3 to 7 years); and all other crop types are annually or seasonally rotated irrigated crops. The relative value of these crop types to tricolored blackbirds is discussed further in Section 2A.23.7.4, *Habitat Value Classes.*

- Grain and hay crops
  - Wheat
  - Miscellaneous grain and hay
  - Mixed grain and hay
- Field crops
  - Sunflower
- Pasture
  - Alfalfa and alfalfa mixtures
  - Mixed pasture
  - Native pasture
  - Induced high-water-table native pasture
  - Miscellaneous grasses
- Nonirrigated mixed pasture
- Nonirrigated native pasture
- Rice
- Idle
  - Land not cropped the current or previous crop season, but cropped within the past three years
  - New lands being prepped for crop production
- Semiagricultural and incidental to agricultural
  - Farmsteads
  - Livestock feedlots
  - Dairies

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Additional detail regarding crop types was available for cultivated lands and was incorporated into the mapping. In the new analysis areas, the following natural communities were assumed to provide the listed habitat type (i.e., breeding nesting and non-breeding roosting, breeding and non-breeding foraging) for tricolored blackbird.

Additional areas mapped include the following land cover types (within 5 miles of breeding colonies documented between 1998 and 2012) as the nesting component of breeding habitat.

- Grasslands
- Tidal brackish emergent wetland
- Tidal freshwater emergent wetland
- Tidal perennial aquatic
    - Tidal perennial aquatic–water
- Valley/foothill riparian

Additional areas mapped include the following land cover types as the foraging component of breeding and nonbreeding habitat:

- Agricultural
    - Cultivated annual graminoid
    - Field crops
    - Grain/hay crops
    - Pasture
    - Rice
    - Truck/nursery/berry crops
- Alkali seasonal wetland complex
- Grassland
    - Pasture
    - Upland annual grasslands & forbs formation
- Managed Wetland
    - Crypsis spp.–wetland grasses– wetland forbs NFD super alliance
    - Vernal pool

Additional areas mapped include the following land cover types as the roosting component of nonbreeding habitat:

- Managed wetland
    - Bulrush–Cattail freshwater marsh NFD super alliance

2A.23.7.2.1 Assumptions

- **Assumption:** Tricolored blackbird nesting habitat is restricted to the vegetation types described in Section 2A.23.7.2, *Habitat Model Description*.

  Rationale: Tricolored blackbirds typically nests in areas with open accessible water, a nesting substrate that is protected from ground predators (e.g., vegetation that is flooded, thorny, or spiny), and suitable foraging habitat (e.g., pastures, dry seasonal pools, agricultural fields such as alfalfa and sunflower) that provides abundant insect prey within 5 miles of the nesting colony (Hamilton et al. 1995; Beedy and Hamilton 1999; University of California Davis no date). Hamilton (2004) reported that open water within 500 meters of nesting substrate is a requirement for colony settlement.

- **Assumption:** Tricolored blackbird foraging habitat is restricted to the vegetation types described in Section 2A.23.7.2, *Habitat Model Description*.

  Rationale: Proximity of nesting colonies to high-value foraging habitat appears to be a key factor for high reproductive success by tricolored blackbirds. Most breeding tricolored blackbirds usually forage within 5 miles of their colony sites (Kyle pers. comm. 2011; Meese pers. comm. 2011). Foraging is typically concentrated in areas that support abundant insect populations, a vital food resource required for egg laying and for successful rearing and fledging of young (University of California Davis no date). Breeding season foraging habitat encompasses grassland, natural seasonal wetlands (e.g., vernal pool complex, alkali seasonal wetland complex), pasturelands (including alfalfa), and sunflower croplands, all habitats known to support abundant insect prey. Foraging value of cultivated lands is substantially reduced whenever widespread use of insecticide occurs.

- **Assumption:** Tricolored blackbird breeding habitat is restricted to the vegetation types described in Section 2A.23.7.2, *Habitat Model Description*.

  Rationale: Beedy et al. (1991) reported breeding colonies occupying sites as small as 0.1 acre. In most cases, however, several acres of suitable nesting substrate are required for a colony, though small numbers of birds (50 to 200) may attempt to nest in such fragments (Meese pers. comm.). Therefore, all potentially suitable vegetation types are considered potential breeding habitats regardless of patch size. The mapping unit size of 1 acre may contribute to underestimating the extent of suitable breeding habitat in the Plan Area.

2A.23.7.3 Nonbreeding Habitat

Although tricolored blackbirds occasionally nest in the Plan Area, greatest use is by wintering birds that often form huge, mixed-species flocks that forage across the landscape. Nonbreeding habitat comprises two key components: the presence of suitable lands for foraging and suitable vegetative structure for roosting. Outside of the breeding season, tricolored blackbirds are primarily granivores that forage opportunistically within grasslands, pasturelands, and croplands (University of California Davis no date). Cultivated lands constitute major foraging sites for nonbreeding tricolored blackbirds, with substantial use associated with a variety of croplands, pasturelands, dairies, and livestock feed lots. Grains associated with livestock feedlots and dairies are particularly attractive to tricolored blackbirds. Roosting by nonbreeding tricolored blackbirds generally occurs in emergent wetlands and shrub stands (Kyle pers. comm.).

The following noncultivated types from the BDCP composite vegetation layer provide nonbreeding season foraging habitat for tricolored blackbirds in the Delta:

- Grassland
  - All types
- Alkali seasonal wetland complex
  - All types
- Vernal pool complex
  - Annual grasses generic
  - Annual grasses/weeds
  - California annual grasslands
  - *Distichlis* (generic)
  - *Distichlis spicata*
  - *Distichlis spicata*–annual grasses
  - *Distichlis*/annual grasses
  - *Distichlis*/*S. maritimus*
  - Ruderal herbaceous grasses and forbs
  - Italian ryegrass (*Lolium multiflorum*)
  - *Salicornia virginica*
  - *Salicornia*/annual grasses

Noncultivated types from the BDCP composite vegetation layer that provide nonbreeding season foraging habitat in Suisun Marsh and Yolo Basin include:

- *Bromus* spp./*Hordeum*
- *Crypsis schoenoides*
- *Crypsis* spp.–wetland grasses–wetland forbs
- Cultivated annual graminoid
- *Cynodon dactylon*
- *Distichlis*/annual grasses
- *Distichlis* (generic)
- *Distichlis spicata*
- *Distichlis*/*Cotula*
- *Distichlis*/*Juncus*
- *Distichlis*/*Lotus*
- *Distichlis*/*S. americanus*
- *Distichlis*/*S. maritimus*

- *Distichlis/Salicornia*
- *Distichlis–Juncus–Triglochin–Glaux*
- *Hordeum/Lolium*
- *Lotus corniculatus*
- Medium upland herbs
- Medium wetland graminoids
- Medium wetland herbs
- Pasture
- Perennial grass
- Short upland graminoids
- Short wetland graminoids
- Tall wetland graminoids
- Upland annual grasslands and forbs formation
- Upland herbs

The following crop types from the DWR 2007 land use survey types represent potentially suitable foraging habitats for tricolored blackbirds during the nonbreeding season, as based upon input provided by species experts (Meese pers. comm. 2011; Kyle pers. comm.).

Pasture types are mostly perennial; alfalfa is semi-perennial (3 to 7 years); and all other crop types are annually or seasonally rotated irrigated crops. The relative value of these crop types to tricolored blackbirds is discussed further in Section 2A.23.7.4, *Habitat Value Classes.*

- Grain and hay crops
  - Wheat
  - Oats
  - Miscellaneous grain and hay
  - Mixed grain and hay
- Field crops
  - Corn
  - Millet
  - Sunflowers
- Pasture
  - Alfalfa and alfalfa mixtures
  - Mixed pasture
  - Native pasture
  - Induced high-water-table native pasture

- Miscellaneous grasses
- Nonirrigated mixed pasture
- Nonirrigated native pasture
- Rice
- Idle
  - Land not cropped the current or previous crop season, but cropped within the past three years
  - New lands being prepped for crop production
- Semi-agricultural and incidental to agricultural
  - Farmsteads
  - Livestock feed lots
  - Dairies

Additional areas mapped include the following natural community and land cover types as nonbreeding season foraging habitat:

- Agricultural
- Cultivated annual graminoid
- Field crops
- Grain/hay crops
- Pasture
- Rice
- Alkali seasonal wetland complex
- Grassland
- Upland annual grasslands and forbs formation
- *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
- Vernal pools

The roosting component of nonbreeding habitat in the Delta consists of the following types from the BDCP composite vegetation layer:

- Managed wetland
  - *Schoenoplectus* spp. in managed wetlands
- Tidal freshwater emergent wetland and tidal brackish emergent wetland
  - Mixed *Schoenoplectus* mapping unit
  - Mixed *Schoenoplectus*/floating aquatics complex
  - Mixed *Schoenoplectus*/submerged aquatics complex
  - Hardstem bulrush (*Schoenoplectus acutus*)

- *Schoenoplectus acutus* pure
- *Schoenoplectus acutus–Typha angustifolia*
- *Schoenoplectus acutus–Typha latifolia*
- *Schoenoplectus acutus*–(*Typha latifolia*)–*Phragmites australis*
- California bulrush (*Schoenoplectus californicus*)
- *Schoenoplectus californicus–Eichhornia crassipes*
- *Schoenoplectus californicus–Schoenoplectus acutus*
- American bulrush (*Schoenoplectus americanus*)
- Narrow-leaf cattail (*Typha angustifolia*)
- *Typha angustifolia–Distichlis spicata*

- Nontidal freshwater perennial emergent
  - American bulrush (*Schoenoplectus americanus*)
  - Hardstem bulrush (*Schoenoplectus acutus*)
  - Mixed *Schoenoplectus*/floating aquatics (*Hydrocotyle–Eichhornia*) complex
  - Mixed *Schoenoplectus*/submerged aquatics (*Egeria–Cabomba–Myriophyllum* spp.) complex
  - Mixed *Schoenoplectus* mapping unit
  - Broad-leaf cattail (*Typha latifolia*)
  - Narrow-leaf cattail (*Typha angustifolia*)
  - *Schoenoplectus acutus*–(*Typha latifolia*)–*Phragmites australis*
  - *Schoenoplectus acutus–Typha angustifolia*
  - *Schoenoplectus acutus* pure
  - *Schoenoplectus acutus–Typha latifolia*
- Valley/foothill riparian
  - Blackberry (*Rubus discolor*)
  - Mexican elderberry (*Sambucus mexicana*)
  - *Salix lasiolepis*–Mixed brambles (*Rosa californica–Vitis californica–Rubus discolor*)
  - *Salix exigua*–(*Salix lasiolepis*)–*Rubus discolor–Rosa californica*
  - *Salix gooddingii*/*Rubus discolor*
  - Black willow (*Salix gooddingii*)
  - Narrow-leaf willow (*Salix exigua*)
  - *Rubus discolor*

The roosting component of nonbreeding habitat in the in the Suisun Marsh and Yolo Basin includes the following types from the BDCP composite vegetation layer:

- *Schoenoplectus* (*californicus* or *acutus*)/*Rosa*
- *Schoenoplectus* (*californicus* or *acutus*)/wetland herb
- *Schoenoplectus* (*californicus* or *acutus*)–*Typha* spp.
- *Schoenoplectus americanus* (generic)
- *Schoenoplectus americanus*/*Lepidium*
- *Schoenoplectus americanus*/*Potentilla*
- *Schoenoplectus californicus*/*S. acutus*
- *Schoenoplectus maritimus*
- *Schoenoplectus maritimus*/*Salicornia*
- *Typha angustifolia*/*Distichlis*
- *Typha* species (generic)
- Bulrush–Cattail freshwater marsh not formally defined (NFD) super alliance
- *Schoenoplectus americanus*/*S. californicus–S. acutus*
- *Schoenoplectus maritimus*/*Sesuvium*
- *Typha angustifolia*
- *Typha angustifolia*/*Phragmites*
- *Typha angustifolia*/*Polygonum–Xanthium–Echinochloa*
- *Typha angustifolia*/*S. americanus*

Additional areas mapped include the following natural community and land cover types as nonbreeding season roosting habitat:

- Tidal brackish emergent wetland
- Tidal freshwater emergent wetland
- Bulrush–cattail freshwater marsh NFD super alliance in managed wetland

2A.23.7.3.1 Assumptions

During the nonbreeding season, tricolored blackbirds forage widely throughout the Plan Area without regard to proximity of colony sites or breeding habitats. Suitable cultivated lands generally include pasturelands, grasslands, and a variety of croplands. Tricolored blackbirds also forage in livestock feedlots and dairies. Because the grain and hay, and field crop types listed above are seasonally rotated, the availability and relative value of individual fields as foraging habitat may change each year. As a result, this model may overestimate or underestimate the extent of available cultivated lands that provide nonbreeding season foraging habitat in any given year.

2A.23.7.4 Habitat Value Classes

The tricolored blackbird is closely associated with cultivated lands to meet their foraging needs, particularly during the nonbreeding season. Most of the Plan Area consists of cultivated lands; however, the value of these lands as foraging habitat for tricolored blackbirds differs widely depending upon crop type and the seasonal foraging patterns of the species.

Each crop type listed in the DWR 2007 land use survey types was assigned a relative foraging value class on a qualitative scale of six possible values (very high to none), for both the breeding and the nonbreeding season, based on input by species experts (Meese pers. comm.; Kyle pers. comm.). Table 2A.23-1 provides the habitat values assigned to cultivated lands crop and habitat types in the Plan Area.

Table 2A.23-1. Tricolored Blackbird Foraging Habitat Value Classes

Foraging Habitat Value Class	Agricultural Crop Type and Habitats	
	Breeding Season[a] Foraging Habitat	**Nonbreeding Season Foraging Habitat**
Very High	Native pasture, nonirrigated native pasture, annual grasslands, vernal pool grasslands, alkali grasslands, native vegetation[b]	Livestock feed lots
High	Dairies, livestock feed lots, rice, s sunflower, alfalfa and mixed alfalfa, mixed pasture, induced high-water-table native pasture, nonirrigated mixed pasture, dairies	Corn, sunflower, alfalfa and mixed alfalfa, mixed pasture, native pasture, nonirrigated native pasture, rice, dairies, annual grasslands, vernal pool grasslands, alkali grasslands, mixed pasture, dairies
Moderate	Miscellaneous grasses, fallow lands cropped within 3 years, new lands prepped for crop production, livestock feed lots	Miscellaneous grass pasture, nonirrigated mixed pasture, fallow lands cropped within 3 years, new lands prepped for crop production
Low	Mixed grain and hay crops, farmsteads, non-irrigated mixed grain and hay, farm residences	Wheat, oats, mixed grain and hay, farmsteads, non-irrigated mixed grain and hay, and non-irrigated misc. grain and hay
Marginal	Rice	None
None	All remaining crop types	All remaining crop types

[a] Generally March through August; occasional breeding in fall (September through November).

[b] Native vegetation is a land use designation within the California Department of Water Quality crop type dataset (2007). For the purposes of incorporating native vegetation classes into the correct species models, and, when applicable, assigning habitat foraging values, the management on these lands most resembles that of native pasture, an irrigated pasture type.

2A.23.8 Recovery Goals

A USFWS recovery plan has not been prepared for this species, and no recovery goals have been established.

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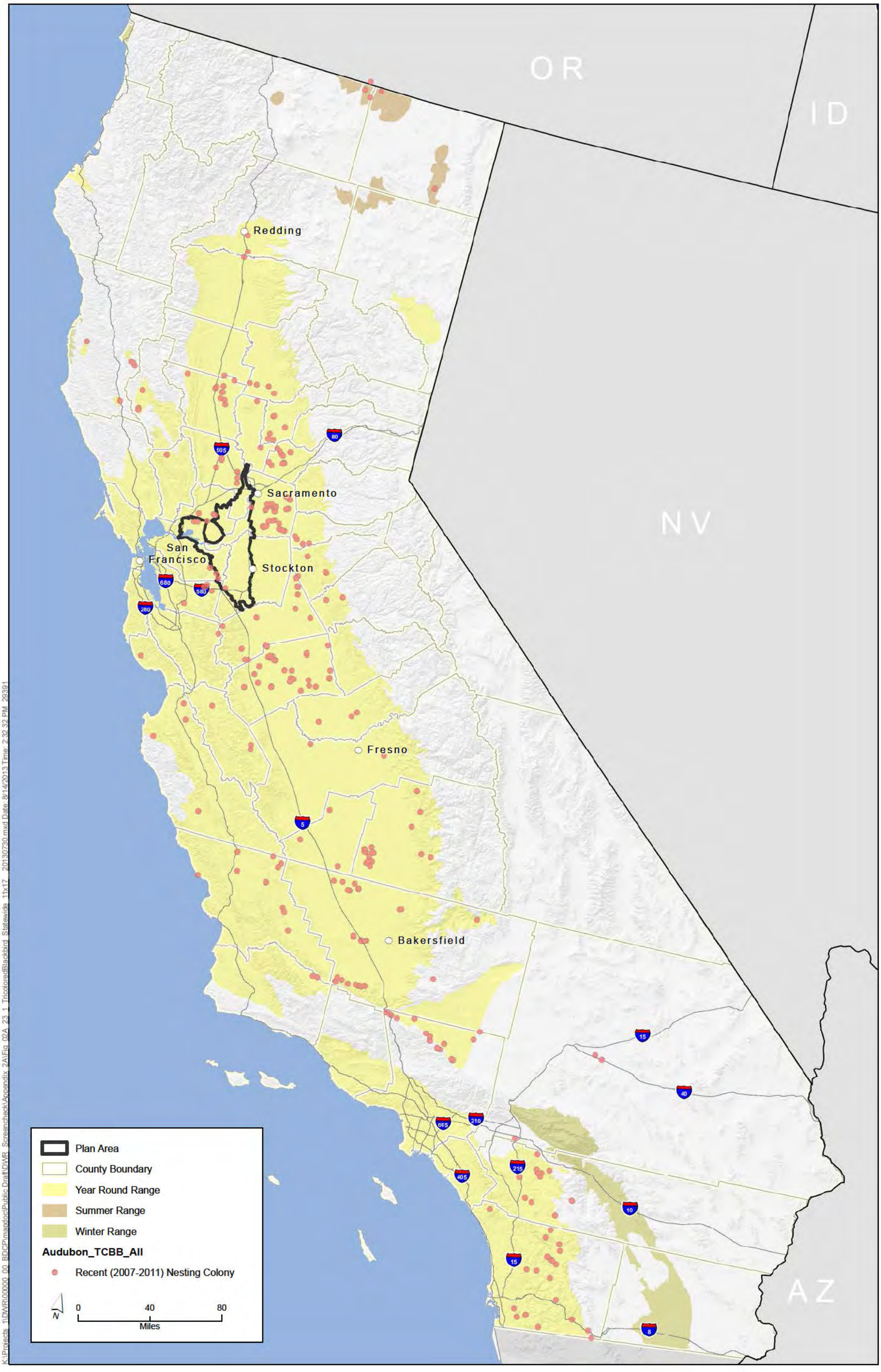
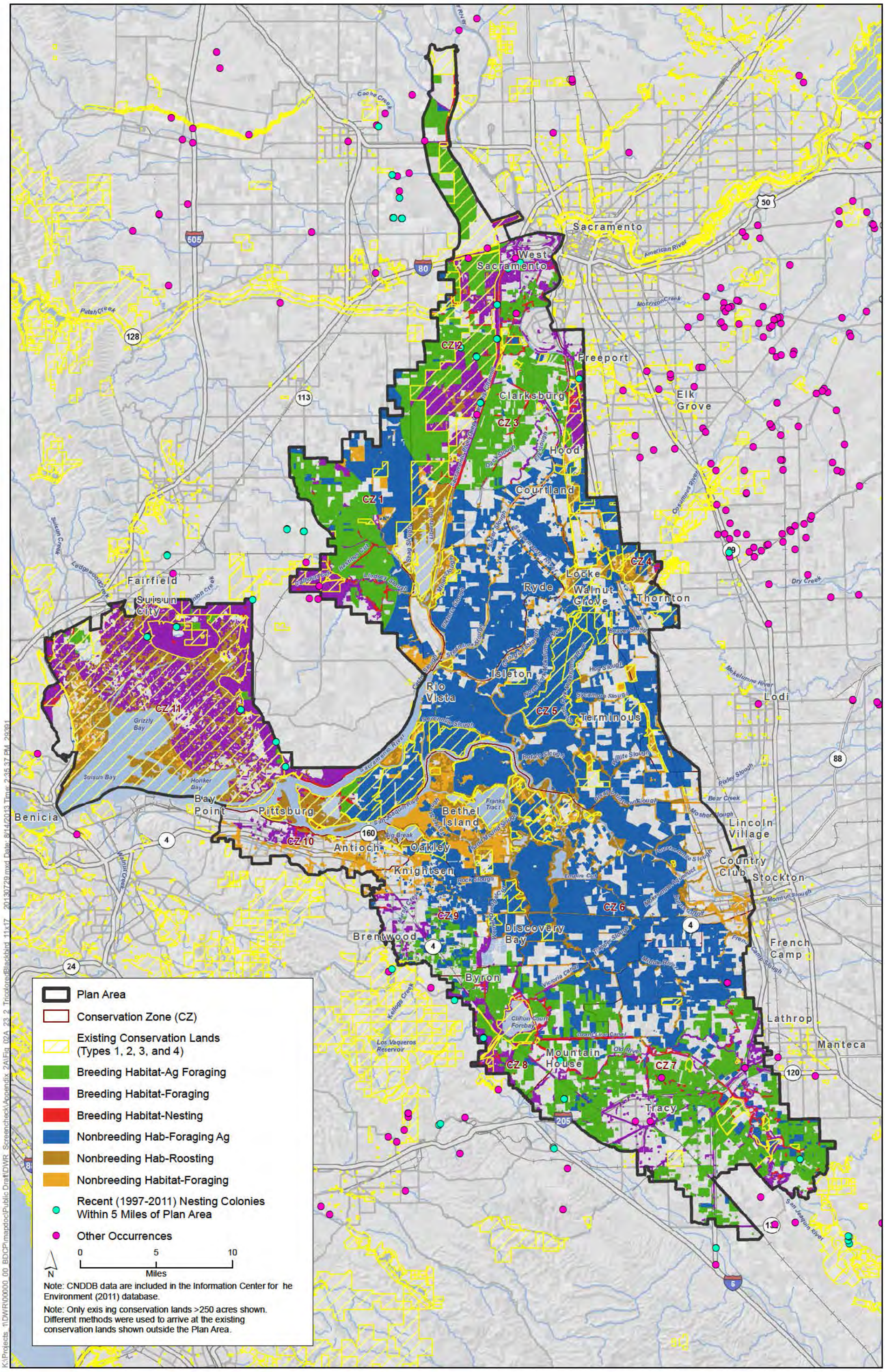
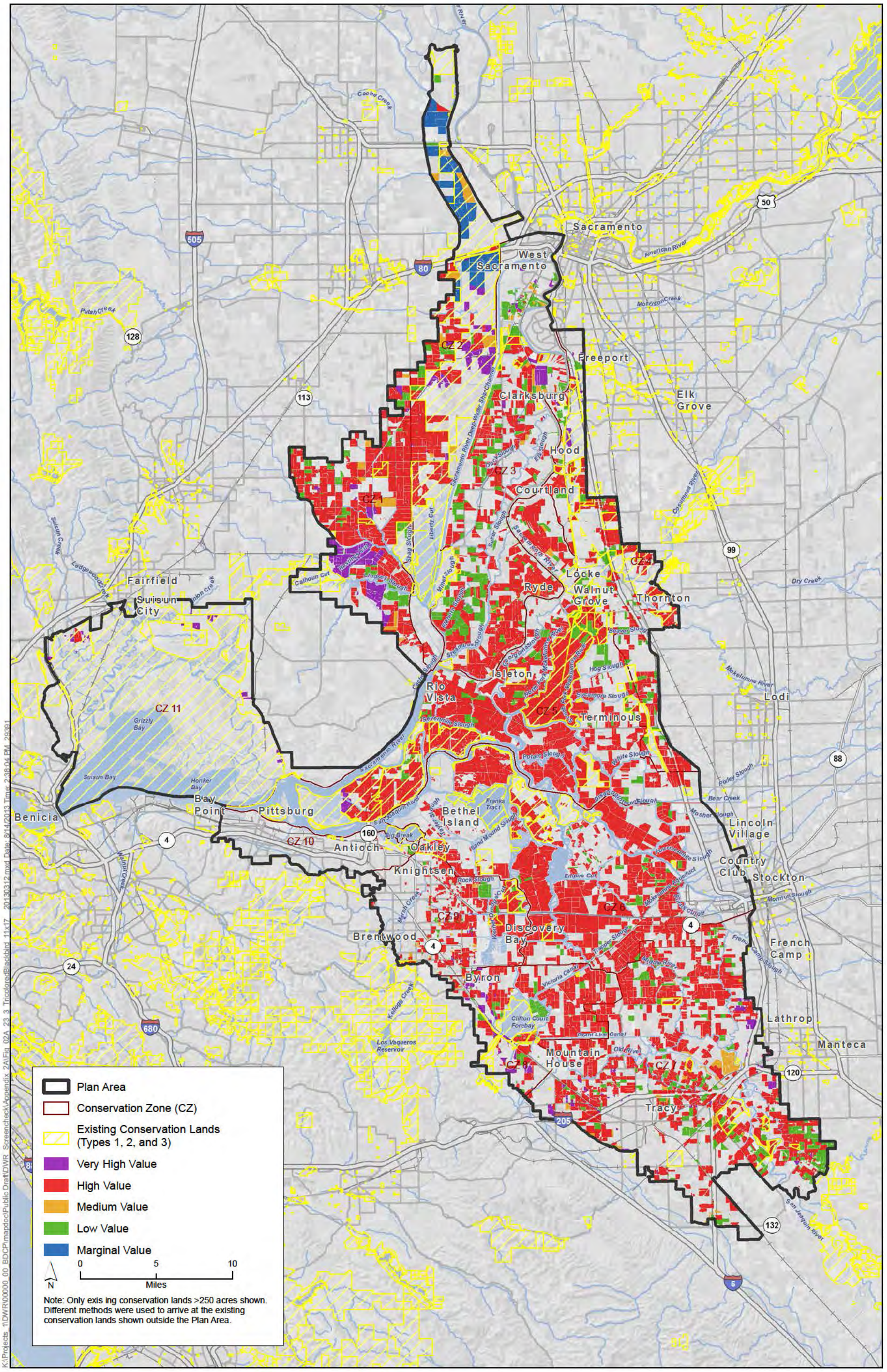


GIS Data Sources: Occurrences, Audubon 2011;
Range, DFG WHR 2008.

Figure 2A.23-1
Tricolored Blackbird Statewide Range and Recent (2007-2011) Occurrences


Plan Area
Conservation Zone (CZ)
Existing Conservation Lands (Types 1, 2, 3, and 4)
Breeding Habitat-Ag Foraging
Breeding Habitat-Foraging
Breeding Habitat-Nesting
Nonbreeding Hab-Foraging Ag
Nonbreeding Hab-Roosting
Nonbreeding Habitat-Foraging
Recent (1997-2011) Nesting Colonies Within 5 Miles of Plan Area
Other Occurrences
0
5
10
N
Miles
Note: CNDDB data are included in the Information Center for he Environment (2011) database.
Note: Only exis ing conservation lands >250 acres shown. Different methods were used to arrive at the existing conservation lands shown outside the Plan Area.
CZ 1
CZ 2
CZ 3
CZ 4
CZ 5
CZ 6
CZ 7
CZ 8
CZ 9
CZ 10
CZ 11
Sacramento
West Sacramento
Freeport
Clarksburg
Elk Grove
Hood
Courtland
Locke
Ryde
Walnut Grove
Thornton
Isleton
Rio Vista
Terminous
Lodi
Fairfield
Suisun City
Bay Point
Pittsburg
Benicia
Bethel Island
Antioch
Oakley
Knightsen
Brentwood
Discovery Bay
Byron
Lincoln Village
Country Club
Stockton
French Camp
Lathrop
Manteca
Mountain House
Tracy
Cache Creek
American River
Morrison Creek
Putah Creek
Suisun Bay
Grizzly Bay
Honker Bay
Los Vaqueros Reservoir
Clifton Court Forebay
Grant Line Canal
Old River
San Joaquin River
Sacramento River
Mokelumne River
Dry Creek
Bear Creek
Mormon Slough
Middle River
Victoria Canal
Empire Cut
Rock Slough
Fourteenmile Slough
Threemile Slough
Potato Slough
Sycamore Slough
Hog Slough
Beaver Slough
Lindsey Slough
Calhoun Cut
Cordelia Slough
Suisun Creek
Ledgewood Creek
Union Creek
Ulatis Creek
Alamo Creek
Kellogg Creek
Marsh Creek
Old River
Piper Slough
Middle River
Trapper Slough
Franks Tract
Big Break
Mokelumne Aqueduct
Delta-Mendota Canal
Pixley Slough
Moshier Slough
Elk Slough
Duck Slough
Cosumnes River
Dry Creek
Stanislaus River
Tom Paine Slough
Fisherman Cut
Hastings Cut
Union Cut
Cache Slough
Steamboat Slough
Miner Slough
Elkhorn Slough
Beaver Slough
Colombia Slough
Fisherman Slough
Ferry Mound Slough
Sand Mound Slough
Old River
Middle River
Victoria Canal
Grant Line Canal
Clifton Court Forebay
Los Vaqueros Reservoir



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011.

Figure 2A.23-3
Tricolored Blackbird Foraging Modeled Habitat Model and Associated Value Rankings

Appendix 2A.24

Western Burrowing Owl (*Athene cunicularia hypugaea*)

2A.24.1 Legal Status

The western burrowing owl (*Athene cunicularia hypugaea*) is designated as a state Bird Species of Special Concern (Shuford and Gardali 2008) by the California Department of Fish and Wildlife (CDFW). Nests are protected in California under California Fish and Game Code Section 3503.5.

The burrowing owl has no federal regulatory status; however, the species is protected under the federal Migratory Bird Treaty Act and is designated as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS) in Region 8 (U.S. Fish and Wildlife Service 2002). Critical habitat has not been designated for this species.

2A.24.2 Species Distribution and Status

2A.24.2.1 Range and Status

There are two subspecies of burrowing owls in North America (Clark 1997; Haug et al. 1993). The breeding range of *A. cunicularia floridana* is restricted to Florida and adjacent islands. The breeding range of *Athene cunicularia hypugaea* extends south from southern Canada throughout most of the western half of the United States and south to central Mexico. The winter range extends from central California southeastward through Arizona, New Mexico, and Texas and south into northern and central Mexico and coincides with southern breeding range where the species is resident year-round (Haug et al. 1993).

Burrowing owls were once widespread and generally common over western North America in treeless, well-drained grasslands, steppes, deserts, prairies, and agricultural lands (Haug et al. 1993). The owl's range has contracted in recent decades, and populations have been generally diminished in some areas.

In California, burrowing owls are widely distributed in suitable habitat throughout the lowland portions of the state (Figure 2A.24-1); however, occupied sites have ranged from 200 feet below sea level at Death Valley, to above 12,000 feet at Dana Plateau in Yosemite (California Department of Fish and Game 2000). In southern California, the species is fairly common along the Colorado River Valley (Rosenberg et al. 1991) and in the agricultural region of the Imperial Valley. Only small, scattered populations are thought to occur in the Great Basin and the desert regions of southern California (DeSante et al. 2007). Burrowing owl breeding populations have greatly declined along the California coast, including the southern coast to Los Angeles, where these owls have been eliminated from virtually all private land and occur only in small populations on some federal lands (Garrett and Dunn 1981; DeSante et al. 2007; Kidd et al. 2007). Breeding populations in Central California occur in the southern San Francisco Bay between Alameda and Redwood City, the interior valleys and hills in the Livermore area, and the Central Valley (DeSante et al. 1997).

Burrowing owls appear to be resident year-round throughout much of central and southern California; however, migratory patterns remain unclear (Haug et al. 1993).

Overall population trends throughout the western burrowing owl's North American range are reportedly declining (James and Espie 1997; Klute et al. 2003). James (1993) reports that 54% of the areas sampled reported declining burrowing owl populations. Breeding bird surveys conducted between 1980 and 1989 also report significant declines in many areas (Haug et al. 1993).

Burrowing owls were formerly common or abundant throughout much of California, but noticeable declines have been reported since the 1940s (Grinnell and Miller 1944) and continue to the present time (DeSante et al. 2007; Shuford and Gardali 2008). The decline has been almost universal throughout California. Conversion of grasslands and pasturelands to incompatible crop types and the destruction of ground squirrel colonies have been the main factors causing the decline of the burrowing owl population (Zarn 1974). Assimilation of poisons applied to ground squirrel colonies may also affect burrowing owls (James et al. 1990).

Surveys in California from 1986 to 1991 found population decreases of 23 to 52% in the number of breeding groups and 12 to 27% in the number of breeding pairs of owls (DeSante et al. 1997). Nearly 60% of burrowing owl colonies that existed in the 1980s reportedly disappeared by the early 1990s (DeSante and Ruhlen 1995; DeSante et al. 1997).

DeSante et al. (2007) estimated a statewide population of 9,266 breeding pairs during a statewide survey from 1991 to 1993. Most owls occurred in four main population areas: the Imperial Valley, the Central Valley, the southern California coast, and the San Francisco Bay Area. An estimated 167 nesting pairs (1.8% of California's population) occur in the Bay Area, where the species often uses burrows created by the California ground squirrel (*Spermophilus beecheyi*) and resides in undeveloped grassland remnants amid a rapidly expanding human population. In the southern California coastal population, burrowing owls have been almost entirely extirpated from private lands and were found only on a few undeveloped federal lands, where an estimated 260 nesting pairs (3% of California's population) persist (DeSante et al. 2007; Kidd et al. 2007). An estimated 2,224 nesting pairs exist in the Central Valley (24% of California's population), where the species is also subject to widespread habitat loss from urbanization. This population often uses burrows created by the California ground squirrel and resides in remaining patches of grassland, along the grassland edges of canals and levees, and along the edges of pastures and some agricultural fields. An estimated 6,570 nesting pairs (71% of California's population) occur in the Imperial Valley, where burrowing owls are almost completely relegated to irrigation canal banks and where they most often use burrows created by the round-tailed ground squirrel (*Spermophilus tereticaudus*) (DeSante et al. 2007).

The DeSante et al. (2007) 1991 to 1993 survey was replicated in 2006 and 2007 by Wilkerson and Seigel (2010), who estimated a population of 8,128 pairs within the DeSante et al. (2007) survey area, a 10.9% decline since the early 1990s. Their total statewide extrapolation (with the addition of the previously unsurveyed Modoc Plateau and Mojave and Sonoran Deserts) was 9,187 pairs with a best estimate of 9,298 pairs statewide. While declines in the San Francisco and Bakersfield areas were particularly notable and insignificant declines were apparent in several other regions, Wilkerson and Seigel noted that the major patterns of burrowing owl occurrence across the state were relatively unchanged since the early 1990s.

Although California has a significant burrowing owl population, development pressures and recent population trends suggest that the species may continue to be extirpated from large portions of its

range in California during the next decade. Coastal areas, in particular, have experienced extirpations or near extirpations in recent years presumably from habitat loss (Desante et al. 2007). While burrowing owls in the Central Valley have exhibited strong site fidelity even with increasing habitat fragmentation, the species has been extirpated from many historically occupied areas due to increasing urbanization and related causes.

2A.24.2.2 Distribution and Status in the Plan Area

There are approximately 420,935 acres of modeled habitat for western burrowing owl in the Plan Area; however approximately 294,238 acres of this habitat (roughly 70%) is low-value cultivated land. Reported occurrence data indicates that within the Plan Area, burrowing owls are concentrated mostly in the higher value grasslands and pasturelands west of the Sacramento Deep Water Ship Channel in Yolo and Solano Counties, and in the grassland habitats along the western edge of the Plan Area roughly between Brentwood/Antioch and Tracy (Figure 2A.24-2). These mostly uncultivated areas support larger and more stable populations of California ground squirrels and are less likely to be disturbed by regular cultivation and other ground disturbances. The species is a year-round resident in the Plan Area; however, local migratory patterns and the extent to which migrants occupy the Plan Area during the nonbreeding season are unclear.

Burrowing owls continue to persist locally in the vicinity of Stockton where they are typically found along levees, canals, field edges, and some ruderal habitats or idle fields. Burrowing owls are also known to occur in the grassland habitats in the vicinity of Stone Lakes. While relatively few burrowing owls have been reported from this area, the grassland habitats could potentially support a larger population. In recognition of this, enhancement of burrowing owl habitat, including the installation of 80 artificial nest boxes, reintroduction of the California ground squirrel, and adjustment of land management activities, is ongoing on the Stone Lakes National Wildlife Refuge. These activities are part of an agreement with the Sacramento Area Flood Control Agency and Sacramento County to use the refuge for purposes of burrowing owl mitigation because of impacts from the South Sacramento Streams Group Project (Sacramento Area Flood Control Agency Resolution Number 07058).

Few burrowing owls have been reported from the central portion of the Sacramento–San Joaquin River Delta (Delta) and the northern Delta east of the Sacramento Deep Water Ship Channel (Figure 2A.24-2), probably due to regular agricultural cultivation, lack of undisturbed habitats, and lack of ground squirrel populations. Active sites in this area are generally restricted to levee embankments and along irrigation canals.

Burrowing owls persist in low numbers in grassland habitats around the perimeter of Suisun Marsh. Gervais et al. (2008) note that populations in the vicinity of Suisun Marsh and San Pablo Bay are declining.

Remaining populations in the vicinity of Stockton, Brentwood/Antioch, and Tracy are subject to continued land use changes from urbanization and populations are likely to decline over time as suitable habitat is removed. Populations in Yolo and Solano Counties west of the Deep Water Ship Channel are less subject to land use changes and thus may be more likely to persist.

Environmental surveys conducted in 2009, 2010, and 2011 collected information about environmental resources in the area where conceptual conveyance options were proposed (i.e., the Conveyance Planning Area) (Delta Habitat Conservation and Conveyance Program 2011). In 2009, the survey goal was to identify all nesting habitat in the conveyance planning area on parcels for

which the surveyors had access, as well as along all boat-accessible waterways. Surveyors documented 13 burrowing owl occurrences, which represented approximately five nest sites. All nest sites were in the southwest corner of the conveyance planning area, where the habitat is alkali grassland-scrub habitat that is heavily disturbed, has extensive patches of bare ground, and has substantial ground squirrel activity.

In 2010, the survey goal was to identify all nesting habitat in the conveyance planning area on parcels that were not accessible in 2009. no additional burrowing owls were observed during the 2010 surveys. In 2011, the survey goal was to identify all nesting habitat in the conveyance planning area on parcels that were not accessible in 2009 and 2010. Surveyors documented 30 burrowing owl occurrences in 2011, representing at least 18 nest sites. One juvenile owl was observed.

Based on the California Department of Water Resources' (DWR) limited surveys of the conveyance facility alignment (2007), almost all burrowing owls that occur in the conveyance planning area nest in the southeast portion in the upland grassland habitats. No burrowing owls were found on Delta islands or in seasonal wetlands.

2A.24.3 Habitat Requirements and Special Considerations

Burrowing owls are found in open, well-drained grasslands, agricultural and range lands, and desert habitats often associated with burrowing animals (Klute et al. 2003). They also occupy golf courses, airports, road and levee embankments, and other disturbed sites where there is sufficient friable soil for burrows (Haug et al. 1993). Because they typically use the burrows created by other species, particularly the California ground squirrel, presence of these species is usually a key indicator of potential occurrence of burrowing owl.

2A.24.3.1 Nesting

In northern California, most reported nest sites occur in abandoned ground squirrel burrows; however, other mammal burrows and various burrow surrogates, such as culverts, pipes, rock piles, and artificially constructed burrows are also used. Burrowing owls may select sites in habitats that allow for modification of burrows and maximize drainage. In addition to providing nesting, roosting, and escape burrows, ground squirrels improve habitats for burrowing owls in other ways. Burrowing owls favor areas with short, sparse vegetation, which is typical around active sciurid colonies (Coulombe 1971; Haug and Oliphant 1990; Plumpton and Lutz 1993b) to facilitate detection of predators and hunting. Additionally, burrowing owls may select areas with a high density of burrows (Plumpton and Lutz 1993b). Typical habitats are treeless, with minimal shrub cover and woody plant encroachment, and have low vertical density of vegetation and low foliage height diversity (Plumpton and Lutz 1993b). While occupied burrows are sometimes found in flat landscapes—often in elevated mounds created by burrowing activity—they are also commonly found on hillsides, levee slopes, or other steep cut banks, probably to facilitate drainage and maximize visibility. Nest sites are also often associated with nearby perches, including stand pipes, fences, or other low structures.

Burrowing owls are tolerant of human-altered open spaces, such as areas surrounding airports, golf courses, and military lands where burrows may be readily adopted (Thomsen 1971; Barclay 2007).

Burrowing owls may use burrows in open areas adjacent to unimproved and improved roads (Brenckle 1936; Ratcliff 1986); a modest volume of vehicle traffic does not appear to significantly affect behaviors or reproductive success (Plumpton and Lutz 1993c), but presumably may also be a source of collision-related mortality. In the south San Francisco Bay region and in the Sacramento area, burrowing owls nest and winter in highly human-affected environments and can habituate to human activity if breeding and foraging habitat remains in a suitable condition.

The dimensions of the nest burrow vary with location, age of burrow, and the species that originally excavated it. Typical burrows constructed by ground squirrels are from 3 to 6 inches (7.6 to 15.2 centimeters) in diameter and extend underground at a gradual downward slope from 3 to 20 feet (0.9 to 6.1 meters) with an enlarged cavity at the end of a tunnel. Feathers, pellets, and white wash are often present at active burrow entrances. The burrow is often lined with grass or other material (Haug et al. 1993).

Burrowing owls may nest solitarily but many nest in loose colonies—usually from 4 to 10 pairs (Zarn 1974); however, larger colonies have been documented. Most pairs occupy a natal burrow, and several satellite burrows where available.

As semicolonial raptors, colony size is indicative of habitat value and quantity. Colony size is also positively correlated with annual site reuse by breeding burrowing owls; larger colonies (those with more than five nesting pairs) are more likely to persist over time than colonies containing fewer pairs or single nesting pairs (DeSante et al. 1997). Nest burrow reuse by burrowing owls has been well documented (Martin 1973; Gleason 1978; Rich 1984; Plumpton and Lutz 1993b;, Lutz and Plumpton 1999). Former nest sites may be more important to continued reproductive success than are mates from previous nest attempts (Plumpton and Lutz 1994). Past reproductive success may influence future site reoccupancy by burrowing owls. Female burrowing owls with large broods tend to return to previously occupied nest sites; females that fail to breed, or produced small broods, may change nest territories in subsequent years (Lutz and Plumpton 1999).

In general, burrowing owls show a high degree of nest site fidelity and reuse the same nesting burrows and satellite burrows for many years if left undisturbed.

2A.24.3.2 Foraging

Burrowing owls forage in open grasslands, pastures, agricultural fields and field edges, fallow fields, and along the edges of roads and levees. Low vegetation aids in maximizing visibility and access. Short perches such as fence posts are often used to enhance visibility. While they will defend the immediate vicinity of the nest, burrowing owls will often forage in common areas (Haug et al. 1993).

2A.24.4 Life History

2A.24.4.1 Description

This small owl stands about 9 inches (23 centimeters) tall. The sexes have a similar appearance (although females are slightly smaller and often slightly darker than males) with distinct oval facial ruff, white supercilium, yellow eyes, and long legs. Wingspan is relatively broad (20 to 24 inches [51 to 61 centimeters]) and wings are somewhat rounded. The owl is sandy-colored with pale tan

spots on the back and upperparts of the wings and white-to-cream with barring on the breast and belly (Haug et al. 1993).

2A.24.4.2 Seasonal Patterns

Burrowing owls are resident in the Central Valley and other portions of central California. The breeding season (defined as from pair bonding to fledging) generally occurs from February to August with peak activity occurring from April through July (Haug et al. 1993). Pairs may be resident at breeding sites throughout the year or disperse out of the breeding area during the nonnesting season. Some individual birds only winter in the region. Burrowing owls have a strong affinity for previously occupied nesting and wintering habitats. They often return to burrows used in previous years, especially if they had been reproductively successful (Lutz and Plumpton 1999). Additionally, burrowing owls often return as breeding adults to the general area in which they were born. For these reasons, efforts that ensure continued use of burrows and territories help to enhance productivity.

2A.24.4.3 Reproduction

Adults begin pair bonding and courtship from February through March. Following pair formation, a nest is established in the natal burrow and females lay a clutch of six to eleven eggs. Average clutch size is seven to nine eggs. Eggs are incubated entirely by the female for a period of between 28 and 30 days. Incubation begins prior to the clutch being complete, which causes asynchronous hatching. During this time, the female is provisioned with food by the male. Following hatching, the young remain in the natal burrow for 2 weeks after which they begin to emerge from the burrow and roost at the burrow entrance. The female begins hunting as soon as the young begin thermoregulation and no longer require continuous brooding. Adults and nestlings will also relocate to satellite burrows presumably to reduce the risk of predation (Desmond and Savidge 1998) and possibly to avoid nest parasites (Dechant et al. 2003). After approximately 44 days, young leave the natal burrow and by 49 to 56 days begin to hunt live insects. On average, three to five young fledge, but fledging rates can range from a single fledgling to as many as eight or nine (Lutz and Plumpton 1999). During this time, the juveniles expand their range and may find cover in satellite burrows. The juveniles continue to be provisioned by the adults until mid-August when they molt into adult plumage and begin to disperse (Landry 1979). King and Belthoff (2001) report that dispersing young use satellite burrows in the vicinity of their natal burrows for about 2 months after hatching before departing the natal area.

2A.24.4.4 Home Range and Territory Size

Few valid measures of territory or home range size of burrowing owls have been published; home range has not often been measured directly (e.g., via telemetry studies) and is highly subject to observer bias or equipment effect. Accordingly, caution is warranted when interpreting home range estimates. The mean minimum convex polygon home range estimate for 22 burrowing owls in Fresno and Kings Counties in California was 467 acres (189 hectares) (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009). Haug and Oliphant (1990) estimated that the mean minimum convex polygon for six owls in Saskatchewan was 595 acres (241 hectares) (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

In Colorado, Plumpton and Lutz (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009) recorded densities of nesting burrowing owls that ranged from 21 to 34 pairs on roughly 2,240 acres (906 hectares) of available habitat (i.e., 106 and 65 acres [43 and 26 hectares] per pair, respectively). Thomsen (1971) estimated territory size based on nearest-neighbor distances between nest burrows, producing a result of six pairs of owls averaging 2 acres (0.8 hectare), with a range of between 0.1 to 4.0 acres (0.04 to 1.6 hectares). The preceding values demonstrate the disparity among studies, the different values attained when using different methods of estimating abundance, and the risk in relying on the results of a single study (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.24.4.5 Foraging Behavior and Diet

Although there are seasonal differences, burrowing owls are active during the day and night and will hunt throughout the 24-hour day, but are mainly crepuscular, hunting mostly at dusk and dawn, and are less active midday. During the fall and winter, they become more nocturnal, and during the breeding season they may hunt all times of the 24-hour day depending on the temperature, number of young, stage of breeding cycle, and other factors. They tend to hunt insects in daylight and small mammals at night. They usually hunt by walking, running, or hopping along the ground, flying from a perch, hovering, and fly-catching in midair.

Burrowing owls tend to be opportunistic feeders. Large arthropods, mainly beetles and grasshoppers, account for a large portion of their diet. Small mammals, especially mice and voles (*Microtus, Peromyscus*, and *Mus* spp.) are also important food items. Other prey animals include reptiles and amphibians, young cottontail rabbits (*Sylvilagus audubonii*), bats, and birds, such as sparrows and horned larks (*Eremophila alpestris*). Consumption of insects increases during the breeding season (Zarn 1974; Tyler 1983; Thompson and Anderson 1988; Green et al. 1993; John and Romanow 1993; Plumpton and Lutz 1993a). Productivity may increase in proportion to the amount of mice and voles in the diet (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

As with most raptors, burrowing owls select foraging areas based on prey availability as well as prey abundance. Prey availability (the ability of a raptor to detect prey) decreases with increasing vegetation cover and thus foraging habitat suitability decreases with increasing grass height or vegetation density. Grasslands are high-value foraging habitats for burrowing owls because they provide relatively consistent vegetation structure, often support mild topography that provides for well-drained terrain and facilitates use by larger populations of ground squirrels, and provide consistent food resources. Pastures are considered low-value habitat because they are of lower value than grasslands (cultivation involves periodic disturbance such as discing) and also provide relatively consistent vegetation structure, often support habitat for ground squirrels in and around the perimeter of fields, and provide a relatively consistent food resource.

2A.24.5 Threats and Stressors

2A.24.5.1 Urbanization and Habitat Fragmentation

Urbanization, including residential and commercial development and infrastructure development (roads and oil, water, gas, and electrical conveyance facilities) is one of the principal causes of habitat loss for burrowing owls and is a continuing threat to remaining northern California populations. Urbanization permanently removes habitat and has led to permanent abandonment of many burrowing owl colonies in the developing portions of the Central Valley, Bay Area, and throughout the state.

Interestingly, while urbanization is considered a key cause for population declines, burrowing owls are known to exhibit strong site fidelity (Johnson 1997). They have shown a relatively high level of tolerance for human encroachment, degradation of native habitats, and fragmentation of habitats (Schultz 1997; Trulio 1997). Active breeding colonies have been reported in small parcels or narrow strips of disturbed habitat along levees or utility corridors and surrounded by urban development. Colonies have also been reported along the edges of airport runways, around the perimeter fences of prisons, and in other urbanized or highly disturbed habitats (Thomsen 1971; Barclay 2007). Disturbances may depress reproductive potential in urban settings as compared with more natural habitats (Thomsen 1971). However, owls will often continue to occupy traditional sites as long as essential habitat elements remain present, until the disturbances force the owls out, or until the extent of available habitat is reduced below habitat requirements (Millsap and Bear 1988).

2A.24.5.2 Agricultural Crop Conversion

Some burrowing owls nest on the edges of agricultural areas and forage in suitable agricultural fields (Gervais et al. 2003), such as recently harvested fields, alfalfa and other hay fields, irrigated pastures, and fallow fields. The conversion of these fields to incompatible crop types, such as orchards, vineyards, and other crops that are not conducive to burrowing owl foraging, reduces available foraging habitat and leads to abandonment of traditional nesting areas. Road and ditch maintenance in agricultural areas can also damage or destroy active nesting and wintering burrows.

2A.24.5.3 Levee Maintenance

Many burrowing owl nests are known to occur along the outside slope of levees (Desante et al. 2004; Rosenberg and Haley 2004). Levee stability practices for flood control, including vegetation removal, grading, and reinforcing with rock can destroy burrowing owl nesting habitat (Catlin and Rosenberg 2006).

2A.24.5.4 Rodent Control

Rodent control, particularly along levees and roadsides, can decimate ground squirrel populations and ultimately reduce available nesting and cover habitat for burrowing owls.

2A.24.5.5 Other Human Disturbances

Although burrowing owls can exhibit a tolerance of some human activities, human-related impacts such as shooting and burrow destruction adversely affect this species (Zarn 1974; Haug et al. 1993).

Artificially enhanced populations of native predators (e.g., gray foxes [*Urocyon cinereoargenteus*], coyotes [*Canis latrans*]) and introduced predators (e.g., red foxes [*Vulpes vulpes*], cats, dogs) near burrowing owl colonies can be a significant local problem. Burrowing owls also get tangled in loose fences, abandoned wire, fishing line, rat traps, and other materials.

The overall effect of population-level threats (e.g., habitat conversion or ground squirrel eradication) is of much greater concern than sources of individual mortality (e.g., shooting or vehicle collisions), as these former forces operate at a population, regional, and/or range-wide level. As obligate burrow nesters that do not typically excavate their own burrows, burrowing owls are largely dependent on burrowing mammals that have no legal status or protection, and are commonly and purposefully eradicated by humans. Whereas individual mortality cumulatively represents a significant number of individuals, a population that is stable and productive can offset these losses. Conversely, populations that are failing because of population-level effects cannot be sustained even in the absence of direct sources of individual mortality. In California, significant economic development pressures exist, and habitat conversion for human purposes continues to degrade the abundance and value of owl nesting habitat (Barclay et al. 1998). Few provisions exist to protect habitats over time. As a result, burrowing owls appear to be declining throughout most of California.

Threats to western burrowing owl can be minimized by protecting and restoring large areas of grassland natural communities, managing cultivated lands to support foraging habitat, reducing the threat of habitat loss and fragmentation, and managing a landscape that supports ground squirrels, which are critical for creating cover and nesting habitat for burrowing owls.

2A.24.6 Relevant Conservation Efforts

Few conservation efforts have been undertaken to conserve burrowing owl populations. The lack of state or federal listing, and the rejection of recent efforts to list the species at the state and federal levels, limits the extent of regulatory influence. There remain several significant data gaps regarding population status and trends, migration, dispersal from nesting sites, and other aspects of annual movements.

Protection typically occurs at the local project level through implementation of the guidelines prepared by CDFW (California Department of Fish and Game 1994). While the guidelines address protection of active sites and compensation for impacts, they do not address conservation or protection at a regional level. CDFW is currently developing a statewide conservation strategy for the burrowing owl.

Regional conservation efforts have focused on the development and implementation of habitat conservation plans/natural community conservation plans. These regional conservation approaches can be an effective tool to manage and sustain burrowing owl populations if they protect sufficient suitable and occupied habitat. The majority of the Plan Area overlaps with other conservation planning efforts that are either currently being implemented or are in development. These include the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County 2006), the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Solano Multispecies Habitat Conservation Plan* (Solano County Water

Agency 2009), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011) and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011). If effectively coordinated, these efforts can be a valuable tool in managing burrowing owl populations in the region.

2A.24.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.24.7.1 GIS Model Data Sources

The western burrowing owl model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture 2005, 2010), Central Valley levee data (California Department of Water Resources 2001), land use survey of the Delta and Suisun Marsh area-version 3 (California Department of Water Resources 2007), and land use survey data (Yolo County 1997). Using these data sets, the model maps the distribution of suitable burrowing owl habitat in the Plan Area in two suitability categories, high value and low value. Vegetation types were assigned to a suitability category based on the species requirements as described above and the assumptions described below.

2A.24.7.2 Habitat Model Description

Habitat value for burrowing owls is generally determined based on major vegetation type (grasslands, pastures and seasonal wetlands, agricultural lands). All vegetation types assigned a high value are included in the model. Low-value vegetation types are only included in the model if they occur within a 0.5-mile radius of high-value habitat.

High-value habitat in the Plan Area includes the following types using the BDCP composite vegetation layer:

- Grasslands
  - California annual grassland–herbaceous (California annual grassland/herbaceous alliance)
  - Ruderal herbaceous grasses and forbs (*Cynodon dactylon* alliance and ruderal herbaceous [nonnative annual forb land])
  - *Bromus diandrus–Bromus hordeaceus*
  - Italian ryegrass (*Lolium multiflorum* alliance)
  - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
  - Degraded vernal pool complex–California annual grasslands
  - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
- Vernal pool complex
  - California annual grasslands–herbaceous

    - Italian ryegrass (*Lolium multiflorum* alliance)
    - Ruderal herbaceous grasses and forbs
    - Annual grasses generic
    - Annual grasses/weeds
    - Perennial grass
- Alkali seasonal wetland complex and vernal pool complex
    - *Distichlis spicata*–annual grasses
    - Annual grasses generic
    - Annual grasses/weeds
    - Perennial grass
- Medium upland graminoids
- Short upland graminoids
- Bare ground
- Pasture
- Upland annual grasslands and forbs formation
- Upland herbs
- Medium upland herbs
- *Distichlis spicata*–annual grasses

High-value habitat also includes the following types using DWR 2007 and Yolo County 1997 land use survey data:

- Native vegetation[1]
- Native pasture
- Miscellaneous grasses
- Mixed pasture
- Nonirrigated mixed pasture
- Nonirrigated native pasture
- Vernal pool complex

Levee slopes in managed and natural seasonal wetlands are included as high-value habitat. DWR's Central Valley levee data was buffered by 100 feet on either side; all managed wetland and natural seasonal wetland types from the BDCP composite vegetation layers situated within the buffered region were included as high-value habitat.

[1] Native vegetation is a land use designation within the DWR crop type dataset (2007). For the purposes of incorporating native vegetation classes into the correct species models and, when applicable, assigning habitat foraging values, the management on these lands most resembled that of native pasture, an irrigated pasture type.

Low-value habitat in the Plan area includes the following types using the BDCP composite vegetation layer.

- Managed wetlands (when not flooded)
  - Temporarily flooded grasslands
  - Rabbitsfoot grass
  - Intermittently flooded perennial forbs
  - Managed annual wetland vegetation (nonspecific grasses and forbs)
  - Shallow flooding with minimal vegetation at time of photographic documentation
  - Seasonally flooded undifferentiated annual grasses and forbs
  - Managed alkali wetland
  - Intermittently or temporarily flooded undifferentiated annual grasses and forbs
- Alkali seasonal wetland complex and other seasonal wetlands (when not flooded)
  - Saltgrass (*Distichlis spicata*)
  - Seasonally flooded annual grasslands
  - Vernal pools
  - Temporarily flooded perennial forbs
- *Baccharis*/annual grasses
- *Bromus* spp./*Hordeum*
- Cultivated annual graminoid
- *Cynodon dactylon*
- *Hordeum*/*Lolium*
- *Lolium* (generic)
- *Lolium*/*Rumex*
- *Lotus corniculatus*
- Short wetland graminoids
- Field crops
- Grain/hay crops
- Truck/nursery/berry crops

Low-value nesting and foraging habitat also include the following agricultural types from the DWR 2007 land use survey and Yolo County 1997 land use survey. These types represent the typical agricultural cover types in the Plan Area and Upper Yolo Bypass that are included in the DWR 2007 and 1997 Yolo County land use surveys. Rotational crop types that are not common to the Plan Area are not included here. Pasture types are mostly perennial; alfalfa is semiperennial (3 to 7 years); and all other types are annually or seasonally rotated irrigated crops, only some of which provide suitable foraging habitat for the western burrowing owl.

- Grain and hay crops
  - Barley
  - Wheat
  - Oats
  - Miscellaneous grain and hay
  - Non irrigated miscellaneous grain and hay
  - Mixed grain and hay
- Field crops
  - Safflower
  - Sugar beets
  - Corn
  - Grain sorghum
  - Sudan
  - Beans
  - Miscellaneous field
  - Sunflowers
  - Artichokes
- Pasture
  - Alfalfa and alfalfa mixtures
  - Clover
- Truck, nursery and berry crops
  - Asparagus
  - Beans
  - Onions and garlic
  - Tomatoes
  - Peppers
  - Idle land not cropped the current or previous crop season, but cropped within the past 3 years
  - New lands being prepped for crop production

Interior grassy slopes of levees surrounding central Delta islands were also considered low-value habitat for burrowing owls. DWR's Central Valley levee data were buffered by 100 feet on either side; BDCP composite vegetation layer for cultivated lands and valley/foothill riparian natural Community types that fell within this buffer were included as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Additional detail regarding crop types was available for cultivated lands and was incorporated into the mapping. In the new analysis areas, the following natural communities were assumed to provide the listed habitat type (i.e., high-value, low-value) for the western burrowing owl.

Additional areas mapped as high-value habitat include the following land cover types:

- Grasslands
    - Upland annual grasslands and forbs formation

Additional areas mapped as low-value habitat include the following land cover types:

- Agricultural
    - Cultivated annual graminoid
    - Field crops
    - Grain/hay crops
    - Truck/nursery/berry crops
- Alkali seasonal wetland complex
- Managed wetland
    - *Crypsis* spp.–wetland grasses–wetland forbs not formally defined (NFD) super alliance
- Tidal perennial aquatic

2A.24.7.3 Assumptions

- **Assumption:** Western burrowing owl nesting habitat is restricted to the vegetation types described in Section 2A.24.7.2, *Habitat Model Description*.

  Rationale: In northern California, most nest sites occur in ground squirrel burrows; however, other mammal burrows and various artificial sites, such as culverts, pipes, and rock piles are also used (Haug et al. 1993). Optimal nesting locations are in an open landscape with level to gently sloping topography, sparse or low grassland or pasture cover, and a high density of burrows. However, nest locations also include disturbed habitats in this landscape, including roadside berms, levee slopes, and debris piles.

- **Assumption:** Western burrowing owl habitat is restricted to the vegetation types described in Section 2A.24.7.2, *Habitat Model Description*.

  Rationale: Western burrowing owls occur primarily in open grassland habitats where vegetation is low to maximize visibility and access. Thus, open grassland habitats are ranked as high-value habitat for burrowing owls. Additional high-value foraging and nesting habitat includes native and irrigated pastures that maintain a relatively constant vegetation structure; berms, road edges, and fencerows around the perimeter of fields; and levee slopes in managed

and natural seasonal wetland types. Low-value nesting and foraging habitat includes seasonal wetland types that are dry during the breeding season and types (e.g., irrigated crops) that exhibit periodic or seasonal foraging value due to management activities and changes in vegetation structure.

- **Assumption**: Burrowing owls will use low value habitat within 0.5 mile of high value habitat

  Rationale: This assumption is based on an underlying assumption that an owl will forage in all directions from a nest at the edge of high value habitat, and assumes a territory size of 450 acres (California Department of Fish and Game 2012). A circle with an area of 450 acres has a radius of approximately 0.47 mile, which was rounded to 0.5 mile.

2A.24.7.4 Habitat Value Categories

As described, the burrowing owl is closely associated with grassland landscapes and to a lesser extent with pasturelands. These types occur primarily along the western edge of the Plan Area. The majority of the Plan Area is cultivated, and while burrowing owls occur in cultivated landscapes, they do so in much less frequency in the Plan Area. While there are differences in use and burrowing owl occurrence between grassland and pastures, these types and their associations were combined into a single high-value habitat category.

Sufficient information is available on the growth and structure of different land cover types to generally categorize each based on their value as nesting/foraging habitat for burrowing owls. Table 2A.24-1 categorizes modeled cover types according to two value classes, high and low. These value classes correspond to the conservation objectives for the burrowing owl with regard to maintaining high value types on protected conservation lands. Table 2A.24-1 provides the rationale for assigning cover types to habitat value categories. Figure 2A.24-2 displays the distribution of foraging habitat and the assigned habitat values in the Plan Area.

Table 2A.24-1. Rationale for Habitat Value Classifications

Habitat Value Class	Assigned Crops and Habitats	Rationale for Assignment to Value Class	Information Sources
High	Unmanaged grassland types: grasslands; vernal pool complex (annual grassland, ruderal grass types); annual grassland generic, annual grasses/weeds, perennial grass; native grassland. Managed grassland and pasture types: grassland (ryegrass); vernal pool complex (ryegrass); alkali seasonal wetlands (annual grasses); short and medium upland graminoids, bare ground, pasture, upland annual grasses and forbs, upland herbs; native pasture, miscellaneous grasses, mixed pasture; levee slopes	Burrowing owls occur in greatest densities in habitats that are not manipulated by cultivation, irrigation, or other practices. Grassland types that meet this general definition and that support both nesting/wintering burrow habitat and foraging habitat are included as high-value habitat for burrowing owls. These types have a greater likelihood of being occupied by ground squirrels, which provide the primarily source of burrowing owl burrows. Burrowing owls also occur in grassland and pasture habitats that are occasionally manipulated through mowing, disking, irrigation, and other related practices; and in some seasonally wet habitats that consist primarily of annual grassland types. These are mostly managed habitats that support appropriate vegetation structure but that are less likely to support ground squirrel populations (due to ground or vegetation management activities) and thus are less likely to contain burrowing owl burrows. However, the edges of these fields often consist of berms and fence rows that are more likely to support ground squirrels and burrowing owl burrows.	Coulombe 1971; Zarn 1974; Haug and Oliphant 1990; Plumpton and Lutz 1993b; Haug et al. 1993; Klute et al. 2003; Dechant et al. 2003; Rosenberg and Haley 2004.
Low	Managed wetland and cultivated types: managed wetland types; alkali seasonal wetland types; cultivated grasses, seasonally flooded grasses; cultivated crops.	Burrowing owls occasionally occur in lower value managed habitats, including cultivated fields and managed wetlands. These types are typically used only for foraging and only when the vegetation structure is suitable for foraging. Burrowing owls that use these types typically use burrows along the edges of fields; but because suitable burrow habitat is less common, occupancy by burrowing owls is less frequent and usually supporting only single owls or single pairs.	Coulombe 1971; Zarn 1974; Haug and Oliphant 1990; Plumpton and Lutz 1993b; Haug et al. 1993; Klute et al. 2003; Dechant et al. 2003; Rosenberg and Haley 2004.

2A.24.8 Recovery Goals

A USFWS recovery plan has not been prepared for this species and no recovery goals have been established.

2A.24.9 References Cited

2A.24.9.1 Literature Cited

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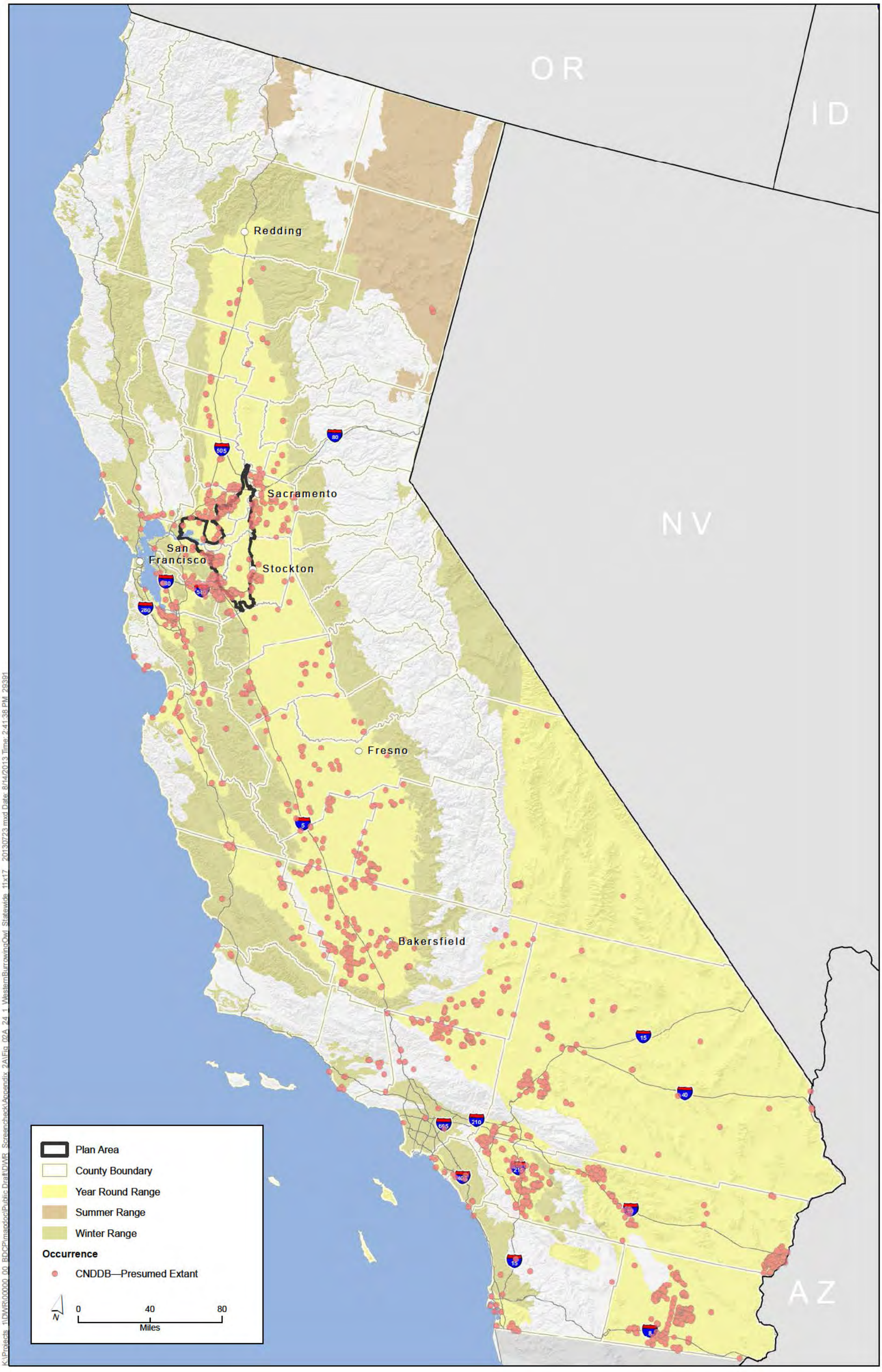
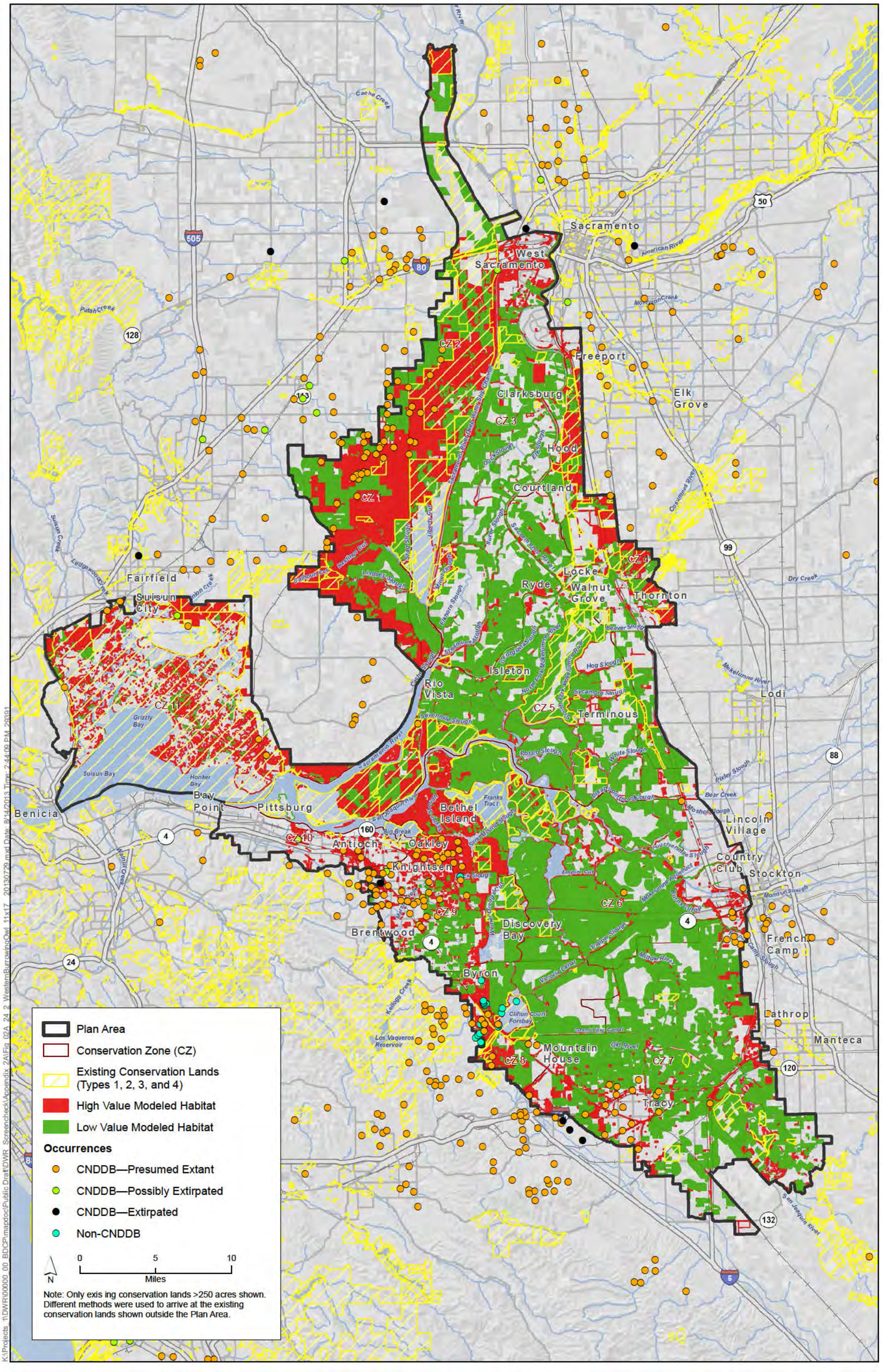


GIS Data Sources: Occurrences, CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.24-1
Western Burrowing Owl Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.24-2
Western Burrowing Owl Habitat Model and Recorded Occurrences

Appendix 2A.25
Western Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*)

2A.25.1 Legal Status

The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is listed as an endangered species under the California Endangered Species Act. Despite the evidence of population declines within the range of *C. a. occidentalis*, taxonomic debate related to the division of the two subspecies (*C. a. occidentalis* and *C. a. americanus*) contributed to the initial determination by the U.S. Fish and Wildlife Service (USFWS) that there was insufficient evidence to support federal listing. Following a second petition to list the species in 1998, USFWS initially agreed that listing may be warranted and issued a 90-day Finding for Petition to list as endangered and commencement of a status review (65 *Federal Register* [FR] 8104).

Additional information gathered during the status review suggested that there was insufficient differentiation to justify division into the two subspecies; thus, USFWS determined that, on the basis of the status of eastern populations, there was insufficient information to list the species. However, in 2001, USFWS determined that there was sufficient information to consider the range of *C. a. occidentalis* as a distinct population segment (DPS), and thus found that there was sufficient evidence to list the yellow-billed cuckoo western DPS (66 FR 38611). USFWS determined, however, that the listing was precluded by higher priority listing actions and that the immediacy of the threat to the species was not imminent. Thus, the species was added to the list of candidate species subject to future federal listing. In October 2013, USFWS proposed to list the species as threatened (78 FR 61621).

2A.25.2 Species Distribution and Status

2A.25.2.1 Range and Status

There are two currently recognized subspecies: *C. a. occidentalis*, found west of the Rocky Mountains and *C. a. americanus*, found in deciduous forests east of the Rocky Mountains. There is a continuing debate over the taxonomic separation of the two subspecies, which is based primarily on morphological and plumage differences (Banks 1988; Franzreb and Laymon 1993), and more recently on genetics studies initiated by USFWS during the status review for federal listing.

The range of western yellow-billed cuckoo historically extended from southern British Columbia to the Rio Grande River in northern Mexico, and east to the Rocky Mountains (Bent 1940). Currently, the only known populations of breeding western yellow-billed cuckoo are in several disjunct locations in California, Arizona, and western New Mexico (Halterman 1991). Yellow-billed cuckoos winter in South America from Venezuela to Argentina after a southern migration that extends from August to October (Laymon and Halterman 1985). They migrate north in late June and early July (de Schauensee 1970).

Studies conducted in 1986 and 1987 indicate that there were approximately 31 to 42 pairs in California (Laymon and Halterman 1987). While a few occurrences have been detected elsewhere recently, including near the Eel River, the only locations in California that currently sustain breeding populations include the Colorado River system in southern California, the South Fork Kern River east of Bakersfield, and isolated sites along the Sacramento River in northern California (Figure 2A.25-1) (Laymon and Halterman 1989; Laymon 1998).

Declines in numbers of the yellow-billed cuckoo in California are a result of "removal widely of essential habitat conditions," as described by Grinnell and Miller (1944). These declines have continued primarily in the San Joaquin Valley, north coast, and central coast (where the populations had been extirpated by 1977) (Gaines and Laymon 1984), and the species was nearly extirpated in the Lower Colorado River Valley by 1999. The Sacramento Valley is an important population center for the western yellow-billed cuckoo (Halterman et al. 2001; Dettling and Howell 2011) and the largest population of cuckoos is on the meandering portion of the middle Sacramento River (Greco 2012). At sites along the Sacramento River, the population was estimated at only 18 pairs (and 19 to 23 unmated individuals) in 1987 (Laymon and Halterman 1989; Halterman 1991), 26 pairs (and 19 unmated individuals) in 1989, and 35 to 40 pairs (38 to 42 unmated individuals) in 2000 (Halterman et al. 2001). Playback surveys conducted in 2010 detected only 18 individual cuckoos between Red Bluff and Colusa despite a predicted population estimate of 38 to 76 (Dettling and Howell 2011). These results indicate a decline in western yellow-billed cuckoo numbers along the Sacramento River since 2000 (Dettling and Howell 2011).

2A.25.2.2 Distribution and Status in the Plan Area

The historical distribution of yellow-billed cuckoo extended throughout the Central Valley, where the species was considered common (Belding 1890). In the mid-1940s, Grinnell and Miller (1944) still considered the Central Valley distribution to extend from Bakersfield to Redding. While there are few historical records from the Plan Area, presumably the species nested along the Sacramento, San Joaquin, and Mokelumne Rivers and along smaller tributary drainages, including Lost Slough, White Slough, and Disappointment Slough (Figure 2A.25-2).

Gaines (1974) reports several sightings of cuckoos near the Plan Area between 1962 and 1973. The Yolo Audubon Society also reports several sightings from Yolo County, including one from the Putah Creek Sinks in 2005. All of these are presumed to be of migrating birds. There are no recently confirmed breeding locations from the Plan Area or vicinity. In summer 2009, the California Department of Water Resources (DWR) detected one and possibly two yellow-billed cuckoos in a remnant patch of riparian forest in the vicinity of Mandeville Island. However, breeding status was not confirmed.

Most riparian corridors in the Plan Area do not support sufficiently large riparian patches for cuckoo breeding; however, the species likely continues to migrate along the Sacramento River and other drainages to northern breeding sites in the Sutter Basin and Butte County. The Plan Area supports several remnant riparian patches in the vicinity of Mandeville and Medford Islands that provide suitable riparian vegetation for cuckoos, but may not provide sufficiently large patch size to support breeding cuckoos.

2A.25.3 Habitat Requirements and Special Considerations

The yellow-billed cuckoo is a riparian obligate species. Its primary habitat association is willow-cottonwood riparian forest, but other tree species such as white alder (*Alnus rhombifolia*) and box elder (*Acer negundo*) may be an important habitat element in some areas, including occupied sites along the Sacramento River (Laymon 1998). Nests are primarily in willow (*Salix* spp.) trees; however, other tree species are occasionally used, including Fremont cottonwood (*Populus fremontii*) and alder. Along the Sacramento River, orchards of English walnut (*Juglans regia*), prune, and almond trees have also been reportedly used for nesting (Laymon 1980). Occupied habitat in Butte County was described by Halterman (1991) as great valley cottonwood riparian forest and great valley mixed riparian forest, including willows, box elder, and white alder. Potential habitat also occurs in valley marshland with willow riparian corridors, such as that found in the Llano Seco area of Butte County.

On the Santa Ana River, nest site height in willow trees averaged 14 feet (4.3 meters), but on the Sacramento River, a nest in a cottonwood tree was reported at 100 feet (30.5 meters) and canopy cover is typically dense (averaging 96.8% at the nest). Patch size was found to be the most important habitat variable to predict presence of western yellow-billed cuckoos on the Sacramento River (Girvetz and Greco 2009). Large patch sizes (20 to 40 hectares, with a minimum width of 100 meters) are typically required for cuckoo occupancy (Laymon 1998; Riparian Habitat Joint Venture 2004).

While yellow-billed cuckoos nest primarily in willow trees, Fremont cottonwood) trees are important foraging habitat, particularly as a source of insect prey. All studies indicate a highly significant association with relatively expansive stands of mature cottonwood-willow forests; however, yellow-billed cuckoos will occasionally occupy a variety of marginal habitats, particularly at the edges of their range (Laymon 1998). Continuing habitat succession has also been identified as important in sustaining breeding populations (Laymon 1998). Meandering streams that allow for constant erosional and depositional processes create habitat for new rapidly growing young stands of willow, which create preferred nesting habitat conditions for western yellow-billed cuckoo. Lateral channel migration and point bar deposition that create new floodplains and channel bend cut-offs that create floodplain lakes are important processes that create viable western yellow-billed cuckoo habitat (Greco 2012).

Primary factors influencing nest site selection in the Butte County population included the presence of cottonwood/willow riparian forest, patch size, and density of understory vegetation (Halterman 1991). Laymon and Halterman (1989) found a significant trend toward increased occupancy with increased patch size. In California, away from the Colorado River, cuckoos occupied 9.5% of 21 sites 20 to 40 hectares (49 to 99 acres) in extent, 58.8% of 17 sites 41 to 80 hectares (101 to 198 acres) in extent, and 100% of 7 sites greater than 80 hectares (198 acres) in extent (Laymon and Halterman 1989).

A habitat model developed by Gaines (1974) for the yellow-billed cuckoo in the Sacramento Valley includes the following elements: patch size of at least 25 acres, at least 100.5 meters (330 feet) wide and 302 meters (990 feet) long, within 100.5 meters (330 feet) of surface water, and dominated by cottonwood/willow gallery forest with a high-humidity microclimate. Laymon and Halterman (1989) further refined the model by classifying habitat patch sizes for suitability. A willow-

cottonwood forest patch greater than 604 meters (1,980 feet) wide and greater than 81 hectares (200 acres) is classified as optimum habitat; a patch 201 to 603.5 meters (660 to 1,980 feet) wide and 41.5 to 81 hectares (102.5 to 200 acres) is suitable; a patch 100.5 to 201 meters (330 to 660 feet) wide and 20 to 40 hectares (50 to 100 acres) is marginal, and smaller patches are unsuitable. The Riparian Habitat Joint Venture recommends restoring habitat in 25 locations to support 625 pairs (25 pairs per location) (Riparian Habitat Joint Venture 2004). Predictions suggest that a minimum of at least 25 pairs in a subpopulation, with interchange with other subpopulations, should be relatively safe from extirpation (Riparian Habitat Joint Venture 2004). To achieve this goal for the Sacramento Valley, it would be necessary to establish or preserve at least 6,070 hectares (15,000 acres) of optimum and suitable habitat. As of 1998, only 2,367 hectares (5,850 acres) of habitat were considered suitable (Laymon 1998).

Results of restoration efforts along the lower Colorado River from 2005 to 2010 indicate that area and tree-related habitat variables are extremely important predictors of cuckoo site occupancy (Bureau of Reclamation 2011). Median size of occupied sites (49.8 hectares) was found to be almost five times as large as unoccupied sites (10.6 hectares), with higher densities of native large trees, and to a lesser extent, native small trees, along with dense canopy cover. These results indicate that the yellow-billed cuckoo prefers a structurally diverse habitat of both large and small native trees. These mixed-height habitat stands would be similar to the historical riparian habitat where frequent spring flooding created patches of small native trees.

2A.25.4 Life History

2A.25.4.1 Description

The yellow-billed cuckoo is a medium-sized bird about 30 centimeters (11.8 inches) in length with a wingspan of 38 to 43 centimeters (15 to 17 inches). The species has a slender, long-tailed profile, with a fairly stout and slightly down-curved bill, which is blue-black with yellow on the base of the lower mandible. Plumage is grayish-brown above and white below, with red primary flight feathers. The tail feathers are boldly patterned with characteristic rows of large white spots on the underside. The legs are short and bluish-gray. Adults have a narrow, yellow eye ring. Juveniles resemble adults, except the tail patterning is less distinct, and the lower bill may have little or no yellow (Hughes 1999).

2A.25.4.2 Seasonal Patterns

In northern California, birds typically arrive onto breeding territories and pair formation occurs from late June to mid-July following the northward migration from South America, which is followed by nest building and raising of young (Halterman 1991). Breeding is restricted to the middle of summer, presumably because of a seasonal peak in large insect abundance (Rosenberg et al. 1982). To accommodate this, development of young is very rapid with a breeding cycle of 17 days from egg-laying to fledging. Following a relatively short period of juvenile dependency after fledging, cuckoos migrate out of California from approximately mid-August to early September. The species migrates to South America during the nonbreeding season and is not present in California between approximately October and May.

2A.25.4.3 Nest Site Selection

Primary factors influencing nest site selection include the presence of cottonwood/willow riparian forest, patch size, and density of understory vegetation. Little information is known about nesting density and spacing; however, along the Sacramento River, in an area of extensive foraging habitat (cottonwoods) and extremely restricted nesting habitat (willows and English walnuts), nests were placed as close as 200 feet apart, showing that they are capable of nesting in close proximity to one another (Laymon 1980).

2A.25.4.4 Reproduction

The pair constructs a flimsy twig nest which is typically 5 to 40 feet above the ground in dense canopy cover. Clutch size is usually three to four eggs, rarely five (Bent 1940). Both the female and the male perform incubation of the eggs, which lasts for 10 to 11 days (Hamilton and Hamilton 1965). Both parents also share brooding duties and provision young with food. Young develop very rapidly and fledge from 6 to 8 days after hatching. Parental care continues for an additional 3 to 4 weeks before the southern migration begins (Halterman 1991).

In the well-studied Kern River population, it was found that 70% of yellow-billed cuckoo pairs were monogamous, while the remaining 30% included a helper at the nest (Laymon 1998). When prey is abundant, cuckoos increase clutch size and may lay eggs in nests of other yellow-billed cuckoo pairs and other nests of other species (Fleischer et al. 1985; Laymon 1998; Hughes 1999). Further, the Kern River studies determined that cuckoos tend to lay more eggs when they are able to feed nestlings a high percentage diet of katydids, and they tend to fledge more young when prey are easily and quickly captured (Laymon 1998).

2A.25.4.5 Home Range and Territory Size

Limited information is available on home range and territory size. Territory size at the South Fork Kern River ranged from 8 to 40 hectares (20 to 100 acres) (Laymon and Halterman 1985), and on the Colorado River as small as 4 hectares (10 acres) (Laymon and Halterman 1989). Patch size, type and quality of habitat, and prey abundance largely determine the size of territories (Halterman 1991).

Yellow-billed cuckoos are loosely territorial and do not defend territories, but given uniform habitat they are regularly spaced throughout the landscape (Laymon 1998). Laymon (1980) found nests placed as close as 60 meters (197 feet) apart along the Sacramento River in an area where foraging habitat was abundant but nesting habitat was extremely limited. Breeding densities at the South Fork Kern River from 1985 to 1996 averaged 0.85 pair per 40 hectares and ranged from a low of 0.15 pair per 40 hectares in 1990 to a high of 1.4 pairs per 40 hectares in 1993 (Laymon 1998).

2A.25.4.6 Foraging Behavior and Diet

Food resources vary greatly from year to year and significantly affect reproductive success (Laymon et al. 1997). Cuckoos forage within the riparian canopy primarily on slow-moving insects. The principal food item is green caterpillar (primarily sphinx moth larvae) (44.9%), with lesser amounts of katydids (21.8%), tree frogs (23.8%), and grasshoppers (8.7%). The diet also includes cicadas, dragonflies, butterflies, moths, beetles, and spiders (Laymon et al. 1997). Primary food

items, particularly sphinx moth larvae, are associated with cottonwood trees and likely explain high reported use of cottonwood trees as foraging habitat for cuckoos (Laymon and Halterman 1985).

Yellow-billed cuckoos are primarily foliage gleaners (Laymon 1998). The typical strategy is to slowly hop from limb to limb in the canopy searching for movement of prey. They also sally from perches to catch flying insects or drop to the ground to catch grasshoppers or tree frogs (Laymon 1998).

2A.25.5 Threats and Stressors

2A.25.5.1 Habitat Loss and Fragmentation

Historical declines of the western yellow-billed cuckoo are attributed to the removal of riparian forests in California for agricultural and urban expansion. Habitat loss and degradation continue to be the most significant threats to remaining populations. Habitat loss continues as a result of bank stabilization and flood control projects, urbanization along edges of watercourses, agricultural activities, and river management that alter flow and sediment regimes. Nesting cuckoos are also sensitive to habitat fragmentation that reduces patch size (Hughes 1999).

2A.25.5.2 Pesticides

Pesticide use associated with agricultural practices may pose a long-term threat to cuckoos. Pesticides may affect behavior and cause death or potentially affect prey populations (Hughes 1999).

2A.25.5.3 Predation

Predation is a significant source of nest failures, which have been recorded at 80% in some areas (Hughes 1999). Fragmentation of occupied habitats could make nest sites more accessible and more vulnerable to predation. Nestlings and eggs are vulnerable to predation by snakes, small mammals, and birds.

2A.25.6 Relevant Conservation Efforts

There have been few conservation efforts directed toward yellow-billed cuckoos in California. The most significant conservation and research efforts have occurred at Audubon California's Kern River Preserve and actions associated with the *Lower Colorado River Multi-Species Conservation Program* (Bureau of Reclamation 2004). The program assists in the recovery of several threatened and near-threatened populations, by creating, protecting, and maintaining habitat in the lower Colorado River Basin. Yellow-billed cuckoos were one of 26 focal species included in the program. Extensive restoration efforts on the historical lower Colorado River floodplain have successfully created yellow-billed cuckoo breeding habitat. Yellow-billed cuckoo surveys are conducted annually in all potentially suitable habitat types within the program boundary to determine breeding habitat selection and preferences (Bureau of Reclamation 2011).

Efforts to protect and restore riparian systems can potentially preserve or create habitat for this species. Some regional habitat conservation planning efforts may also provide protections, primarily through protection of existing occupied habitat. Western yellow-billed cuckoo is also a covered species in other neighboring regional conservation plans including the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *Yolo County Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), and *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.25.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.25.7.1 GIS Model Data Sources

The yellow-billed cuckoo model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]), and aerial photography (U.S. Department of Agriculture 2005, 2010). Using these data sets, the model maps the distribution of suitable yellow-billed cuckoo nesting and migratory habitat in the Plan Area. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.25.7.2 Habitat Model Description

The western yellow-billed cuckoo model has two habitat components: breeding and migratory. Both models include the same vegetation types; however, if a patch of habitat meets the minimum patch size criterion of 50 acres, it is considered breeding habitat. If the patch of suitable vegetation is smaller than 50 acres, it is considered migratory habitat. The breeding and migratory habitat models in the Delta include the following valley/foothill riparian vegetation types from the BDCP composite vegetation layer.

- Fremont cottonwood (*Populus fremontii*)
- White alder (*Alnus rhombifolia*)
- Oregon ash (*Fraxinus latifolia*)
- Box elder (*Acer negundo*)
- Hinds' walnut (*Juglans hindsii*)
- Black willow (*Salix gooddingii*)
- Arroyo willow (*Salix lasiolepis*)
- Shining willow (*Salix lucida*)
- Narrow-leaf willow (*Salix exigua*)
- *Alnus rhombifolia*/*Salix exigua* (*Rosa californica*)

- *Alnus rhombifolia*/*Cornus sericea*
- *Acer negundo–Salix gooddingii*
- *Salix gooddingii–Populus fremontii* (*Quercus lobata–Salix exigua–Rubus discolor*)
- *Salix gooddingii*/*Rubus discolor*
- *Salix lasiolepis*–mixed brambles (*Rosa californica–Vitis californica–Rubus discolor*)
- *Salix exigua*–(*Salix lasiolepis–Rubus discolor–Rosa californica*)
- *Salix gooddingii*/wetland herbs
- *Salix gooddingii–Quercus lobata*/wetland herbs
- *Salix lasiolepis–Cornus sericea*/*Schoenoplectus*[1] spp. (*Phragmites australis–Typha* spp.) complex unit
- *Cornus sericea–Salix exigua*
- *Cornus sericea–Salix lasiolepis*/(*Phragmites australis*)
- *Quercus lobata*/*Rosa californica* (*Rubus discolor–Salix lasiolepis*/*Carex* spp.)
- *Quercus lobata–Acer negundo*
- *Quercus lobata – Alnus rhombifolia* (*Salix lasiolepis–Populus fremontii–Quercus agrifolia*)

With the same minimum patch size of 50 acres applied to the breeding model component, breeding and migratory habitat in Suisun Marsh and Yolo Basin includes the following valley/foothill riparian types from the BDCP composite vegetation layer.

- Mixed Fremont cottonwood–willow spp. NFD alliance
- Fremont cottonwood–valley oak–willow (ash–sycamore) riparian forest NFD alliance
- Mixed willow super alliance
- *Fraxinus latifolia*
- *Salix laevigata*/*S. lasiolepis*
- *Salix lasiolepis*/*Quercus agrifolia*
- Valley oak alliance–riparian
- Willow trees

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. The additional areas mapped included only patches greater than 50acres in the valley/foothill riparian natural community type.

[1] Formerly known as *Scirpus*.

2A.25.7.3 Assumptions

- **Assumptions:** Western yellow-billed cuckoo habitat is restricted to the vegetation types described in Section 2A.25.7.2, *Habitat Model Description*.

  Rationale: The yellow-billed cuckoo is a riparian obligate species. Its primary habitat association is willow-cottonwood riparian forest, but other species such as alder (*Alnus rhombifolia*) and box elder (*Acer negundo*) may be an important habitat element in some areas, including occupied sites along the Sacramento River (Laymon 1998).

- **Assumption:** All mapped habitat categories with a minimum patch size of 50 acres provide potentially occupied habitat for the Western yellow-billed cuckoo.

  Rationale: Canopy cover is typically dense (averaging 96.8% at the nest) and large patch sizes (generally greater than 50 acres [20.23 hectares]) are typically required (Laymon 1998).

2A.25.8 Recovery Goals

A USFWS recovery plan has not been prepared for this species and no recovery goals have been established.

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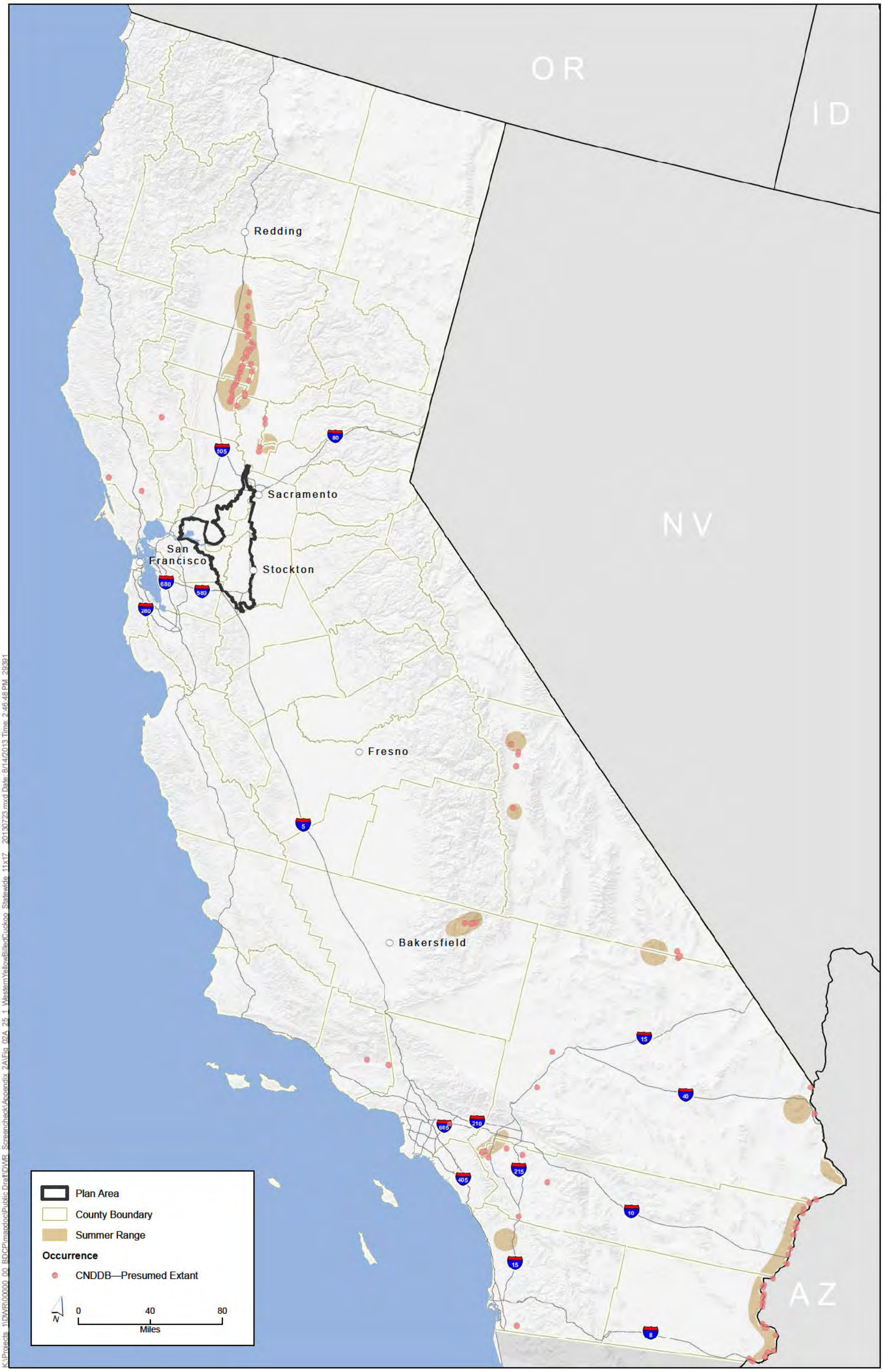
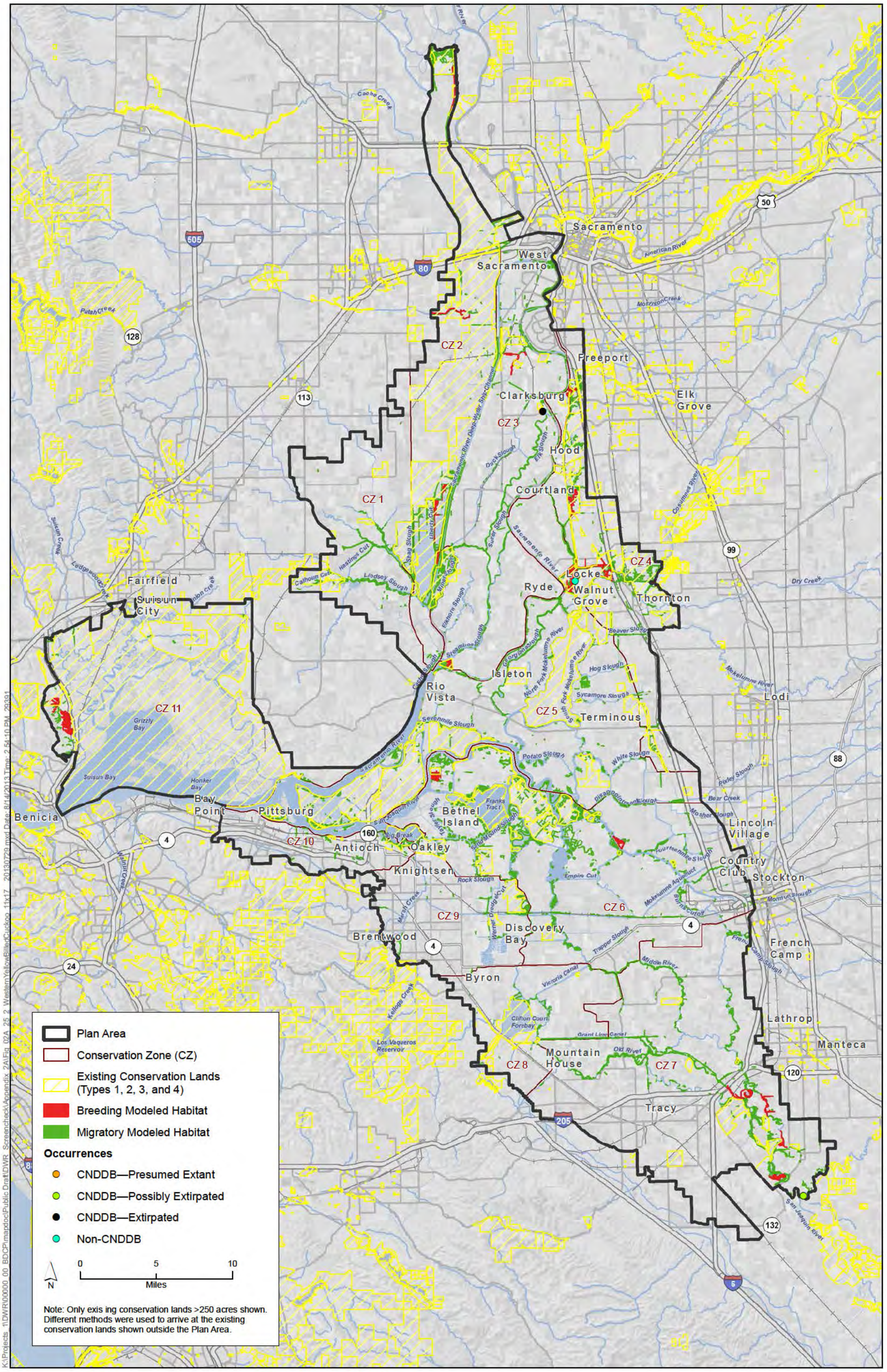


GIS Data Sources: Occurrences, CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.25-1
Western Yellow-Billed Cuckoo Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009.

Figure 2A.25-2
Western Yellow-Billed Cuckoo Habitat Model and Recorded Occurrences

Appendix 2A.26
White-Tailed Kite (*Elanus leucurus*)

2A.26.1 Legal Status

The white-tailed kite is designated as a state Fully Protected species pursuant to California Department of Fish and Wildlife (CDFW) Code Section 3511. Nests are protected in California under California Fish and Game Code, Section 3503.5.

The white-tailed kite has no federal regulatory status; however, the species is protected under the federal Migratory Bird Treaty Act.

2A.26.2 Species Distribution and Status

2A.26.2.1 Range and Status

The white-tailed kite was threatened with extinction in North America during the early 20th century (Eisenmann 1971). Until the 1960s, the species was in decline throughout its North American range, but since then has recovered in some areas. Currently, the distribution of the species includes the east coast and southeast United States, the southwest United States from Texas to California, and north to Washington State, and from Mexico to South America (Dunk 1995). Relatively stable resident populations occur in California, portions of coastal Oregon and Washington, southern Florida, southern Texas, and portions of northern Mexico. The species is rare in remaining portions of its North American range. The species has expanded its range in some Central American locales (Eisenmann 1971).

California populations were in a serious decline prior to the 1960s, likely due to habitat loss, shooting, and possible egg collecting (Pickwell 1930; Waian and Stendell 1970). From the 1940s to the 1970s, populations and distribution increased (Fry 1966; Waian and Stendall 1970; Eisenmann 1971), as a result of protection from shooting and possibly from increasing agricultural development, which may have increased rodent habitat and expanded the foraging range of the white-tailed kite (Eisenmann 1971; Small 1994). In the Sacramento Valley, the kite population has increased predominantly in irrigated agricultural areas where meadow voles (*Microtus californicus*) are found (Warner and Rudd 1975).

California is the breeding range stronghold for the white-tailed kite in North America (Figure 2A.26-1); the species occupies nearly all areas up to the western Sierra Nevada foothills and southeastern deserts (Small 1994; Dunk 1995). It is common to uncommon and a year-round resident in the Central Valley, other lowland valleys, and along the entire length of the coast (Dunk 1995).

Although the white-tailed kite is probably resident through most of its breeding range, dispersal occurs during the nonbreeding season, leading to a winter range expansion that includes most of California (Small 1994; Dunk 1995).

2A.26.2.2 Distribution and Status in the Plan Area

The white-tailed kite is distributed throughout the Plan Area during the breeding and wintering seasons (Figure 2A.26-2), although relatively few nesting locations have been documented. The species is under-represented in the California Natural Diversity Database (CNDDB), which reports only five locations within the Plan Area (California Department of Fish and Game 2011). Recent surveys in the Yolo and Sacramento County portions of the Plan Area have documented active nests sites in riparian habitats in the Yolo Bypass and along Steamboat and Georgiana sloughs, and the Sacramento River (Estep 2007, 2008). Surveys from 2009 to 2011 documented 10 active white-tailed kite nest sites (Delta Habitat Conservation and Conveyance Program 2011). Additional incidental observations are regularly noted in Audubon field notes, environmental documents, and management plans in the Delta. CDFW also maintains nesting and winter roosting records of white-tailed kites from the Yolo Bypass Wildlife Area. Most nesting habitat for kites in the Plan Area consists of riparian woodlands and scrub along large and small drainages. Nesting distribution is limited by the dearth of suitable trees in much of the central Delta, and nesting density in that area is likely significantly lower than that found in the northern and southern portions of the Plan Area. However, overall the species is likely under-represented by reported occurrences throughout the Plan Area. Most of the Plan Area, including grassland, seasonal wetland, and agricultural cover types, provides potential foraging habitat for kites. Thus, the species potentially occurs throughout the Plan Area during winter and near suitable nesting habitat during the breeding season.

2A.26.3 Habitat Requirements and Special Considerations

The white-tailed kite inhabits low-elevation, open grasslands, savannah-like habitats, agricultural areas, wetlands, and oak woodlands (Dunk 1995). They nest in trees—usually those with a dense canopy—but nest trees can vary from single, isolated trees to trees in large woodlands. Habitat elements that influence nest site selection and nesting distribution include habitat structure (usually a dense canopy) and prey abundance and availability (primarily the association with meadow vole), while the association with specific vegetation types (e.g., riparian, oak woodland) appears less important (Dunk 1995; Erichsen 1995).

2A.26.3.1 Nesting

White-tailed kite nests have been documented in a variety of tree species, including valley oak (*Quercus lobata*), Fremont cottonwood (*Populus fremontii*), willows (*Salix* spp.), interior live oak (*Quercus wislizeni*), box elder (*Acer negundo*), ornamental trees such as olive and pine trees, and occasionally in tall shrubs (Dixon et al. 1957; Dunk 1995; Erichsen 1995; Estep 2007, 2008). As noted above, nest trees are selected for structure and security, and typically have a dense canopy or are within a dense group of trees, such as riparian forest or oak woodland. Kites will occasionally use isolated trees.

Most nests in the Sacramento Valley are found in oak/cottonwood riparian forests, valley oak woodlands, or other groups of trees and are usually associated with compatible agricultural foraging habitat, such as pasture and hay crops, compatible row and grain crops, or natural vegetation such as seasonal wetlands and annual grasslands (Erichsen 1995).

Kites often nest in close association with several other raptors, including Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*Buteo jamaicensis*), and red-shouldered hawk (*Buteo lineatus*), particularly in riparian habitats of the Sacramento Valley (Erichsen 1995; Estep 2007, 2008).

2A.26.3.2 Foraging

A variety of foraging habitat types are used, but those that support larger and more accessible prey populations are more suitable. The presence and abundance of white-tailed kites is strongly correlated with the presence of meadow voles (Stendell 1972). As a result, population cycles of meadow voles can also influence nesting and wintering abundance of white-tailed kites. For example, those portions of the Plan Area that are subject to seasonal flooding experience fluctuating prey numbers, which affects the occurrence of white-tailed kites until prey populations recover. Preferred cover types include alfalfa and other hay crops, irrigated pastures, and some cultivated habitats, particularly sugar beets and tomatoes, both of which can support relatively large populations of voles (Estep 1989) and which have been highly correlated with the density of kite nest sites (Erichsen et al. 1994). Kites also forage in dry pastures, annual grasslands, rice stubble fields, and occasionally in orchards (Erichsen 1995).

Winter foraging habitat is similar to breeding season foraging habitat, particularly the association with agricultural habitats and vole populations; however, there is less association with riparian forests and woodlands.

2A.26.3.3 Winter Roosts

White-tailed kites roost communally during the winter, sometimes in concentrations of hundreds of birds. This roosting behavior usually occurs in large trees, but sometimes occurs in other upland habitats. Significant winter communal roosts have been reported in the Yolo Bypass on the Yolo Bypass Wildlife Area (Feliz pers. comm.)

2A.26.4 Life History

2A.26.4.1 Description

White-tailed kites are medium-sized hawks (total length of 32 to 38 centimeters [12.6 to 15 inches]) with a long white tail; large, black shoulder patches; and red eyes. In adults, these features contrast with the gray back and white underparts. The sexes are similar in size, but females tend to have darker backs than males. Juveniles have yellow eyes, buff streaks on the breast and head, and gray and white-tipped feathers on the back. White-tailed kites are readily recognized by their foraging behavior, frequently hovering (kiting) in the air while hunting for prey.

2A.26.4.2 Seasonal Patterns

Although apparently a resident bird throughout most of its breeding range, dispersal occurs during the nonbreeding season resulting in some range expansion during the winter. Stendell (1972) believed the white-tailed kite to be resident, becoming nomadic during periods of low prey abundance. While population changes and local and regional movements appear to be somewhat predictable based on vole and other rodent cycles, it remains unknown whether in northern

California this constitutes a migration movement or nomadic response to changes in the prey populations (Dunk and Cooper 1994).

2A.26.4.3 Reproduction

The breeding season, from pair bonding to juvenile dependence, occurs from approximately January to October with peak activity from May through August (Dunk 1995). Nests are constructed of loosely piled sticks and twigs, and lined with grass, straw, or rootlets. The nest is placed near the top of a dense oak, willow, or other tree; usually 6 to 20 meters (20 to 65 feet) above ground in trees that vary from 3 to 50 meters (10 to 164 feet) in height (Dixon et al. 1957). Females typically lay a clutch of four eggs, with a range of three to six. The female incubates exclusively and performs most brooding while the male provisions the female and nestlings. Eggs are incubated for about 28 days. Young fledge in 35 to 40 days following hatching, with the peak fledging period occurring in June (Erichsen 1995).

2A.26.4.4 Home Range/Territory Size

Territory size is variable and regulated primarily by prey abundance and vegetation structure (i.e., accessibility of prey); however, this species also responds to the abundance of interspecific and intraspecific competitors (Dunk 1995; Erichsen 1995). Reported average territory sizes include 1.6 to 21.5 hectares (3.95 to 53.13 acres) (Dunk and Cooper 1994), 19 to 52 hectares (46.95 to 128.49 acres) with a mean of 29 hectares (71.66 acres) (Waian 1973), and 17 to 120 hectares (42.01 to 296.53 acres) (Henry 1983). As with other raptors species, particularly those occurring in agricultural habitats, home ranges may overlap and foraging may be limited to a small portion of the total area, possibly because of competition or fluctuating prey accessibility due to changes in vegetation structure (Henry 1983). Kites use communal roosts during the nonbreeding season (Waian and Stendell 1970). Home ranges for nonbreeders are more difficult to determine since communal roosts may be tens of kilometers away (Dunk 1995).

2A.26.4.5 Foraging Behavior and Diet

White-tailed kites generally hunt from a central perch over areas as large as 3 square kilometers (1.16 square miles) (Warner and Rudd 1975), but foraging usually occurs within 0.8 kilometer (0.5 mile) from the nesting site during the breeding season (Hawbecker 1942). Kites are not particularly territorial. The nest site and immediately surrounding area are defended against crows and other raptors (Pickwell 1930; Dixon et al. 1957), and small defended wintering territories of about 0.10 square kilometers (0.04 square miles) have been documented (Bammann 1975).

The white-tailed kite preys mostly on voles, but also takes other small, diurnal mammals, and occasionally birds, insects, reptiles, and amphibians. Small mammal prey accounts for 95% of the kite diet (Dunk 1995). It forages in undisturbed, open grasslands, meadows, farmlands and emergent wetlands, ungrazed grasslands, fencerows and irrigation ditches adjacent to grazed lands (Dunk 1995). It soars, glides, and hovers less than 30 meters (98 feet) above the ground in search of prey. It hunts almost exclusively by hovering from 5 to 25 meters (16 to 82 feet) in height, with hovering bouts lasting up to 60 seconds. During this time, kites scan the ground searching for prey and watching for potential competitors or predators. The hovering bout ends in a dive to the ground for prey, flight to another location, soaring or interacting with another bird, or flight to the perch (Warner and Rudd 1975).

2A.26.5 Threats and Stressors

2A.26.5.1 Habitat Loss and Fragmentation

Urbanization, including residential and commercial development and infrastructure development (roads and oil, water, gas, and electrical conveyance facilities) is one of the principal causes of continuing habitat loss for the white-tailed kite and is a continuing threat to remaining populations, particularly in rapidly urbanizing areas in the Sacramento Valley. Urbanization permanently removes habitat and results in permanent abandonment of nesting territories. Proximity to urban areas also influences kite occurrence. While there are examples of kites nesting and roosting in urban areas, in general, the species is intolerant of noise and human activities and will abandon nesting areas that are subject to increasing levels of human disturbances. Kites are also sensitive to habitat fragmentation. Low-density urbanization or isolation of habitats —even if relatively large patches remain undisturbed—also leads to territory abandonment.

2A.26.5.2 Agricultural Crop Conversion

As noted above, white-tailed kite populations are closely associated with rodent abundance and accessibility, which can be influenced by crop patterns. Kite populations have recovered to some extent in California due in part to the expansion of compatible agricultural types. The conversion to crop patterns that do not support sufficient rodent prey, or that restrict accessibility to prey, can result in the abandonment of traditionally active territories.

2A.26.6 Relevant Conservation Efforts

There are few conservation efforts addressing white-tailed kite populations. The lack of state or federal listing limits the extent of regulatory influence. There are several significant data gaps regarding population status and trends, migration, dispersal from nesting sites, and other aspects of annual movements.

Protection typically occurs at the local project level pursuant to the California Environmental Quality Act (CEQA). While project-level mitigation may address protection of active sites and avoidance of take of this fully protected species, they do not address conservation or protection at a regional level.

Regional conservation efforts have focused on the development and implementation of habitat conservation plans and natural community conservation plans. These regional conservation approaches can be an effective tool to manage and sustain white-tailed kite populations if they protect sufficient suitable and occupied habitat. Much of the Plan Area overlaps with or is near other conservation planning efforts that are either currently being implemented or are in development. These plans include the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/ Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency. 2011), and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011). To date there has been limited coordination between

these otherwise complementary conservation planning efforts with respect to managing covered species.

2A.26.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods.*

2A.26.7.1 GIS Model Data Sources

The white-tailed kite model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), and land use survey of the Delta and Suisun Marsh area-version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable white-tailed kite habitat in the Plan Area according to the species' two primary life requisites: nesting habitat and foraging habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.26.7.2 Habitat Model Description

Modeled nesting/roosting habitat includes the following types from the BDCP composite vegetation layer.

- Agricultural land
    - Eucalyptus
- Valley/foothill riparian
    - White alder (*Alnus rhombifolia*)
    - *Alnus rhombifolia*/*Salix exigua* (*Rosa californica*)
    - *Alnus rhombifolia*/*Cornus sericea*
    - Oregon ash (*Fraxinus latifolia*)
    - Box elder (*Acer negundo*)
    - *Acer negundo-Salix gooddingii*
    - Hinds' walnut (*Juglans hindsii*)
    - Fremont cottonwood (*Populus fremontii*)
    - Black willow (*Salix gooddingii*)
    - *Salix gooddingii*/wetland herbs
    - *Salix gooddingii–Populus fremontii* (*Quercus lobata–Salix exigua–Rubus discolor*)
    - *Salix gooddingii–Quercus lobata*/wetland herbs
    - *Salix gooddingii*/*Rubus discolor*
    - Coast live oak (*Quercus agrifolia*)

- Valley oak (*Quercus lobata*)
- *Quercus lobata*/*Rosa californica* (*Rubus discolor*–*Salix lasiolepis*/*Carex* spp.)
- *Quercus lobata*–*Acer negundo*
- *Quercus lobata*–*Alnus rhombifolia* (*Salix lasiolepis*–*Populus fremontii*–*Quercus agrifolia*)
- *Quercus lobata*–*Fraxinus latifolia*
- Arroyo willow (*Salix lasiolepis*)
- *Salix lasiolepis*–Mixed brambles (*Rosa californica*–*Vitis californica*–*Rubus discolor*)
- *Salix lasiolepis*–(*Cornus sericea*)/*Scirpus* spp. –(*Phragmites australis*–*Typha* spp.) complex unit
- Shining willow (*Salix lucida*)
- *Salix Exigua*–(*Salix lasiolepis*–*Rubus discolor*–*Rosa californica*)
- Black willow (*Salix gooddingii*) –valley oak (*Quercus lobata*) restoration
- Valley oak (*Quercus lobata*) restoration
- White alder (*Alnus rhombifolia*)/Arroyo willow (*Salix lasiolepis*) restoration

Modeled nesting/roosting habitat includes the following types from the BDCP composite vegetation layer.

- Eucalyptus
- *Eucalyptus globulus*
- *Fraxinus latifolia*
- Fremont cottonwood–valley oak–willow (ash–sycamore) riparian forest NFD alliance
- Landscape trees
- Mixed Fremont cottonwood–willow spp. NFD alliance
- Mixed willow super alliance
- Oaks
- *Quercus agrifolia*
- *Salix lasiolepis*/*Quercus agrifolia*
- Valley oak alliance–riparian
- Willow trees

Modeled breeding habitat for white-tailed kite includes all valley riparian types that support an overstory component. The model does not distinguish habitat value according to overstory composition, tree density, structure, or patch size. Natural vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP composite vegetation data layer. Breeding habitats may also function as winter roosting sites.

Modeled foraging habitat in the Delta includes the following types from the BDCP composite vegetation layer.

- Grasslands
  - Ruderal herbaceous grasses and forbs
  - California annual grasslands–herbaceous
  - *Bromus diandrus–Bromus hordeaceus*
  - Italian ryegrass (*Lolium multiflorum*)
  - *Lolium multiflorum-Convolvulus arvensis*
  - Degraded vernal pool complex–California annual grasslands
  - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
  - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
  - Degraded vernal pool complex–rabbitsfoot grass
- Managed wetlands
  - Temporarily flooded grasslands
  - Rabbitsfoot grass (*Polypogon monspeliensis*)
  - Poison hemlock (*Conium maculatum*)
  - Intermittently flooded perennial forbs
  - Managed annual wetland vegetation (nonspecific grasses and forbs)
  - Shallow-flooding with minimal vegetation
  - Seasonally flooded undifferentiated annual grasses and forbs
  - Managed alkali wetland (*Crypsis*)
  - Intermittently or temporarily flooded undifferentiated annual grasses and forbs.
- Alkali seasonal wetland complex and other natural seasonal wetlands
  - *Distichlis spicata*–annual grasses
  - Saltgrass (*Distichlis spicata*)
  - Seasonally flooded grasslands
  - Vernal pools
  - Degraded vernal pool complex-vernal pools
  - *Juncus balticus*–meadow vegetation
  - Temporarily flooded perennial forbs
  - Alkaline vegetation mapping unit
  - *Allenrolfea occidentalis* mapping unit
  - *Suaeda moquinii* mapping unit
  - Salt scalds and associated sparse vegetation

- Vernal pool complex
  - *Allenrolfea occidentalis* mapping unit
  - Annual grasses generic
  - Annual grasses/weeds
  - California annual grasslands–herbaceous
  - *Distichlis spicata*
  - *Distichlis*/annual grasses
  - *Distichlis spicata*–annual grasses
  - *Distichlis*/*S. maritimus*
  - *Distichlis* (generic)
  - Italian ryegrass (*Lolium multiflorum*)
  - Ruderal herbaceous grasses and forbs
  - Salt scalds and associated sparse vegetation
  - Seasonally-flooded grasslands
  - *Suaeda moquinii* mapping unit
  - Vernal pools

Foraging habitat includes the following types from the BDCP composite vegetation layer.

- *Agrostis avenacea*
- Annual grasses generic
- Annual grasses/weeds
- *Atriplex lentiformis* (generic)
- *Atriplex triangularis*
- *Atriplex*/annual grasses
- *Atriplex*/*Distichlis*
- *Atriplex*/*S. maritimus*
- *Atriplex*/*Sesuvium*
- *Baccharis*/annual grasses
- *Brassica nigra* (generic)
- *Bromus* spp.(*Hordeum*)
- *Crypsis schoenoides*
- *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
- Cultivated annual graminoid
- *Distichlis* (generic)

- *Distichlis spicata*
- *Distichlis–Juncus–Triglochin–Glaux*
- *Distichlis*/annual grasses
- *Distichlis /Cotula*
- *Distichlis/Juncus*
- *Distichlis/Lotus*
- *Distichlis/S. americanus*
- *Distichlis/S. maritimus*
- *Distichlis/Salicornia*
- *Atriplex triangularis* (generic)
- Fallow disked field
- Field crops
- Flooded managed wetland
- *Frankenia/Agrostis*
- *Frankenia/Distichlis*
- *Hordeum/Lolium*
- Intermittently flooded to saturated deciduous shrubland
- *Juncus balticus*
- *Juncus balticus/Conium*
- *Juncus balticus/Lepidium*
- *Juncus balticus/Potentilla*
- *Lepidium* (generic)
- *Lepidium/Distichlis*
- *Leymus* (generic)
- *Lolium* (generic)
- *Lolium/Lepidium*
- *Lolium/Rumex*
- *Lotus corniculatus*
- Medium upland herbs
- Medium upland shrubs
- Medium wetland graminoids
- Medium wetland herbs
- Flooded managed wetland

- Pasture
- Perennial grass
- *Phalaris aquatica*
- *Polygonum–Xanthium–Echinochloa*
- *Polypogon monspeliensis* (generic)
- Rice
- *Rumex* (generic)
- *Salicornia* (generic)
- *Salicornia virginica* (currently known as *S. pacifica*)
- *Salicornia*/annual grasses
- *Salicornia*/*Atriplex*
- *Salicornia*/*Cotula*
- *Salicornia*/*Crypsis*
- *Salicornia*/*Polygonum–Xanthium–Echinochloa*
- *Salicornia*/*Sesuvium*
- *Sesuvium verrucosum*
- *Sesuvium*/*Distichlis*
- *Sesuvium*/*Lolium*
- Short upland graminoids
- Short wetland graminoids
- Short wetland herbs
- Tall wetland graminoids
- Tall wetland herbs
- Truck/nursery/berry crops
- Upland annual grassland and forbs formation
- Upland herbs
- Wetland herbs
- Degraded vernal pool complex–California annual grasslands
- Degraded vernal pool complex–ruderal herbaceous grasses and forbs
- Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
- Degraded vernal pool complex–rabbit's foot grass
- Degraded vernal pool complex–vernal pools
- Grain/hay crops

The following California Department of Water Resources (DWR) 2007 Land Use survey types are included as suitable agricultural foraging habitats for white-tailed kite. These types represent the typical agricultural cover types in the Plan Area that are included in the DWR 2007 land use survey. Rotational crop types that are not common to the Plan Area are not included here. Pasture types are mostly perennial; alfalfa is semi-perennial (3 to 7 years); and all other types are annually or seasonally rotated irrigated crops, only some of which provide suitable foraging habitat for white-tailed kites.

- Oats
- Miscellaneous grain and hay
- Mixed grain and hay
- Field crops
    - Safflower
    - Sugar beets
    - Corn
    - Grain sorghum
    - Sudan
    - Beans
    - Miscellaneous field
    - Sunflowers
- Pasture
    - Alfalfa and alfalfa mixtures
    - Clover
    - Mixed pasture
    - Native pasture
    - Miscellaneous grasses
    - Wheat
    - Nonirrigated miscellaneous grain and hay
    - Nonirrigated mixed grain and hay
- Truck, nursery and berry crops
    - Asparagus
    - Beans
    - Onions and garlic
    - Tomatoes
    - Peppers

- Idle
  - Land not cropped the current or previous crop season, but cropped within the past 3 years
  - New lands being prepped for crop production
- Native vegetation[1]

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Additional detail regarding crop types was available for cultivated lands and was incorporated into the mapping. For white-tailed kite, in the new analysis areas, the following natural communities are assumed to provide the listed habitat type (i.e., foraging, nesting, and roosting).

Additional areas mapped as foraging habitat includes the following vegetation types.

- Agricultural
  - Cultivated annual graminoid
  - Field crops
  - Pasture
  - Rice
- Alkali seasonal wetland complex
- Grassland
  - Pasture
  - Upland annual grasslands and forbs formation
- Managed wetland
  - *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
  - Vernal pools
- Nontidal freshwater perennial emergent wetland
  - Cultivated annual graminoid
- Other natural seasonal wetland
- Tidal brackish emergent wetland
- Tidal perennial aquatic

Additional areas mapped as nesting and roosting habitat includes the following vegetation types.

- Valley/foothill riparian
  - Intermittently flooded to saturated deciduous shrubland

[1] Native vegetation is a land use designation within the DWR crop type dataset (2007). For the purposes of incorporating native vegetation classes into the correct species models, and, when applicable, assigning habitat foraging values, the management on these lands most resembles that of native pasture, an irrigated pasture type.

- Mixed Fremont cottonwood–willow species, NFD alliance
- Mixed willow super alliance
- Valley oak (*Quercus lobata*)
- Valley oak alliance–riparian

- Vernal pool complex

2A.26.7.3 Assumptions

- **Assumption:** White-tailed kite nesting/roosting habitat is restricted to the vegetation types described in Section 2A.20.7.2, *Habitat Model Description*.

  Rationale: White-tailed kites nest in a variety of woodland habitat types (Dunk 1995; Erichsen 1995). Modeled nesting habitat on the valley floor includes all riparian forest and some willow scrub habitats regardless of width or density. On the valley floor, kites also nest in isolated trees along irrigation canals, windbreaks and other tree rows, roadside trees, and in trees around rural residences (Erichsen 1995). Because these habitats are often below the minimum mapping unit, kite breeding habitat may be underrepresented here. Kites also roost in these habitats during winter. Large kite roosts have been reported in the Yolo Bypass on CDFW's Yolo Bypass Wildlife Area (Feliz pers. comm.).

- **Assumption:** White-tailed kite foraging habitat is restricted to the vegetation types described in Section 2A.20.7.2, *Habitat Model Description*.

  Rationale: Foraging habitat types are considered available year-round; however, flooded seasonal wetlands receive less use during periods of inundation. During the breeding season, kites generally restrict their foraging territories to an approximately 1 square mile around the nest (Warner and Rudd 1975). During the nonbreeding season, kites are not confined to the limits of breeding territories and can be found throughout the Plan Area. Breeding and wintering season foraging habitat was not differentiated in this model.

2A.26.7.4 Habitat Value Classes

As described, the white tailed kite is closely associated with agricultural lands in the Plan Area. Most of the Plan Area consists of agricultural land and most agricultural land has some value as foraging habitat for white-tailed kites. However, the value of crop types differs widely with respect to prey abundance and accessibility to foraging kites. Because of the dynamic nature of the agricultural landscape and the variability of crop patterns and conditions seasonally and annually, only a portion of the agricultural landscape is suitable or available for foraging in any given season or year.

Sufficient information is available on the growth and structure of different agricultural crops (Estep 2009) and the prey abundance and white-tailed kite use of different crop types to generally categorize crops based on their value as foraging habitat. Table 2A.26-1 categorizes modeled cover types according to five relative value classes: very high, high, moderate, low, and marginal. These value classes correspond to the conservation objectives for the white-tailed kite with regard to maintaining moderate to very high-value types on protected conservation lands. Table 2A.26-1 provides the rationale for assigning crop types and other agricultural land uses to habitat value categories. Figure 2A.26-3 displays the distribution of foraging habitat and the assigned habitat values in the Plan Area.

Table 2A.26-1. White-Tailed Kite Foraging Habitat Value Classes

Foraging Habitat Value Class	Assigned Agricultural Crops/Habitats	Rationale for Assignment of Agricultural Crop Class	Sources[1]
Very High	Alfalfa	Alfalfa has the highest value because it is semi-perennial (up to 5 years before rotation), which increases prey abundance; has a relatively low profile such that prey are accessible season-long; and has a management regime (mowing and irrigation) which further increases prey accessibility.	Erichsen 1995; Estep 1989, 2009; Swolgaard et al. 2008
High	Native pasture, mixed pasture, clover, miscellaneous grasses, managed wetlands, other seasonal wetlands, grasslands, nonirrigated native pasture and pasture	These pasture types provide a relatively consistent vegetation structure and rodent prey populations. There is less seasonal variability with respect to prey abundance and accessibility compared with grain and vegetable crops, but they lack the management practices that enhance prey accessibility found in alfalfa. Managed seasonal wetlands and other seasonal wetland types also provide consistently high-value foraging habitat during the breeding season. Value of seasonal wetlands decreases during the winter season when these fields may be all or partially inundated. Grassland types (with the exception of annual grasslands) may also provide high-value foraging habitat are consistently available year-round.	Erichsen 1995; Estep 1989, 2009; Swolgaard et al. 2008
Medium	Sugar beets, tomatoes, grain and hay, annual grasslands, wheat, oats, non-irrigated misc. grain and hay, cropped within last 3 years, new lands being prepped for crop production, grain/hay crop, grassland natural comm, alkali seasonal wetland natural community, managed wetland natural community, other natural seasonal wetland, annual grasses generic, annual grasses/weeds, *Baccharis*/annual grasses, *Bromus* spp./*Bordeum*, *Crypsis schoenoides*, *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance, cultivated annual graminoid, *Cynodon dactylon*, *Distichlis*/annual grasses, fallow disced field, *Hordeum*/*Lolium*, *Lolium* (generic), *Lolium*/*Rumex*, *Lotus corniculatus*,	Certain row crops, such as beets and tomatoes also have relatively high value because they support large rodent prey populations, are accessible season-long because of their relatively low vegetation profile, and they are harvested prior to migration, when an abundance of prey becomes available. Most grain crops (primarily wheat in Yolo County) provide value during and following harvesting, when prey become accessible. Annual grasslands also provide moderate value foraging habitat and while they are consistently available year-round, they generally provide less microtine prey than other grassland types.	Erichsen 1995; Estep 1989, 2009; Swolgaard et al. 2008

Foraging Habitat Value Class	Assigned Agricultural Crops/Habitats	Rationale for Assignment of Agricultural Crop Class	Sources[1]
	medium upland herbs, medium wetland graminoids, medium wetland herbs, perennial grass, short upland graminoids, short wetland graminoids, tall wetland graminoids, upland annual grasslands & forbs formation, upland herbs, agriculture		
Low	Rice stubble, orchards	Kites occasionally use rice fields following harvest and during idle periods and have occasionally been observed to use orchards for foraging.	Erichsen 1995
Marginal	Broccoli, safflower, corn, grain sorghum, sunflower, sudan, dry beans, field crops, asparagus, green beans, cole crops, carrots, melons/ squash/cucumbers, onions/ garlic, peppers, artichokes, lettuce (all types), spinach, mixed truck and berries, miscellaneous field crops.	The truck and berry/field crop agriculture types are suitable for a portion of the breeding season depending on their structure and planting/harvesting regime. In general, they produce less prey abundance and less prey availability than the other agriculture types listed above.	Estep 1989, 2009; Swolgaard et al. 2008

2A.26.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

2A.26.9 References Cited

2A.26.9.1 Literature Cited

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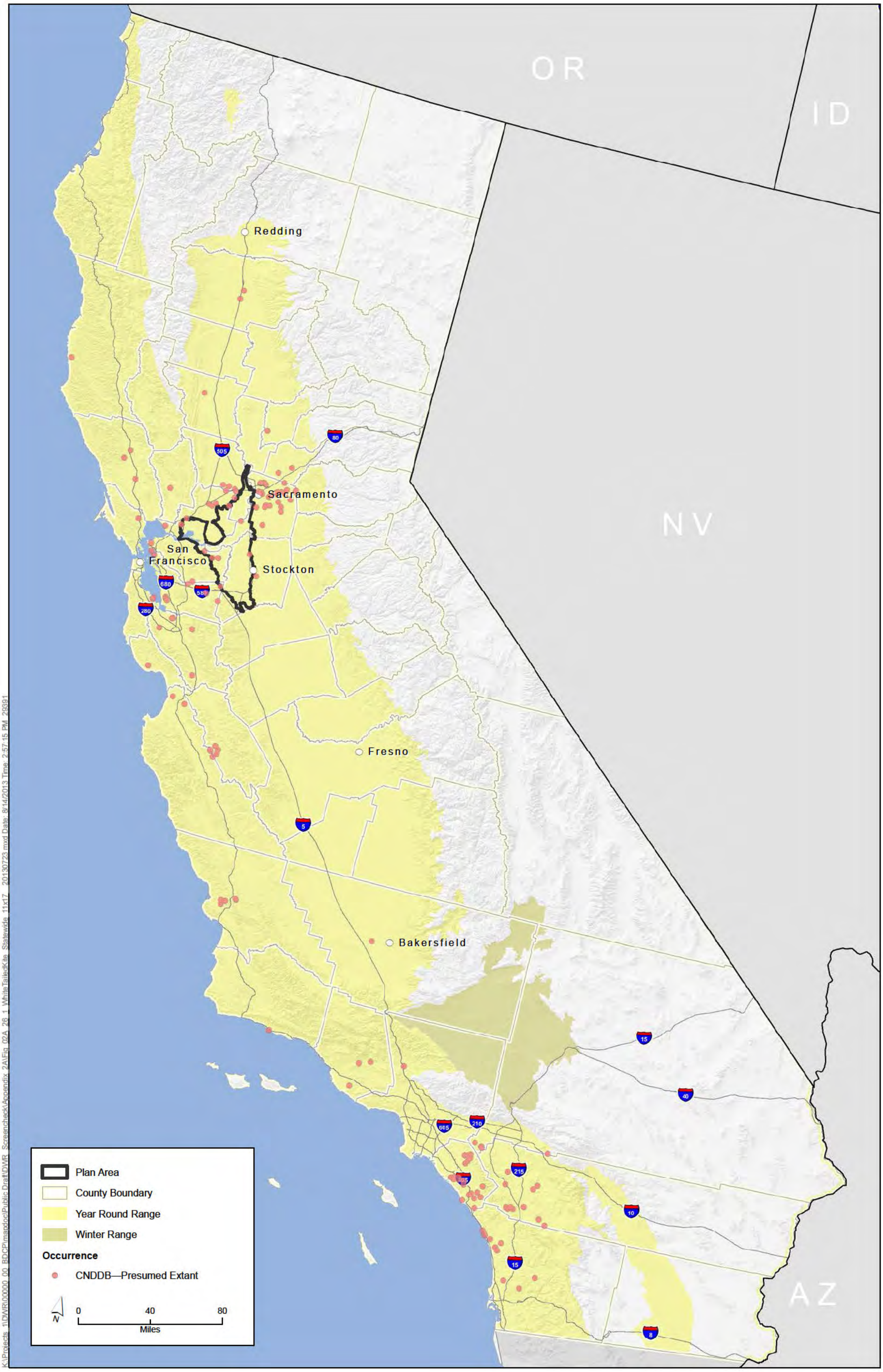
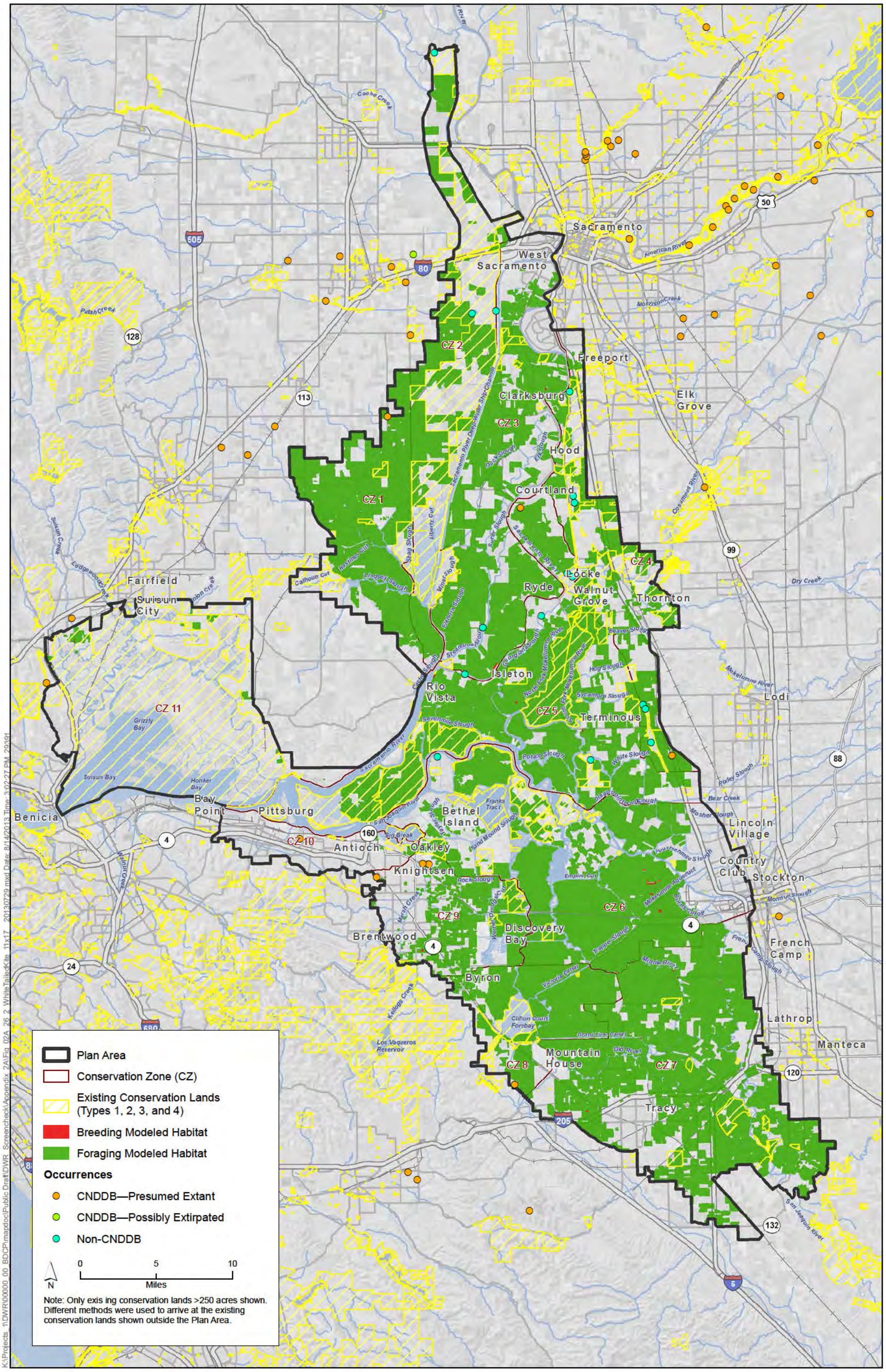


GIS Data Sources: Occurrences, CNDDB June 2013;
Range, DFG WHR 2008.

Figure 2A.26-1
White-Tailed Kite Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013, Estep 2007-2008, and DHCCP 2009-2011

Figure 2A.26-2
White-Tailed Kite Habitat Model and Recorded Occurrences

Appendix 2A.27
Yellow-Breasted Chat (*Icteria virens*)

2A.27.1 Legal Status

The yellow-breasted chat (*Icteria virens*) is designated as a state Bird Species of Special Concern by the California Department of Fish and Wildlife (CDFW) (Shuford and Gardali 2008). In California, nests are protected under California Fish and Game Code, Section 3503. The yellow-breasted chat has no federal regulatory status; however, the species is protected under the federal Migratory Bird Treaty Act.

2A.27.2 Species Distribution and Status

2A.27.2.1 Range and Status

The yellow-breasted chat is a neotropical migrant songbird. Its breeding range extends from southern Canada to Mexico (McKibbin and Bishop 2010). The southern extent of its breeding range is in Mexico and Guatemala, although a few birds winter in southern California (Small 1994). Yellow-breasted chats are widespread summer residents of eastern North America; however, they have a much more fragmented distribution in western North America (U.S. Forest Service 2008). In western North America, their range includes southeast Alberta, southern Saskatchewan, southwest and south-central British Columbia, the Cascade Range; central Oregon valleys; southern Idaho and northern Nevada; and portions of California, Utah, western Colorado, and central Arizona (Eckerle and Thompson 2001; U.S. Forest Service 2008; McKibbin and Bishop 2010).

Grinnell and Miller (1944) reported that chats bred over the entire length and breadth of California exclusive of higher mountains and coastal islands, and were more numerous toward the interior. In migration, chats were similarly widespread with fewer restrictions as to habitat (dense riparian plant growth). In California, the species' current range is not completely known because of population declines (Small 1994); however, the species is thought to inhabit most of its historical range, with the exception of most of the Central Valley (Comrack 2008) (Figure 2A.27-1).

This species was formerly a common summer resident in coastal southern and central California, along the Colorado River, and throughout the Central Valley (Grinnell and Miller 1944). However, the species is currently reported as an uncommon resident in riparian habitats on the Modoc Plateau, Klamath Mountain region, along the north and south Coast Ranges, in the Sierra Nevada foothills, and in the Transverse and Peninsular Ranges (Small 1994; Eckerle and Thompson 2001). It appears to be extirpated from the San Joaquin and Sacramento valleys, but still occurs along some foothill tributaries.

Few data are available regarding population decreases or increases over large sections of the species' range (Eckerle and Thompson 2001). California Breeding Bird Survey data from 1966 through 1998 show an population increase trend of 1.1% per year (Sauer et al. 1999; Ricketts and Kus 2000). However, these data are not considered statistically significant and should be

interpreted with caution (Ricketts and Kus 2000). The species has apparently declined dramatically in southern California (Garrett and Dunn 1981).

2A.27.2.2 Distribution and Status in the Plan Area

Comrack (2008) includes the central Sacramento–San Joaquin River Delta (Delta) within the current breeding range of the yellow-breasted chat. There are few breeding records of yellow-breasted chat from this area or elsewhere within the Plan Area (Figure 2A.27-2). Most are fall and winter migrants found along Putah Creek near the northern edge of the Plan Area in Yolo and Solano Counties or along the Cosumnes River in the Cosumnes River Preserve. The National Audubon Society (2008) notes that several pairs of yellow-breasted chat have been recorded at several locations in the Delta, including Liberty Island, Sherman Island, and Piper Slough. However, no additional information confirmed nesting activity at these locations. Comrack (2008) also reported breeding records from the Contra Costa Breeding Bird Atlas within the Delta and additional breeding records from White Slough in San Joaquin County. Recent field surveys have confirmed late-spring and summer occurrences of chats within the Plan Area (Delta Habitat Conservation and Conveyance Program 2011). A total of 51 nest sites were identified from 2009 to 2011 (Delta Habitat Conservation and Conveyance Program 2011).While breeding was not confirmed, this suggests a reasonable possibility that the species is breeding in the Plan Area.

2A.27.3 Habitat Requirements and Special Considerations

Yellow-breasted chats nest and forage in dense riparian thickets of willows, vines, and brush associated with streams and other wetland habitats (Small 1994; Ricketts and Kus 2000). The species has been classified as an open-canopy obligatory species (i.e., it prefers open overstory and brushy understory), with population density directly related to shrub density to a height of 4.5 meters (14.8 feet) (Crawford et al. 1981). Some taller trees, such as tall willows (*Salix* spp.), cottonwood (*Populus* spp.), alder (*Alnus* spp.) and sycamore (*Platanus* spp.) are also required for song perches (Dunn and Garrett 1997). Several studies indicate a strong association with early successional vegetation, including clearcut areas and powerline corridors with dense shrubby vegetation such as Himalayan blackberry (*Rubus armeniacus*), wild grape (*Vitis* spp.), and/or willows, with sapling-sized trees as opposed to mature riparian forest (Kroodsma 1982; Melhop and Lynch 1986; Annand and Thompson 1997; Comrack 2008). Kroodsma (1982) also reported a preference for blackberry thickets and avoidance of areas with a high percentage of grass cover.

Yellow-breasted chats occur up to 1,463 meters (4,800 feet) in valley foothill riparian habitats and up to 1,981 meters (6,499 feet) east of the Sierra Nevada in desert riparian habitats (DeSante and Ainley 1980; Garrett and Dunn 1981; Gaines 1992). Nests are usually constructed within 1 meter of the ground but can be placed up to 2.4 meters from the ground (Ehrlich et al. 1988) in dense shrubs (Barber and Martin 1997; Ricketts 1999).

A variety of trees and shrubs are used as nest substrate, including willow, alder, and several shrub species, including blackberry. At the Lower Clear Creek Floodway in Shasta County, Burnett and DeStaebler (2003) found that most chat nests were associated with Himalayan blackberry. Other species used for nesting include California blackberry (*Rubus californica*), California wild rose (*Rosa californica*), and pipevine (*Aristolochia californica*) (Ricketts and Kus 2000). Additionally, chats have

been found to use saltcedar (*Tamarix* spp.) preferentially to native habitat (Hunter et al. 1988). During migration, yellow-breasted chats use habitat similar to their breeding habitat (Dunn and Garrett 1997).

2A.27.4 Life History

2A.27.4.1 Description

The yellow-breasted chat is the largest of the North American warblers (average total length equals 18 centimeters [7.1 inches]; average wing length equals 17.8 centimeters [7.0 inches]; average weight equals 25 grams [0.88 ounces]). The sexes are similar, with plain olive-green to olive-gray upper parts, a deep yellow throat and breast, and a grayish face with black lores, white supercilium, and whitish spectacles contrasting with the surrounding feathers (Dunn and Garrett 1997; Eckerle and Thompson 2001).

2A.27.4.2 Seasonal Patterns

Yellow-breasted chats are migratory and usually arrive at California breeding grounds in April from their wintering grounds in Mexico and Guatemala (Green 2005). Northern populations may arrive at breeding grounds from late April to early May (Ricketts and Kus 2000). In the Sierra Nevada, they may move upslope after breeding (Gaines 1992). Departure for wintering grounds occurs from August to September (Ricketts and Kus 2000). Spring migration occurs from March to May (Dunn and Garrett 1997).

Little information is available on juvenile dispersal. Banding studies in Indiana showed that many juveniles moved away from the forests where they were born. Data on dispersal after breeding are also scarce. Data from the eastern United States indicate an extremely low fidelity to breeding sites between years; however, in southern California, the limited amount of available habitat may foster a higher level of breeding site fidelity (Eckerle and Thompson 2001).

2A.27.4.3 Reproduction

Yellow-breasted chats breed from early May to early August, with peak breeding activity occurring in June (Green 2005). Males arrive at breeding grounds before females (Eckerle and Thompson 2001). Pairs are monogamous, although pairs may nest near one another in loose colonies (Ehrlich et al. 1988). Following arrival at the breeding grounds, nests are constructed and three to six eggs are laid from mid-May to mid-July (Thompson and Nolan 1973). Females incubate eggs for 11 to 15 days (Green 2005). Once eggs hatch, both sexes tend to the nestlings until they fledge (Harrison 1978). Approximately 8 to 11 days are required for fledging (Petrides 1938; Green 2005). They will occasionally produce a second brood in the season. Of 24 females nesting in southern Indiana for which all nesting attempts within a single year were known, only 2 (8%) had a second brood (Thompson and Nolan 1973). However, recent stable isotope analysis showed that some yellow-breasted chats, breed in the north, and then migrate to coastal Mexico or Baja California Sur to breed a second time (Rohwer et al. 2009). Survival rates of fledglings are unknown.

2A.27.4.4 Foraging Behavior and Diet

Chats forage by foliage gleaning, consuming insects and berries about equally (Ehrlich et al. 1988; Green 2005). Adults feed on a variety of arthropods, including beetles and weevils, true bugs, ants, bees, caterpillars, and spiders. Nestlings are typically fed a diet of soft-bodied orthopterans (e.g., grasshoppers) and larval lepidopterans (Petrides 1938). In late summer and fall, chats feed largely on small fruits, such as the fruits of honeysuckle, wild strawberry, blackberry, mulberry, chokecherry, sumac, and nightshade (Dunn and Garrett 1997).

2A.27.4.5 Home Range and Territory Size

Yellow-breasted chats typically nest in loose colonies, although males usually defend distinct territories (Ehrlich et al. 1988). Territorial defense appears to be less effective as population densities increase (Eckerle and Thompson 2001). Territory size ranges from 0.3 to 3.2 acres (0.1 to 1.3 hectares) (Zeiner et al. 1990). Thompson and Nolan (1973) reported 28 territories averaging 3.2 acres (1.3 hectares) in Indiana and reported that territory sizes decreased as more males arrived. Brewer (1955) reported territories averaging 0.3 acres (0.1 hectares) and varying from 0.1 to 0.7 acres (0.04 to 0.3 hectares) in Illinois. Dennis (1958) reported territory varying from 1.2 to 2.5 acres (0.5 to 1.0 hectares) in Virginia. Territory sizes have not been measured in California, but in California riparian habitat, breeding densities ranged from 6.5 to 27 males per 100 hectares (Eckerle and Thompson 2001) and Gaines (1974) reported a breeding density from the Sacramento Valley of one chat per 10 acres (4 hectares). Although some known breeding sites are consistently active each year, some data suggest low site fidelity (Thompson and Nolan 1973).

2A.27.5 Threats and Stressors

2A.27.5.1 Habitat Loss and Alteration

A major factor leading to declines in populations of yellow-breasted chats is the loss and degradation of riparian woodland habitat throughout the species' range (Remsen 1978; Rosenberg et al. 1991). Habitat loss and degradation can occur through clearing of vegetation for agriculture, timber harvest, development, or flood control.

Flood control and river channelization eliminates early successional riparian habitat (willow/alder shrub habitats with a dense understory) that chats (and many other riparian focal species) use for breeding (Ricketts and Kus 2000).

Timber harvest may have initial negative impacts on nesting chats; however, Annand and Thompson (1997) noted that chats preferred clearcut areas, suggesting that timber harvest impacts may be temporary and could ultimately have a beneficial impact in some situations.

Grazing can also have a significant effects on riparian vegetation (Sedgwick and Knopf 1987). Cattle and other livestock can trample vegetation and eat seedlings, saplings, shrubs, and herbaceous plants. This can lead to a reduction in cover and nesting sites and affect insect prey populations (Eckerle and Thompson 2001).

2A.27.5.2 Cowbird Parasitism

Brown-headed cowbirds (*Molothrus ater*) may significantly affect yellow-breasted chats by laying eggs in chats' nests in a phenomenon called brood parasitism (Gaines 1974; Remsen 1978). The chat is among the 17 hosts most parasitized by cowbirds (Ricketts and Kus 2000). In a 3-year study in Missouri, 31% of nests were parasitized by cowbirds (Burhans and Thompson 1999). While data are limited on the extent of cowbird parasitism on yellow-breasted chats in California, parasitism could have a significant impact on local reproductive performance. However, research conducted at the Lower Clear Creek Floodway in Shasta County suggest that low nest success is driven by predation rather than nest parasitism and is a likely factor contributing to observed declines (Young and Burnett 2010).

2A.27.5.3 Predation

Yellow-breasted chats are subject to occasional predation by accipiters, small mammals, and snakes (Green 2005). Potential nest predators in California include western scrub-jays (*Aphelocoma californica*), American crows (*Corvus brachyrhynchos*), common ravens (*Corvus corax*), black rats (*Rattus rattus*), dusky-footed woodrats (*Neotoma fuscipes*), raccoons (*Procyon lotor*), and several species of snakes (Ricketts and Kus 2000). Predation of nests may be intensified where insufficient riparian scrub cover or insufficient riparian width occurs, potentially reducing reproduction and recruitment (Green 2005).

2A.27.6 Relevant Conservation Efforts

There have been few conservation efforts directed toward yellow-breasted chats in California. Efforts to protect and restore riparian systems can potentially preserve or create habitat for this species. Some regional habitat conservation planning efforts may also protect the species, primarily through preserving existing occupied habitat. Neighboring habitat conservation plan/natural community conservation plans finalized or in progress plans that include the yellow-breasted chat as a covered species include the following: *Yolo Natural Heritage Program Plan Habitat Conservation Plan/natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the South Sacramento County Habitat Conservation Plan (Sacramento County 2010), and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.27.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, Species *Habitat Suitability Model Methods*.

2A.27.7.1 GIS Model Data Sources

The yellow-breasted chat model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf

2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]). Using these data sets, the model maps the distribution of suitable yellow-breasted chat nesting and migratory habitat in the Plan Area using two qualitative parameters, primary habitat and secondary habitat. Vegetation types were assigned based on the species requirements, as described above, and the assumptions described below.

2A.27.7.2 Habitat Model Description

The yellow-breasted chat habitat model is made up of three components: nesting (Delta), migratory (Delta), and nesting and migratory (Suisun). Yellow-breasted chat nesting and migratory habitat consists of all valley riparian types with a shrub component that includes blackberry, California wild rose, dogwood, coyote bush, willow, and other shrub species, and an overstory component that includes valley oak, coast live oak, Fremont cottonwood, white alder, box elder, Oregon ash, willow, or walnut. Distinguishing primary from secondary habitat within the Delta was based on a qualitative assessment of the suitability of the understory and overstory layers within each type. Types that are classified as primary habitat support a greater percentage of cover of a suitable shrub layer, particularly blackberry and California wild rose, and also have an open to moderately dense overstory canopy. Determining whether a riparian habitat was considered primary or secondary habitat in the Delta was done through a review of the species associations and ranges of percentage cover from Hickson and Keeler-Wolf (2007). Because this information was not available in the Suisun Marsh data set (Boul and Keeler-Wolf 2008), the nesting and migratory model components were not similarly differentiated.

The nesting and migratory model components in the Delta consist of the following valley riparian types from the BDCP composite vegetation layer.

- Nesting habitat
  - White alder (*Alnus rhombifolia*)
  - *Alnus rhombifolia*/*Salix exigua* (*Rosa californica*)
  - *Acer negundo*–*Salix gooddingii*
  - Hinds' walnut (*Juglans hindsii*)
  - Black willow (*Salix gooddingii*)
  - *Salix gooddingii*–*Populus fremontii* (*Quercus lobata*–*Salix exigua*–*Rubus discolor*)
  - *Salix gooddingii*/*Rubus discolor*
  - Coast live oak (*Quercus agrifolia*)
  - *Quercus lobata*/*Rosa californica* (*Rubus discolor*–*Salix lasiolepis*/*Carex* spp.)
  - *Quercus lobata*–*Acer negundo*
  - *Quercus lobata*–*Alnus rhombifolia* (*Salix lasiolepis*–*Populus fremontii*–*Quercus agrifolia*)
  - *Quercus lobata*–*Fraxinus latifolia*
  - *Salix lasiolepis*–mixed brambles (*Rosa californica*–*Vitis californica*–*Rubus discolor*)
  - *Salix exigua* (*Salix lasiolepis*–*Rubus discolor*–*Rosa californica*)

- Migratory habitat
  - *Alnus rhombifolia*/*Cornus sericea*
  - Oregon ash (*Fraxinus latifolia*)
  - Box elder (*Acer negundo*)
  - Fremont cottonwood (*Populus fremontii*)
  - *Salix gooddingii*/wetland herbs
  - *Salix gooddingii–Quercus lobata*/wetland herbs
  - Coyote bush (*Baccharis pilularis*)
  - Blackberry (*Rubus discolor*)
  - California wild rose (*Rosa californica*)
  - Mexican elderberry (*Sambucus mexicana*)
  - California dogwood (*Cornus sericea*)
  - *Cornus sericea–Salix exigua*
  - *Cornus sericea–Salix lasiolepis*/(*Phragmites australis*)
  - Arroyo willow (*Salix lasiolepis*)
  - *Salix lasiolepis–Cornus sericea/Scirpus* spp./*Scirpus* spp. (*Phragmites australis–Typha* spp.) complex unit
  - Shining willow (*Salix lucida*)
  - Narrow-leaf willow (*Salix exigua*)

Modeled nesting and migratory habitat in Suisun Marsh consists of the following valley riparian types from the BDCP composite vegetation layer.

- *Fraxinus latifolia*
- Fremont cottonwood-valley oak-willow riparian forest (ash-sycamore) not formally defined (NFD) association
- Mixed Fremont cottonwood–willow species, NFD alliance
- Mixed willow super alliance
- *Quercus agrifolia*
- *Rosa californica*
- *Rosa*/*Baccharis*
- *Rubus discolor*
- *Salix laevigata*/*S. lasiolepis*
- *Salix lasiolepis*/*Quercus agrifolia*
- Valley oak alliance–riparian
- Willow trees

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area, so most of the new analysis areas were mapped at the natural community level. For yellow-breasted chat, additional areas mapped as nesting and migratory habitat included the following vegetation types.

- Valley/foothill riparian
  - Intermittently flooded to saturated deciduous shrubland
  - Mixed willow super alliance
  - Valley oak (*Quercus lobata*)
  - Valley oak alliance–riparian
- Vernal pool complex

2A.27.7.3 Assumptions

- **Assumption:** Yellow breasted chat habitat is restricted to the vegetation types described in Section 2A.27.7.2, *Habitat Model Description*.

  Rationale: Yellow-breasted chats nest and forage in dense riparian thickets of willows, vines, and brush associated with streams and other wetland habitats (Small 1994). Population density is directly related to shrub density (Crawford et al. 1981), with a preference for blackberry noted in several studies (Kroodsma 1982; Burnett and DeStaebler 2003), although a variety of other shrubs and thickets are considered suitable, including wild grape, willows, and California wild rose (Melhop and Lynch 1986; Annand and Thompson 1997; Ricketts and Kus 2000; Comrack 2008). While uncommon, there are historical and several relatively recent breeding records of chats within the Plan Area, and late spring and summer occurrences of chats have been confirmed by surveys (Delta Habitat Conservation and Conveyance Program 2011). Vegetation types that are listed as primary habitat are considered to have a higher probability of breeding activity, and while chats generally use similar habitat during the breeding and nonbreeding seasons, both the primary and secondary types are considered suitable migratory habitat.

2A.27.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species, and no recovery goals have been established.

2A.27.9 References Cited

2A.27.9.1 Literature Cited

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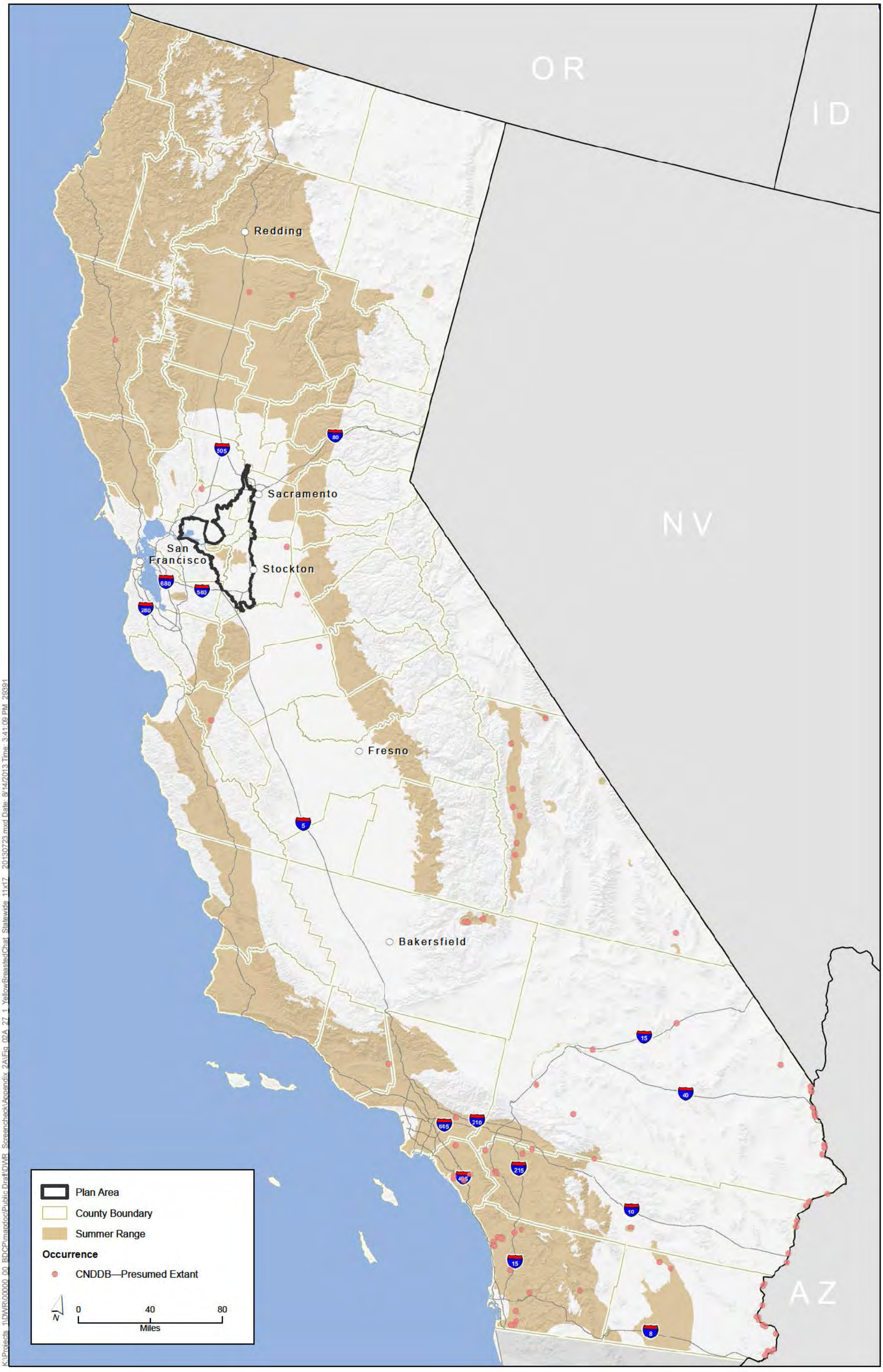
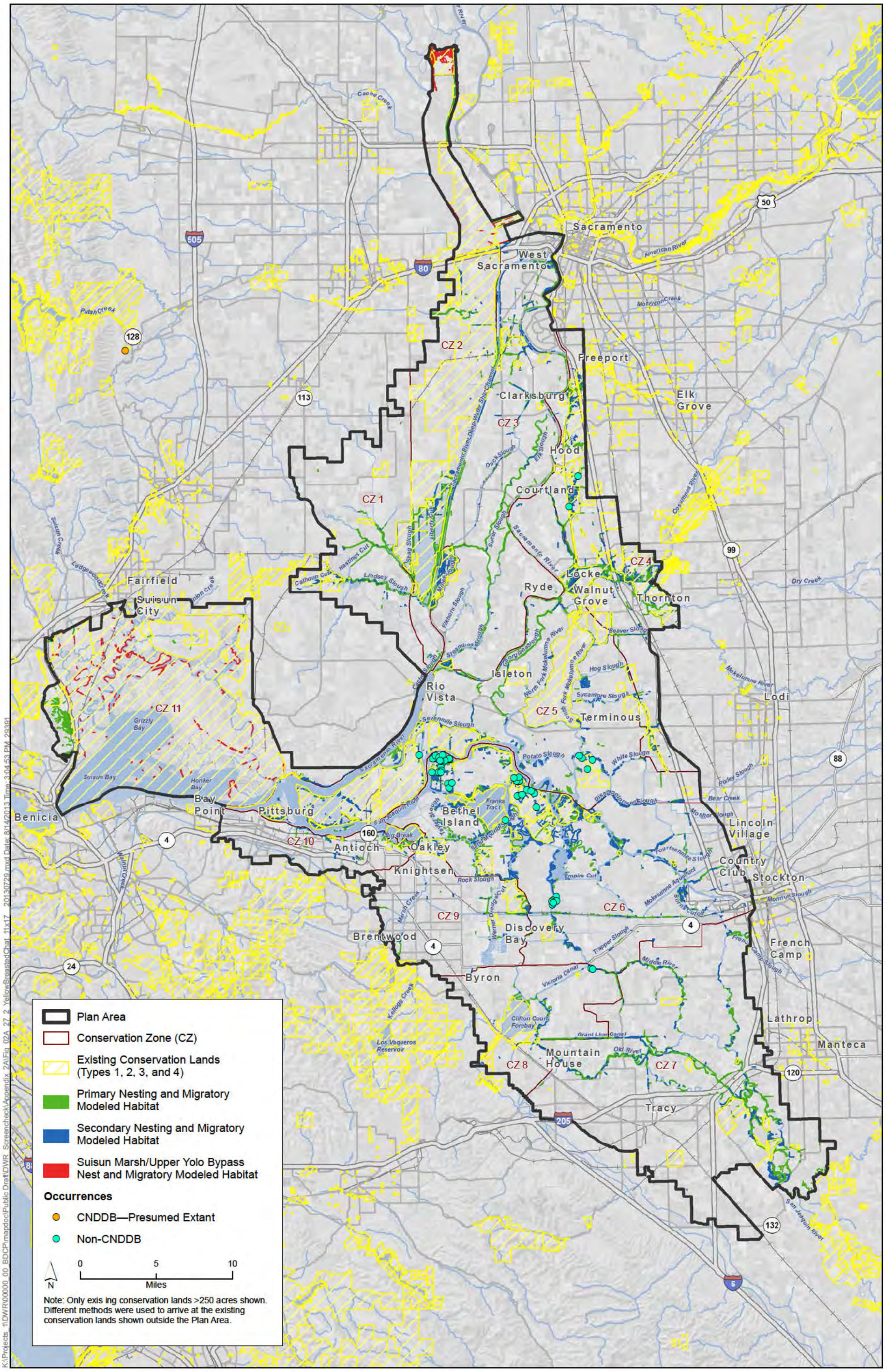


GIS Data Sources: Occurrences, CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.27-1
Yellow-Breasted Chat Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013, and DHCCP 2009-2011.

Figure 2A.27-2
Yellow-Breasted Chat Habitat Model and Recorded Occurrences

Appendix 2A.28
Giant Garter Snake (*Thamnophis gigas*)

2A.28.1 Legal Status

The U.S. Fish and Wildlife Service (USFWS) listed the giant garter snake (*Thamnophis gigas*) as federally threatened on October 20, 1993 (58 *Federal Register* [FR] 54053). The State of California listed the species as state threatened on June 27, 1971 (California Department of Fish and Game 2008). The *Draft Recovery Plan for the Giant Garter Snake* was completed in 1999 (U.S. Fish and Wildlife Service 1999) and a 5-year review was initiated in 2011 (76 FR 30377). USFWS is currently preparing a revised draft recovery plan for the giant garter snake. Critical habitat has not been designated for this species.

2A.28.2 Species Distribution and Status

2A.28.2.1 Range and Status

The giant garter snake is endemic to wetlands in the Sacramento and San Joaquin Valleys and was historically distributed throughout the San Joaquin Valley (Hansen and Brode 1980). Its current distribution extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County (Figure 2A.28-1). No occurrences of giant garter snakes are known from the northern portion of the San Joaquin Valley north to the eastern fringe of the Sacramento–San Joaquin River Delta (Delta), where the floodplain of the San Joaquin River is limited to a relatively narrow trough (Hansen and Brode 1980; 58 FR 54053). The resulting gap of approximately 75 kilometers (46.6 miles) separates the southern and northern populations, with no giant garter snakes known from the lowland regions of Stanislaus County (Hansen and Brode 1980; California Department of Fish and Game 2011).

Occurrence records indicate that giant garter snakes are currently distributed in 13 unique population clusters coinciding with historical flood basins, marshes, wetlands, and tributary streams of the Central Valley (Hansen and Brode 1980; Brode and Hansen 1992; U.S. Fish and Wildlife Service 1999). These populations are isolated, without protected dispersal corridors to other adjacent populations, and are threatened by land use practices and other human activities, including development of wetland and suitable agricultural habitats. USFWS recognizes these 13 extant populations (58 FR 54053), including Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin-Willow Slough, Yolo Basin-Liberty Farms, Sacramento Basin, Badger Creek-Willow Creek, Coldani Marsh, East Stockton Diverting Canal and Duck Creek, North and South Grassland, Mendota, and Burrel-Lanare. These populations extend from Fresno north to Chico and encompass 11 counties: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties.

2A.28.2.2 Distribution and Status in the Plan Area

The Plan Area is in the Mid-Valley Recovery Unit identified in the draft recovery plan (U.S. Fish and Wildlife Service 1999), and three of the thirteen giant garter snake populations identified by USFWS occur in the Plan Area, including Yolo Basin/Willow Slough, Yolo Basin/Liberty Farms, and Coldani Marsh/White Slough populations (U.S. Fish and Wildlife Service 1999).

Recent survey efforts suggest that extant giant garter snake populations continue to persist mainly in the periphery of the Plan Area in two locations north of the San Joaquin River, including the Yolo Bypass from the Yolo Basin Wildlife Area north to Willow Slough area and Coldani Marsh/White Slough area in the eastern Delta. The few isolated records occurring within most of the Delta suggest the lack of other extant populations; and that while giant garter snakes may have occupied this region at one time, longstanding reclamation of wetlands for intense agricultural applications has eliminated most suitable habitat (Hansen 1986) and prevented the re-establishment of viable giant garter snake breeding populations.

The California Natural Diversity Database (CNDDB) (California Department of Fish and Game 2011) reports 26 presumed extant giant garter snake occurrences sparsely distributed north of State Route (SR) 4 in the central and northern Delta portions of the Plan Area (Figure 2A.28-2). Five are west of the Sacramento Deep Water Ship Channel in the wetlands and pasturelands of the Yolo Basin; five are from the cultivated and remnant grassland areas east of the Sacramento River north of Walnut Grove; three are from the vicinity of White Slough south of SR 12 and west of Interstate 5 (I-5); and five are in the central Delta, including two reported from the vicinity of Sherman Island. There are eight additional CNDDB occurrences north of Interstate 80 in the northernmost extent of the Plan Area. With the exception of recent detections made from the Yolo Basin, most of these CNDDB records are from the mid-1980s (California Department of Fish and Game 2011). There are no records from the area west of the Sacramento and Mokelumne Rivers and east of the Deep Water Ship Channel north of SR 12. There are only two records south of the San Joaquin River and none south of SR 4. Recent findings demonstrate that the giant garter snake appears extant in portions of the Yolo Basin (Wylie et al. 2003, 2004; Wylie and Amarello 2006; Hansen 2007, 2009; Hansen pers. comm.; California Department of Fish and Game 2011), and at Coldani Marsh/White Slough (Hansen 2011; Hansen pers. comm.) (Figure 2A.28-2).

Historically, giant garter snakes occurred in both the south and north Delta regions (Hansen and Brode 1980; Hansen 1988; California Department of Fish and Game 2011). Individuals have been observed in the north Delta region east of the Sacramento River at North Stone Lake, Beach Lake, and near Locke (California Department of Fish and Game 2011). The species also was recorded on Sherman Island near the Antioch Bridge north of the City of Oakley (California Department of Fish and Game 2011; Hansen pers. comm.). Other documented occurrences are distributed around the periphery of the north and east Delta. The extent to which these historically occupied areas represent viable breeding populations is unclear, given agricultural conversion of much of the Delta. Nonetheless, survey efforts since the mid-1980s suggest that much of the Delta is unoccupied or supports few giant garter snakes.

Still, Hansen (1988) reported that although the major permanent waterways of the Delta are apparently unsuitable for the giant garter snake, small backwater sloughs and toe drains support suitable habitat for, and thus could potentially support, small numbers of giant garter snakes.

The following describes the historical and current survey work and occurrence information in the Plan Area.

2A.28.2.2.1 South Delta

During 1987 and 1988, live trapping and visual surveys were conducted at various locations in the California Department of Water Resources (DWR) South Delta Water Management Project area ,including Trapper Slough, Salmon Slough, and along the irrigation canal at SR 4 near the Clifton Court Forebay expansion area. No giant garter snakes were observed during either year, although virtually all islands and channels contained some suitable habitat (ECOS 1990).

In 1994, surveys were conducted to determine the status of the giant garter snake in DWR's Interim South Delta Project area. The purpose of this study was to focus on particular areas containing the most suitable habitat and to conduct live trapping as well as additional ground surveys. Ground surveys for giant garter snakes were undertaken during previous work in the south Delta region in 1987, 1988, and 1993. Although no giant garter snakes were observed during any of these surveys, suitable habitat for the snake was present in some of the more remote sloughs and waterways in the project area (e.g., Tom Paine Slough, Salmon Slough, and Paradise Cut). Based on the presence of apparently suitable habitat, the potential for isolated populations of the giant garter snake was not ruled out (Miriam Green Associates 1995).

There are only two isolated records of giant garter snakes on the south side of the San Joaquin River in the northern aspect of the species' range. Although the historical and current distribution of giant garter snake in the Delta is poorly understood, the south bank of the San Joaquin River lies within the apparent gap between the northern and southern populations (California Department of Fish and Game 2011). The isolated records on Sherman Island represents the northern population's known southern extent in the Plan Area. The known southern terminus of the northern population outside of the Plan Area occurs north and east of the San Joaquin River in Duck Creek (California Department of Fish and Game 2011). The nearest locality record to the south lies approximately 50 air miles distant in Merced County; no giant garter snakes are documented in Stanislaus County between the documented extremes of the Sacramento Valley and San Joaquin Valley populations.

2A.28.2.2.2 North Delta

Surveys were also conducted to determine the status of giant garter snakes in DWR's Interim North Delta Program area (Miriam Green Associates 1996). The species was observed at scattered locations in the program area during 1994 surveys, but was not encountered in the major waterways of the North Delta. The species was observed in marsh and canal habitats along the Upland Canal from the confluence of Sycamore Slough and the Upland Canal south to the vicinity of White Slough on the Terminous and Shin Kee Tracts. Giant garter snakes also occur in the Upland Canal and the Coldani Marsh, north and east of Shin Kee Tract, respectively (Miriam Green Associates 1996).

2A.28.2.2.3 Coldani Marsh/White Slough and Eastern Delta Fringe

Between 1974 and 1978, 13 rectangular borrow pits were excavated from 1 to 5 miles west of I-5 to provide fill for freeway construction (California Department of Water Resources 1995). The pits are fed by groundwater and periodic runoff from precipitation, irrigation, and high canal flows, creating a series of ponds characterized by vegetated sloping or vertical banks and open water with adjacent uplands and high ground. White Slough Wildlife Area encompasses ponds 7 through 13 along a roughly 14-mile (22.5-kilometer) stretch between Thornton and Stockton.

The White Slough Wildlife Area supports one of 13 extant giant garter snake populations recognized by USFWS (Coldani Marsh/White Slough population) (U.S. Fish and Wildlife Service 1999). First identified on site in 1974 (California Department of Fish and Game 2011), giant garter snakes were observed at the White Slough Wildlife Area from 1976 until the mid-1990s (Hansen and Brode 1980; Hansen 1988, 1996). Among sites supporting two giant garter snake populations recognized in San Joaquin County, the White Slough location is perhaps the only locality still supporting a viable snake population.

Most giant garter snake observations at White Slough Wildlife Area are concentrated at Pond 9, but surveys conducted by George Hansen in 1994 yielded additional sightings at Pond 7, Pond 11, and a site between Ponds 6 and 7 (California Department of Water Resources 1995; California Department of Fish and Game 2011). Although channels and drainages including Telephone Cut, Sycamore Slough, Hog Slough, and Beaver Slough were surveyed, observations were made only at the ponds (Green pers. comm.). Each of the ponds where snakes were observed are characterized by slow-moving water with mud banks and bottoms, vegetation cover, and access to high ground (California Department of Water Resources 1995).

In 2009 and 2010, under a grant provided by the Central Valley Project (CVP) Habitat Restoration Program, Hansen conducted rigorous trap and visual encounter sampling at Ponds 7–13 of the White Slough Wildlife Area to determine the current status and distribution of giant garter snake. Giant garter snakes were only confirmed within the emergent wetlands west of Pond 9 along the Upland Canal (Coldani Marsh), east of Guard Road and south of SR 12 (California Department of Fish and Game 2011; Hansen 2011; Hansen pers. comm.). In total, 27 snakes representing a normal age/size and gender distribution were captured.

Surveys conducted in and near Lost Slough in 1996 and 2004 failed to detect giant garter snakes east of I-5 (Hansen 2004a; Wylie pers. comm.).

2A.28.2.2.4 Antioch/Oakley and West Delta

Recent, intensive trapping surveys conducted within Contra Costa County independently by Eric Hansen and by Swaim Biological have failed to detect giant garter snakes. Likewise, Swaim Biological intensively trapped in regions northeast of Oakley in 2003 and 2005, including Marsh Creek, Big Break, and Contra Costa Canal, without success (Swaim Biological 2004;2005a, b, c, d, e, f; 2006). With few exceptions, these surveys spanned 3 to 5 months of the species' active period. Swaim Biological also rigorously investigated bullfrog stomach contents to see if undetected giant garter snakes had been consumed; none was detected. While all of these surveys produced captures of common snake species, giant garter snakes were not detected, and, in all cases, it was determined that the area did not support resident breeding populations of giant garter snakes. Each report cited marginal habitat value as a probable explanation for the species' absence.

2A.28.2.2.5 Central Delta

In support of DWR's Delta Wetlands Project, Eric Hansen intensively trapped for giant garter snakes on Webb Tract and on Bacon Island in 2003 and 2004 without success (Patterson and Hansen 2004; Patterson 2005). Ongoing 2009 surveys in the central Delta conducted by DWR have resulted in no giant garter snake occurrences (Patterson pers. comm.).

2A.28.2.2.6 Yolo County and Yolo Bypass

Giant garter snakes are documented in two distinct concentrations along the eastern edge of Yolo County (Hansen 2006, 2007, 2008; Wylie and Amarello 2006; California Department of Fish and Game 2011). The first concentration lies north of the Yolo Basin in the northeastern portion of Yolo County, northwest of Knights Landing and in the southern end of the Colusa Basin near Sycamore Slough and the Colusa Basin Drainage Canal. Wylie and Amarello (2006) report a population density in the Colusa Basin Drainage Canal of 20 plus or minus 3 snakes per kilometer (0.6 mile) during 2006, falling within 2003 and 2004 confidence intervals; noting, however, that local distribution appears to have shifted away from areas formerly in rice production that have either been fallowed or converted to other crop types.

The second concentration lies in the east-central portion of Yolo County and corresponds with the USFWS Yolo Basin-Willow Slough population (U.S. Fish and Wildlife Service 1999). Recent records are from the Yolo Bypass east of Conaway Ranch near the Tule Canal; the Willow Slough/Willow Slough Bypass from Conaway Ranch south to the Yolo Wildlife Area; the Davis Wetlands complex south of Conaway Ranch between the Willow Slough Bypass and the Yolo Bypass; the Yolo Wildlife Area along the east edge of the Yolo Bypass west levee; and the adjacent rice fields west of the Yolo Wildlife Area (Hansen 2006, 2007, 2008) (Figure 2A.28-2).

Surveys conducted in 2005, 2006, and 2007 resulted in captures of 34, 9, and 1 unique individual(s), respectively, in the Yolo Wildlife Area; 8, 18, and 8 unique individuals, respectively, in the adjacent rice fields; and 36 unique individuals (2007 only) in the Davis Wetlands complex (Hansen 2006, 2007, 2008). Hansen (2006, 2007, 2008) reports an even distribution within size classes, estimating local populations ranging from approximately 8 to 57 in the Yolo Bypass at the Yolo Wildlife Area; approximately 5 to 17 in the adjacent rice fields; and from approximately 26 to 67 in the Davis Wetlands Complex (Hansen 2006, 2007, 2008), which lies along the western Yolo Bypass levee north of Interstate 80 (I-80).

In 2009, Eric Hansen trapped in all portions of Conaway Ranch, north of I-80 in the Yolo Bypass, capturing 64 giant garter snakes in a period of roughly 12 weeks (California Department of Fish and Game 2011; Hansen 2009; Hansen pers. comm.). Of the 64 individuals, 29 were captured in rice fields in the interior of the Yolo Bypass and 35 were captured in the land-side rice fields beyond the Yolo Bypass west levee.

The U.S. Geological Survey (USGS) conducted surveys for giant garter snake in 2004 and 2005 in the southern portion of the Yolo Basin near Cache Slough between Liberty Island and Lower Ulatis Creek in Solano County (Wylie and Martin 2005). Surveys were conducted in areas that supported habitat similar to known occupied sites and in areas where several historical occurrences were apparently reported. No giant garter snakes were found during these surveys (Wylie and Martin 2005).

While suitable habitat continues to persist along natural streams and artificial channels throughout much of the Delta, historical and recent occurrence records based on a substantial survey effort suggest two primary geographic areas that retain extant populations and probably a greater likelihood of potential occurrence and re-establishment of populations. These include the Yolo Bypass and vicinity west of the StocktonDeep Water Ship Channel and the eastern Delta fringe from approximately the Stone Lakes area south to Stockton and generally east of the Mokelumne River (Figure 2A.28-2).

2A.28.3 Habitat Requirements and Special Considerations

The giant garter snake resides in marshes, ponds, sloughs, small lakes, low-gradient streams, and other waterways, and in agricultural wetlands, including irrigation and drainage canals, rice fields, and the adjacent uplands (58 FR 54053). The species requires the following habitat elements.

- Adequate water during the snake's active season (early spring through mid-fall) to provide food and cover.
- Emergent, herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Schoenoplectus,* formerly *Scirpus*), accompanied by vegetated banks for escape cover and foraging habitat during the active season.
- Basking habitat of grassy banks and openings in waterside vegetation.
- High-elevation uplands for cover and refuge from floodwaters during the snake's dormant season in the winter (Hansen and Brode 1980; Hansen 1998; U.S. Fish and Wildlife Service 2006a).

In some rice-growing areas, giant garter snakes have adapted well to vegetated, artificial waterways and associated rice fields (Hansen and Brode 1993). The giant garter snake resides in small mammal burrows and soil crevices located above prevailing flood elevations throughout its winter dormancy period (U.S. Fish and Wildlife Service 2006a). Burrows are typically located in sunny exposures along south- and west-facing slopes.

Because of lack of habitat and emergent vegetation cover, giant garter snakes generally are not present in larger rivers and wetlands with sand, gravel, or rock substrates. In addition, the major rivers have been highly channelized, removing oxbows and backwater areas that probably at one time provided suitable habitat. Riparian woodlands can provide suitable habitat, but it is not likely because most have excessive shade, lack of basking sites, and absence of prey populations. Giant garter snakes are also usually absent from most permanent waters that support established populations of predatory game fishes and from sites that undergo routine dredging, mechanical or chemical weed control, or compaction of bank soils (Hansen and Brode 1980; Rossman and Stewart 1987; Brode 1988; U.S. Fish and Wildlife Service 1999, 2006a).

Changing agricultural regimes, development, and other shifts in land use create an ever-changing mosaic of available habitat. Giant garter snakes move around in response to these changes in order to find suitable sources of food, cover, and prey. Connectivity between regions is therefore extremely important for providing access to available habitat and for genetic interchange. In an agricultural setting, giant garter snakes rely largely on the interconnected network of canals and ditches that provide irrigation and drainage to provide this connectivity.

In the Central Valley, rice fields have become important habitat for giant garter snakes. Irrigation water typically enters the rice fields during April along canals and ditches. Giant garter snakes use these canals and their banks as permanent habitat for both spring and summer active behavior and winter hibernation. Where these canals are not regularly maintained, lush aquatic, emergent, and streamside vegetation develops prior to the spring emergence of giant garter snakes. This vegetation, in combination with cracks and holes in the soil, provides much-needed shelter and cover during spring emergence and throughout the remainder of the summer active period.

Rice is planted during spring, after the winter fallow fields have been cultivated and flooded with several inches of standing water. In some cases, giant garter snakes move from the canals and ditches into these rice fields soon after the rice plants emerge above the water's surface, and they continue to use the fields until the water is drained during late summer or fall (Hansen and Brode 1993). It appears that the majority of giant garter snakes move back into the canals and ditches as the rice fields are drained; a few may overwinter in the fallow fields, where they hibernate in burrows in the small berms separating the rice checks (low dikes) (Hansen 1998).

While in the rice fields, the snakes forage in the shallow, warm water for small fish and the tadpoles of bullfrogs and tree frogs. For shelter and basking sites, giant garter snakes use the rice plants, vegetated berms dividing the rice checks, and vegetated field margins. Gravid (pregnant) females may be observed in the rice fields during summer, and at least some giant garter snakes are born there (Hansen and Brode 1993; Hansen 1998).

Water is drained from the fields during late summer or fall by a network of drainage ditches. These ditches are sometimes routed alongside irrigation canals and are often separated from the irrigation canals by narrow vegetated berms that may provide additional shelter. Remnants of old sloughs also may remain within rice-growing regions, where they serve as drains or irrigation canals. Giant garter snakes may use vegetated portions along any of these waterways as permanent habitat. Studies indicate that despite the presence of ditches or drains, giant garter snakes will generally abandon aquatic habitat that is not accompanied by adjacent shallow-water wetlands (Wylie and Amarello 2006; Hansen 2007; Jones & Stokes 2008), underscoring the important role that this crop plays in this species' life history.

2A.28.4 Life History

2A.28.4.1 Description

Giant garter snakes are one of the largest snakes in the genus *Thamnophis*. A sexually dimorphic species, females can reach sizes in excess of 5.3 feet and 1.87 pounds (1.6 meters and 0.8 kilograms), while proportionally smaller males seldom exceed 0.55 pound (0.25 kilogram). Giant garter snakes possess a dark brown or olive background color separated by light-colored longitudinal stripes. For this species, coloration is geographically and individually variable. Snakes from the San Joaquin Valley region may exhibit a black-checkered pattern along the back and sides, and often lack a distinct dorsal stripe; snakes from the Sacramento Valley region are typically darker, with a complete dorsal stripe that varies from bright yellow to orange or dull brown.

2A.28.4.2 Activity

After spending cool winter months in dormancy or periods of reduced activity, giant garter snakes typically emerge from late March to early April and remain active through October; the timing of annual activity is subject to varying seasonal weather conditions. Daily activity consists of emerging from burrows after sunrise, basking to warm bodies to active temperatures, and foraging or courting for the remainder of the day (Hansen and Brode 1993). Activity generally peaks during spring emergence and courtship occurs from April into June, after which observations of giant garter snakes diminish significantly until a second peak is observed after females give birth during late July into August (Hansen and Brode 1993; Wylie et al. 1997; U.S. Fish and Wildlife Service 1999; Hansen

2004b). Giant garter snakes then remain actively foraging and occasionally courting until the onset of cooler fall temperatures.

Giant garter snakes are strongly associated with aquatic habitats, typically overwintering in burrows and crevices near active season foraging habitat (Hansen 2004b). Individuals have been noted using burrows as far as 164 feet (50 meters) from marsh edges during the active season, and retreating as far as 820 feet (250 meters) from the edge of wetland habitats while overwintering, presumably to reach hibernacula above the annual high watermark (Hansen 1986; Wylie et al. 1997; U.S. Fish and Wildlife Service 1999).

2A.28.4.3 Reproduction

Upon emerging from overwintering sites, male giant garter snakes immediately disperse in search of mates and continue breeding from March into early May. Female giant garter snakes brood young internally, giving birth to live young from late July through early September (Hansen and Hansen 1990). Brood size ranges from 10 to 46 young, with a mean of 23.1 (n = 19) (Hansen and Hansen 1990). Young immediately disperse and seek shelter to absorb their yolk sacs, after which they molt and begin feeding on their own. Averaging 0.11 to 0.18 ounce (3 to 5 grams) with a snout-to-vent length of approximately 8.1 inches (20.6 centimeters), young giant garter snakes will double their size within their first year (Hansen and Hansen 1990; U.S. Fish and Wildlife Service 1999). Sexual maturity probably averages 3 years in males and 5 years in females (U.S. Fish and Wildlife Service 1999).

2A.28.4.4 Home Range

Data based on radiotelemetry studies show that home range varies by location, with median home range estimates varying between 23 acres (range [10.3 to 203 acres], n = 8) (9 hectares, range = 4.2 to 82 hectares) in a semi-native perennial marsh system and 131 acres (range [3.2 to 2,792 acres], n = 29) (53 hectares, range = 1.3 to 1130 hectares) in a managed refuge (U.S. Fish and Wildlife Service 1999).

2A.28.4.5 Foraging Behavior and Diet

Giant garter snakes feed on small fishes, tadpoles, and small frogs (U.S. Fish and Wildlife Service 1999), specializing in ambushing prey underwater (Brode 1988). Historically, giant garter snakes preyed on native species such as the thick-tailed chub (*Gila crassicauda*) and California red-legged frog (*Rana aurora draytonii*) (which have been extirpated from the giant garter snakes' current range), as well as the Pacific tree frog (*Pseudacris regilla*) and Sacramento blackfish (*Orthodox microlepidus*) (Cunningham 1959; Rossman et al. 1996; U.S. Fish and Wildlife Service 1999). Giant garter snakes now use introduced species, such as small bullfrogs (*Rana catesbeiana*) and their larvae, carp (*Cyprinus carpio*), and mosquitofish (*Gambusia affinis*). While juveniles probably consume insects and other small invertebrates, giant garter snakes are not known to consume larger terrestrial prey such as small mammals or birds.

2A.28.5 Threats and Stressors

Habitat loss and fragmentation, flood control activities, changes in agricultural and land management practices, predation from introduced species, parasites, and water pollution are the main causes for the decline of this species.

2A.28.5.1 Habitat Loss and Fragmentation

Continued loss of wetland or other suitable habitat resulting from agricultural and urban development constitutes the greatest threat to this species' survival. Conversion of Central Valley wetlands for agriculture and urban uses has resulted in the loss of as much as 95% of historical habitat for the giant garter snake (Wylie et al. 1997). In areas where the giant garter snake has adapted to agriculture, maintenance activities such as vegetation and rodent control, bankside grading or dredging, and discharge of contaminates, threaten their survival (Hansen and Brode 1980; Hansen and Brode 1993; U.S. Fish and Wildlife Service 1999; Wylie et al. 2004). In developed areas, threats of vehicular mortality also are increased. Paved roads likely have a higher rate of mortalities than dirt or gravel roads due to increased traffic and traveling speeds. As many as 31 giant garter snake traffic mortalities have been reported during a 4-year period in the Natomas Basin (Hansen and Brode 1993).

The loss of wetland habitat is compounded by elimination or compaction of adjacent upland and associated bankside vegetation cover, as well as water fouling; these conditions are often associated with cattle grazing (Thelander 1994). While irrigated pastures may provide the summer water that giant garter snakes require, high stocking rates may degrade habitat by removing protective plant cover and underground and aquatic retreats such as rodent and crayfish burrows (Hansen 1986; U.S. Fish and Wildlife Service 1999). Studies of wandering garter snakes (*Thamnophis elegans vagrans*) in northern California have shown population numbers to be much higher in areas where grazing was excluded (Szaro et al. 1985). Radiotelemetry studies in perennial wetlands where grazing was differentially excluded show that giant garter snakes avoid areas where grazing is frequent (Hansen 2002). However, cattle grazing may provide an important function in controlling invasive vegetation that can compromise the overall value of wetland habitat (Hansen 2002).

2A.28.5.2 Predation

Giant garter snakes are also threatened by the introduction of exotic species. Examinations of gut contents confirm that introduced bullfrogs (*Lithobates catesbeianus*) prey on juvenile giant garter snakes throughout their range (Treanor 1983; Dickert 2003; Wylie et al. 2003). While the extent of this predation and its effect on population recruitment is poorly understood, estimates based on preliminary data from a study conducted at Colusa National Wildlife Refuge suggests that 22% of neonate (newborn) giant garter snakes succumb to bullfrog predation (Wylie et al. 2003). Other studies of bullfrog predation on snakes have documented bullfrogs ingesting other species of garter snakes up to 31.5 inches (80 centimeters) long, resulting in a depletion of this age-class within the population (Bury and Wheelan 1984).

Large vertebrates, including raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargenteus*), river otters (*Lutra canadensis*), opossums (*Didelphis virginiana*), northern harriers (*Circus cyaneus*), hawks (*Buteo* spp.), herons (*Ardea herodias, Nycticorax nycticorax*), egrets (*Ardea alba*, *Egretta thula*), and American bitterns (*Botaurus*

lentiginosus) also prey on giant garter snakes (U.S. Fish and Wildlife Service 1999). In areas near urban development, giant garter snakes may also fall prey to domestic or feral house cats. In permanent waterways, introduced predatory game fishes, such as bass (*Micropterus* spp.), sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus* spp.), prey on giant garter snakes and compete with them for smaller prey (58 FR 54053; Hansen 1998).

2A.28.5.3 Water Pollution

Selenium contamination and impaired water quality have been identified as a threat to giant garter snakes, particularly in the southern portion of their range (U.S. Fish and Wildlife Service 1999). While little data are available regarding the effects of specific contaminants, the bioaccumulative properties of selenium in the foodweb have been well documented in the Kesterson National Wildlife Refuge area (Ohlendorf et al. 1988; Saiki and May 1988; Saiki et al. 1991; U.S. Fish and Wildlife Service 1999).

2A.28.6 Relevant Conservation Efforts

Conservation efforts for the giant garter snake have included restoration efforts on wildlife refuges and through mitigation banking. With the continued loss of habitat within the range of the species, the snake has become increasingly dependent on ten refuges and wildlife management areas in the Central Valley (Czech 2006).

Hundreds of acres in the California refuge system are known to be occupied by the snake; however, thousands of acres of apparently suitable habitat in the refuge system are currently unoccupied (Czech 2006). This suggests that factors such as winter flooding and predation (especially by nonnative species such as bullfrogs) may be limiting in some areas. The giant garter snake prefers summer flooding and winter drying, and Central Valley refuges system properties are likely managed intensively for wintering waterfowl with a reversed water regime, resulting in habitat features that are problematic for giant garter snake conservation. These opposing requirements suggest that separate conservation areas for the snake are necessary. In 1995, the Colusa National Wildlife Refuge acquired 449 acres (182 hectares) of fallow rice fields, and efforts to restore the ecological integrity of the land have proven beneficial to the snake (Czech 2006).

Some mitigation banks are also designed specifically for giant garter snake habitat preservation and restoration, including the 565-acre (229-hectare) Gilsizer Slough South Giant Garter Snake Conservation Bank in Sutter County, and the 424-acre (172-hectare) Sutter Basin Conservation Bank. Giant garter snake mitigation banks in the Plan Area include the 379-acre (153-hectare) Pope Ranch in Yolo County and the 129-acre (52-hectare) South Stone Lakes Giant Garter Snake Preserve in Sacramento County.

Other wetland conservation efforts, under appropriate management regimes, can also benefit giant garter snakes. Central Valley wetland conservation occurs through both public and privately managed refuges, mitigation banks, and duck clubs, creating a large network of wetland preserves throughout the historical range of the giant garter snake. A large percentage of these wetland conservation efforts, however, are geared toward waterfowl management, often placing greater emphasis on winter water rather than the summer water upon which giant garter snakes depend (U.S. Fish and Wildlife Service 1999). With proper consideration given to design, location, and

management, these efforts might also significantly benefit the giant garter snake and other wetland-dependent species (U.S. Fish and Wildlife Service 1999).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the giant garter snake as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts. The program has funded several projects designed to supplement current knowledge of giant garter snake populations and habitat use. Two projects were recently funded that contain actions to benefit giant garter snake through ongoing monitoring of semipermanent wetlands, rice cover crop rotation fields, and waterways adjacent to agricultural lands. Another project will evaluate the effects of fallowing agricultural habitat on giant garter snake by monitoring habitat use under normal rice growing conditions and comparing results with analogous data from those same fields and adjacent irrigation ditches after fallowing. This project will also monitor habitat use on wetland restoration sites and assess population demographics and viability of the giant garter snake. Study areas for all three projects include Barker Slough and Hastings Cut in Yolo County, Gilsizer Slough in Sutter County, areas in Richvale Water District in Butte County, and various other rice fields and managed wetlands in Butte County. These coordinated projects were initiated in 2007 and are in the early stages of data collection. They are designed to provide information that will help guide future restoration and conservation activities as they pertain to managing rice farms and surrounding natural habitats for the giant garter snake. Continuing project activities include ongoing telemetry of radio-marked snakes to evaluate habitat use and behavior, and trapping of snakes to develop mark/recapture estimates. Results from these projects will support filling in some of the research data gaps for the giant garter snake, including determination of optimal habitat, effects of cropping patterns and specific agricultural practices on movement patterns and viability, value of restored habitats, and species status and distribution. Additionally, results from these research projects will directly facilitate future revisions of the conservation measures in this strategy.

In addition, the CALFED Bay-Delta Ecosystem Restoration Program implementing agencies have facilitated the development and preparation of the draft Sacramento Valley Giant Garter Snake Conservation Strategy. Giant garter snake is also a covered species under the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), and the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County 2006). The species is proposed for coverage in the *Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* currently under development (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.28.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, Species *Habitat Suitability Model Methods.*

2A.28.7.1 GIS Model Data Sources

The giant garter snake model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; TAIC 2008 [Yolo Basin]), DWR 2007 land use survey of the Delta area-version 3, land use survey of the Delta and Suisun Marsh area - version 3 (California Department of Water Resources 2007), and the USGS-National Hydrography Dataset, 1:24,000 (U.S. Geological Survey 1999). Using these data sets, the model maps the distribution of suitable giant garter snake habitat in the Plan Area. Vegetation types and spatial buffers were assigned based on the species' requirements as described above and the assumptions described below.

2A.28.7.2 Habitat Model Description

Modeled breeding, foraging, and movement habitat for the giant garter snake includes aquatic land cover types occurring throughout the Plan Area and Yolo Bypass north to Fremont Weir.

With the exception of Suisun Marsh (which lies outside of the species' acknowledged range), all perennial aquatic and emergent wetland habitat (described below) as well as artificial canals and ditches in the Plan Area and Yolo Basin were considered for including as aquatic habitat in the model. For this reason, a geographic information system (GIS) layer was developed to exclude habitat west of Sherman Island and the western tip of Sherman Island. The BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta] and TAIC 2008 [Yolo Basin]) data sets were used to characterize tidal and nontidal emergent wetland types and perennial aquatic vegetation types. The tidal perennial aquatic types were also used to characterize the shorelines of larger hydrologic features such as Liberty Island and Sacramento and San Joaquin Rivers, and the area within 20 feet (6 meters) of bank margins for inclusion in the model. The suitability of aquatic habitat types is not quantitatively ranked or qualitatively defined (e.g. high, moderate, or low value). Features are instead evaluated separately as tidal freshwater or nontidal freshwater types based on the differences in prey/predator and cover composition and relative stability of habitat associated with the different hydrographic profiles.

The model includes the following aquatic cover categories and associated types.

- Tidal aquatic habitat
  - Tidal freshwater perennial aquatic–all types
  - Tidal freshwater emergent wetland–all types
- Nontidal aquatic habitat
  - Nontidal freshwater emergent wetland–all types
  - Nontidal freshwater perennial aquatic–all types
  - Managed wetland (all except Suisun)
  - Bulrush–cattail freshwater marsh, not formally defined (NFD) super alliance (all except Suisun)
- Agriculture
  - Rice
  - Wild rice

Modeled upland overwintering and movement habitat for giant garter snakes includes all terrestrial land cover types immediately adjacent to and within 200 feet (61 meters) of the aquatic habitat types previously listed.

The suitability of each land cover type potentially providing suitable upland habitat is ranked on a scale of 1 to 5 (from lowest to highest habitat value) according to species associations within vegetation and cover types (U.S. Fish and Wildlife Service 2006b); rankings are then validated by referencing aerial imagery (U.S. Department of Agriculture 2005) and known sites in the field. The model includes the following upland and overwintering movement terrestrial land cover types, which are reported along with their associated value rankings.

- Agriculture
  - Native vegetation[1]–5
  - Non-irrigated mixed pasture–4
  - Non-irrigated native pasture–4
- Alkali seasonal wetland complex
  - Alkali heath (*Frankenia salina*)–5
  - *Allenrolfea occidentalis* mapping unit–5
  - Alkaline vegetation mapping unit–5
  - Creeping wild ryegrass (*Leymus triticoides*)–5
  - *Distichlis spicata*–annual grasses–5
  - Distichlis spicata–Juncus balticus–5
  - *Distichlis spicata*–*Salicornia virginica* (formerly *Sarcocornia*)–5
  - *Frankenia salina*–*Distichlis spicata*–5
  - *Juncus balticus*-meadow vegetation–5
  - Pickleweed (*Salicornia virginica*)–5
  - *Salicornia virginica*–*Cotula coronopifolia*–5
  - *Salicornia virginica*–*Distichlis spicata*–5
  - Salt scalds and associated sparse vegetation–5
  - Saltgrass (*Distichlis spicata*)–5
  - *Suaeda moquinii*–(*Lasthenia californica*) mapping unit–5
- Developed
  - Levee rock riprap–3
  - Unclassified–1

[1] Native vegetation is a land use designation within the DWR crop type dataset (2007). For the purposes of incorporating native vegetation classes into the correct species models and, when applicable, assigning habitat foraging values, the management on these lands most resembles that of native pasture, an irrigated pasture type.

- Grassland
  - *Bromus diandrus*–*Bromus hordeaceus*–5
  - California annual grasslands-herbaceous–5
  - Degraded vernal pool complex–California annual grasslands–herbaceous–5
  - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)–5
  - Italian ryegrass (*Lolium multiflorum*)–5
  - *Lolium multiflorum*–*Convolvulus arvensis*–5
  - Ruderal herbaceous grasses & forbs–5
  - Upland annual grasslands & forbs formation–5
  - Unclassified–5
- Inland dune scrub
  - *Lotus scoparius*-Antioch Dunes–2
  - *Lupinus albifrons*-Antioch Dunes–2
- Managed wetland
  - Barren gravel and sand bars–1
  - Bulrush–cattail fresh water marsh NFD super alliance–4
  - *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance–4
  - Intermittently flooded perennial forbs–4
  - Intermittently or temporarily flooded undifferentiated annual grasses and forbs–4
  - *Lepidium latifolium*–*Salicornia virginica*–*Distichlis spicata*–4
  - Managed alkali wetland (*Crypsis*)–4
  - Managed annual wetland vegetation (nonspecific grasses & forbs)–4
  - Perennial pepperweed (*Lepidium latifolium*)–4
  - Poison hemlock (*Conium maculatum*)–4
  - *Polygonum amphibium*–4
  - Rabbitsfoot grass (*Polypogon maritimus*)–4
  - *Schoenoplectus* (formerly *Scirpus*) spp. in managed wetlands–4
  - Seasonally flooded undifferentiated annual grasses and forbs–4
  - Shallow flooding with minimal vegetation at time of photography–2
  - Smartweed *Polygonum* spp. –mixed forbs–4
  - Temporarily flooded grasslands–4
- Other natural seasonal wetland
  - Degraded vernal pool complex-vernal pools–3

- *Juncus bufonius* (salt grasses)–4
- Santa Barbara sedge (*Carex barbarae*)–4
- Seasonally flooded grasslands–4
- Temporarily flooded perennial forbs–4
- Vernal pools–3

- Valley/foothill riparian
  - *Acacia–robinia*–2
  - *Acer negundo-Salix gooddingii*–2
  - *Alnus rhombifolia*/*Cornus sericea*–2
  - *Alnus rhombifolia*/*Salix exigua* (*Rosa californica*)–2
  - Arroyo willow (*Salix lasiolepis*)–2
  - *Baccharis pilularis*/annual grasses & herbs–2
  - Black willow (*Salix gooddingii*) –2
  - Black willow (*Salix gooddingii*) –valley oak (*Quercus lobata*) restoration–2
  - Blackberry (*Rubus discolor*)–3
  - Blackberry NFD super alliance–3
  - Box elder (*Acer negundo*)–2
  - Buttonbush (*Cephalanthus occidentalis*)–2
  - California dogwood (*Cornus sericea*)–2
  - California wild rose (*Rosa californica*)–3
  - Coast live oak (*Quercus agrifolia*)–2
  - *Cornus sericea–Salix exigua*–2
  - *Cornus sericea–Salix lasiolepis*/(*Phragmites australis*)–2
  - Coyote bush (*Baccharis pilularis*)–2
  - Fremont cottonwood–valley oak–willow (ash–sycamore) riparian forest NFD association–2
  - Fremont cottonwood (*Populus fremontii*)–2
  - Giant cane (*Arundo donax*)–1
  - Hinds' walnut (*Juglans hindsii*)–2
  - Horsetail (*Equisetum* spp.)–3
  - Intermittently flooded to saturated deciduous shrubland–3
  - Intermittently or temporarily flooded deciduous shrublands–3
  - Mexican elderberry (*Sambucus mexicana*)–2
  - Mixed Fremont cottonwood–willow spp. NFD alliance–2

  - Mixed willow super alliance–2
  - Narrow-leaf willow (*Salix exigua*)–2
  - Oregon ash (*Fraxinus latifolia*)–2
  - Pampas grass (*Cortaderia selloana–C. jubata*)–3
  - *Quercus lobata–Acer negundo*–1
  - *Quercus lobata–Alnus rhombifolia* (*Salix lasiolepis–Populus fremontii–Quercus agrifolia*)–1
  - *Quercus lobata–Fraxinus latifolia*–1
  - *Quercus lobata*/*Rosa californica* (*Rubus discolor–Salix lasiolepis*/*Carex* spp.)–1
  - Restoration sites–2
  - *Salix exigua*–(*Salix lasiolepis–Rubus discolor–Rosa californica*)–2
  - *Salix gooddingii–Populus fremontii*–(*Quercus lobata–Salix exigua–Rubus discolor*)–2
  - *Salix gooddingii–Quercus lobata*/wetland herbs–2
  - *Salix gooddingii*/*Rubus discolor*–2
  - *Salix gooddingii*/wetland herbs–2
  - *Salix lasiolepis*–(*Cornus sericea*)/*Schoenoplectus* spp. –(*Phragmites australis–Typha* spp.) complex unit–2
  - *Salix lasiolepis*–mixed brambles (*Rosa californica–Vitis californica–Rubus discolor*)–2
  - Shining willow (*Salix lucida*)–2
  - Temporarily or seasonally flooded–deciduous forests–2
  - Tobacco brush (*Nicotiana glauca*) mapping unit–2
  - Valley oak (*Quercus lobata*)–1
  - Valley oak (*Quercus lobata*) restoration–1
  - Valley oak alliance–riparian–1
  - White alder (*Alnus rhombifolia*)–2
  - White alder (*Alnus rhombifolia*) –arroyo willow (*Salix lasiolepis*) restoration–2
  - Unclassified–2
- Vernal Pool Complex
  - *Allenrolfea occidentalis* mapping unit–3
  - California annual grasslands–herbaceous–4
  - *Distichlis spicata*–annual grasses–4
  - Italian ryegrass (*Lolium multiflorum*)–3
  - Mixed *Schoenoplectus* mapping unit–3
  - Ruderal herbaceous grasses & forbs–3

- Salt scalds and associated sparse vegetation–3
- Saltgrass (*Distichlis spicata*)–4
- Seasonally flooded grasslands–3
- *Suaeda moquinii*–(*Lasthenia californica*) mapping unit–3
- Vernal pools–3

Once the land cover types were ranked, points were added to features on a scale of one to three (lowest to highest value), based on proximity to historical and recent occurrence records: one point for less than 10 miles, two points for less than 5 miles, and three points for less than 1 mile from occurrence records (California Department of Fish and Game 2011; Hansen pers. comm.). Each feature was then defined qualitatively (high, moderate, and low value) based on its numeric score. Qualitative value classes, their cumulative point ranges, and their general attributes with regard to the species' life requisites are described below.

High-value features (6 to 8 points) are characterized by all of the features required to support permanent populations of giant garter snakes, including the following attributes.

- Access to sufficient water during the active season.
- Emergent, herbaceous aquatic vegetation accompanied by vegetated banks to provide basking and foraging habitat.
- Bankside burrows, holes and crevices providing short-term refuge.
- Vegetated high ground or upland habitat above the annual high water mark to provide cover and refugia from floodwaters during the dormant winter season.

Moderate-value features (4 to 5 points) are characterized by any combination of suitable features required to support transient giant garter snakes on a temporary basis, or to act as connective corridors between areas of more stable or desirable habitat. These features need only possess the vegetation and refugia required to provide minimal coverage for dispersing snakes. Moderate value features are considered unlikely to support permanent populations of giant garter snakes and are characterized by one or more of the following attributes.

- Moderate ground disturbance.
- Sparse vegetation.
- Dense, riparian overstory.
- Inundation by tide or floodwaters.
- Isolation from adequate sources of prey.

Low-value features (0 to 3 points) are devoid of the water, vegetation, and refugia required to support giant garter snakes for any meaningful time. These features are generally associated with large rivers, lakes, intensive agriculture (other than rice), routine ground disturbance, or urban development.

In addition to the methodology described above for most the Plan Area, upland habitat areas mapped for Plan expansion areas include the following land cover types.

- Pasture

- Alkali seasonal wetland complex
- Grassland
- Grassland–pasture
- Upland annual grasslands and forbs formation
- *Crypsis* species–wetland grasses–wetland forbs NFD super alliance
- Vernal pools
- Other natural seasonal wetland
- Vernal pool complex

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Additional detail regarding crop types was available for cultivated lands and was incorporated into the mapping. For the giant garter snake, in the new analysis areas, the following natural communities are assumed to provide the listed habitat type.

- Agriculture
  - Rice (aquatic nontidal)
- Managed wetland (all except Suisun)
  - Bulrush–cattail freshwater marsh, NFD super alliance (all except Suisun) (aquatic nontidal)
- Nontidal freshwater perennial emergent wetland
  - Nontidal perennial aquatic–water (aquatic nontidal)

In the areas of additional analysis, the following tidal aquatic natural communities were assumed to provide giant garter snake aquatic habitat.

- Tidal freshwater emergent wetland (aquatic tidal)
- Tidal perennial aquatic
  - Tidal perennial aquatic–water (all except Suisun) (aquatic tidal)

In the areas of additional analysis, the following upland natural communities within 200 feet of aquatic habitat were assumed to provide giant garter snake upland habitat.

- Agriculture
  - Cultivated annual graminoid (upland–4)
  - Field crops (upland–1)
  - Grain/hay crops (upland–4)
  - Pasture (upland–3)

- Grasslands
  - Pasture (upland–3)
  - Upland annual grasslands & forbs formation (upland–5)
- Managed wetlands
  - *Crypsis* spp.-wetland grasses-wetland forbs NFD super alliance (upland–4)
  - Vernal pools (Upland–3)
- Other seasonal wetlands (upland–4)
- Vernal pool complex (upland–3)

2A.28.7.3 Assumptions

Giant garter snakes inhabit marshes, ponds, sloughs, small lakes, low-gradient streams and other waterways, and agricultural wetlands, including irrigation and drainage canals, rice fields, and the adjacent uplands (U.S. Fish and Wildlife Service 2006b). In the Sacramento Valley, their habitat requirements include adequate water during the snake's active season (early spring through mid-fall) to provide food and cover, and emergent herbaceous wetland vegetation for escape cover and foraging habitat during the active season.

- **Assumption:** Suisun Marsh does not support potentially occupied giant garter snake habitat.

  Rationale: Suisun Marsh lies outside of the acknowledged range of the species (U.S. Fish and Wildlife Service 1999).

- **Assumption:** Giant garter snakes could potentially use any watercourse within 1,000 feet of aquatic habitat, perennial marsh, or flooded rice field in the Plan Area, except in Suisun Marsh.

  Rationale: Watercourses, perennial marsh, and flooded rice fields are most likely consistently inundated during most of the snake's active season and are therefore available for breeding, foraging, or movement.

- **Assumption:** Tidal perennial aquatic habitat suitable for giant garter snake consists of those areas within 20 feet (6 meters) of bank margins.

  Rationale: In tidal perennial aquatic features (e.g., the Sacramento and San Joaquin Rivers and tidal zones in the central Delta), giant garter snakes are limited to shallow, near-shore habitats providing vegetative cover, foraging, thermoregulating opportunities, and refuge from predatory fishes. Accordingly, tidal perennial aquatic features are buffered internally by 20 feet (6 meters) to capture the near-shore habitat and exclude the relatively deep water areas that are considered unsuitable.

- **Assumption:** All watercourses in the Plan Area that are within 1,000 feet (305 meters) of perennial water or rice can be used as movement corridors, either electively or as a result of displacement by flood events.

  Rationale: Because many potential benefits are conferred by aquatic habitats, and because information regarding water persistence, predator and prey densities, and vegetation density and type are generally lacking, the suitability of aquatic features is not defined qualitatively (e.g., high, medium, and low value). Instead, suitability is inferred in relation to the qualitative rankings assigned to associated upland habitat, which are described above, and by the

differences in habitat stability and value between tidal freshwater or nontidal freshwater types, which are described below.

- **Assumption:** Potentially occupied giant garter snake upland habitat consists of the vegetation types listed in Section 2A.28.7.2, *Habitat Model Description*, and upland habitat values are consistent with the designated value rankings for each vegetation type listed.

  Rationale: Giant garter snakes require basking habitat of grassy banks and openings in waterside vegetation. They also require uplands for cover and refuge from floodwaters during the snake's dormant season in the winter (U.S. Fish and Wildlife Service 2006b). Riparian woodlands are unlikely to provide suitable habitat as a result of excessive shade, lack of basking sites, and absence of prey populations (U.S. Fish and Wildlife Service 2006b). However, giant garter snakes can potentially occur along watercourses with willow-dominated riparian or riparian scrub habitats, particularly where emergent herbaceous wetland vegetation is present, because of the relatively low overstory structure and intermittent occurrence of the riparian vegetation. Vegetation types that are relatively open are most likely to provide basking sites and burrows, and are likely to have the highest habitat value for giant garter snakes.

- **Assumption:** Potentially occupied giant garter snake upland habitat consists of appropriate land cover types within 200 feet (61 meters) of modeled aquatic habitat.

  Rationale: Giant garter snakes use grassy stream banks and upland habitats adjacent to perennial watercourses or wetlands as overwintering and movement habitat.

2A.28.7.4 Model Limitations

Suitable upland overwintering habitat is overestimated in areas subject to prolonged inundation by flood events such as that which occurs in the Yolo Bypass. Periodic inundation influences suitability for use as overwintering habitat and, depending on the frequency of inundation, could create a biological sink as snakes reestablish overwintering patterns in the inundation zone during nonflood years and then are displaced from or killed at overwintering sites during an inundation event. Because there is little research on this topic, the Yolo Bypass is included as potential overwintering habitat for giant garter snake; however, it is likely that either the bypass is not used for this purpose because of the current frequency and extent of flooding or that it represents a site where snakes are periodically displaced during the inactive season when inundation occurs.

Most historical and recent occurrences of the giant garter snake in the Plan Area have been reported from areas outside of the central Delta, including portions of the Yolo Basin and at Coldani Marsh/White Slough along the eastern edge of the Plan Area (California Department of Fish and Game 2011; Hansen 2006, 2007, 2008, 2009, 2011; Wylie and Amarello 2006; Hansen pers. comm.). These areas are also consistent with the USFWS' description of extant populations within the Plan Area and Yolo Basin (U.S. Fish and Wildlife Service 1999). Additional relatively recent occurrences extend north of Coldani Marsh/White Slough to Stone Lakes and east of the Mokelumne and Sacramento Rivers. The northern and eastern portions of the Plan Area are known to support extant populations and are where recent and historical records suggest a greater likelihood of undiscovered extant populations to occur as described above.

Scattered records from the central Delta suggest that giant garter snakes may have occupied this region at one time, but longstanding reclamation of wetlands for intense agricultural applications has eliminated most suitable habitat (Hansen 1986). Historical and recent surveys conducted in the

Delta have failed to identify any extant population clusters in the region (Hansen 1986; Patterson 2003, 2005; Patterson and Hansen 2004), including 2009 surveys conducted by DWR. There is also some speculation that recent observations in the central Delta (e.g., Sherman Island) could be of snakes that occasionally move into the central Delta by 'washing-down' from known populations, such as Liberty Island or Coldani Marsh/White Slough, and that these occurrences do not represent local breeding populations (Hansen pers. comm.). There are also only two known isolated occurrences south of the San Joaquin River and none south of SR 4. This area is within the approximately 50-air-mile gap that separates the northern and southern populations (Hansen and Brode 1980; 58 FR 54053). Thus, by including these solitary records in the qualitative ranking of upland habitat value, the model likely overestimates the relative value of upland habitat in the central Delta due to its proximity to records that likely represent single displaced snakes, not viable populations like in the eastern and northern portions of the Plan Area. Nonetheless, because suitable habitat has been documented and potential occupancy could not be entirely ruled out (ECOS 1990; Miriam Green Associates 1995), areas that support suitable habitat (as defined here) are considered potentially occupied by giant garter snakes; suitability rankings reflect this potential. The western end of Sherman Island represents the western extent of potentially occupied habitat, and consistent with the permitted *East Contra Costa Habitat Conservation Plan/Natural Communities Conservation Plan* (Contra Costa County 2006), SR 160 approximately represents the westernmost extent south of the San Joaquin River near Antioch.

2A.28.8 Recovery Goals

The *Draft Recovery Plan for the Giant Garter Snake* was prepared in 1999 by USFWS. The overall objective of this recovery plan is to delist the giant garter snake. The goals of the draft plan include stabilizing and protecting existing populations, and conducting research necessary to further refine recovery criteria. A revised recovery plan is currently in preparation by USFWS.

The plan lists the following conservation actions:

- Protect existing populations and habitat.
- Restore populations to former habitat.
- Survey to determine species distributions.
- Monitor populations.
- Conduct necessary research, including studies on demographics, population genetics, and habitat use.
- Develop and implement incentive programs, and an outreach and education plan.

The recovery plan divided the Central Valley into four recovery units to aid in the recovery process.

- Sacramento Valley Unit, extending from the vicinity of Red Bluff south to the confluence of the Sacramento and Feather Rivers.
- Mid-Valley Unit, extending from the American and Yolo Basins south to Duck Slough near the City of Stockton.
- San Joaquin Valley Unit, extending south of Duck Slough to the Kings River.
- South Valley Unit, extending south of the Kings River to the Kern River Basin.

Populations in the Plan Area are included in the Mid-Valley Unit. Recovery criteria for this unit are as follows:

- Monitoring shows that in 17 out of 20 years, 90% of the subpopulations in the recovery unit (with the exception of the East Stockton–Diverting Canal and Duck Creek population) contain both adults and young.
- The six existing populations in the recovery unit are protected from threats that limit populations.
- Supporting habitat in the recovery unit is adaptively managed and monitored.
- Subpopulations are well connected by corridors of suitable habitat.
- Repatriation has been successful at all suitable sites that had recently (within the last 10 years) extirpated populations.

In addition, the CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the giant garter snake as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

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2A.28.9.1 Literature Cited

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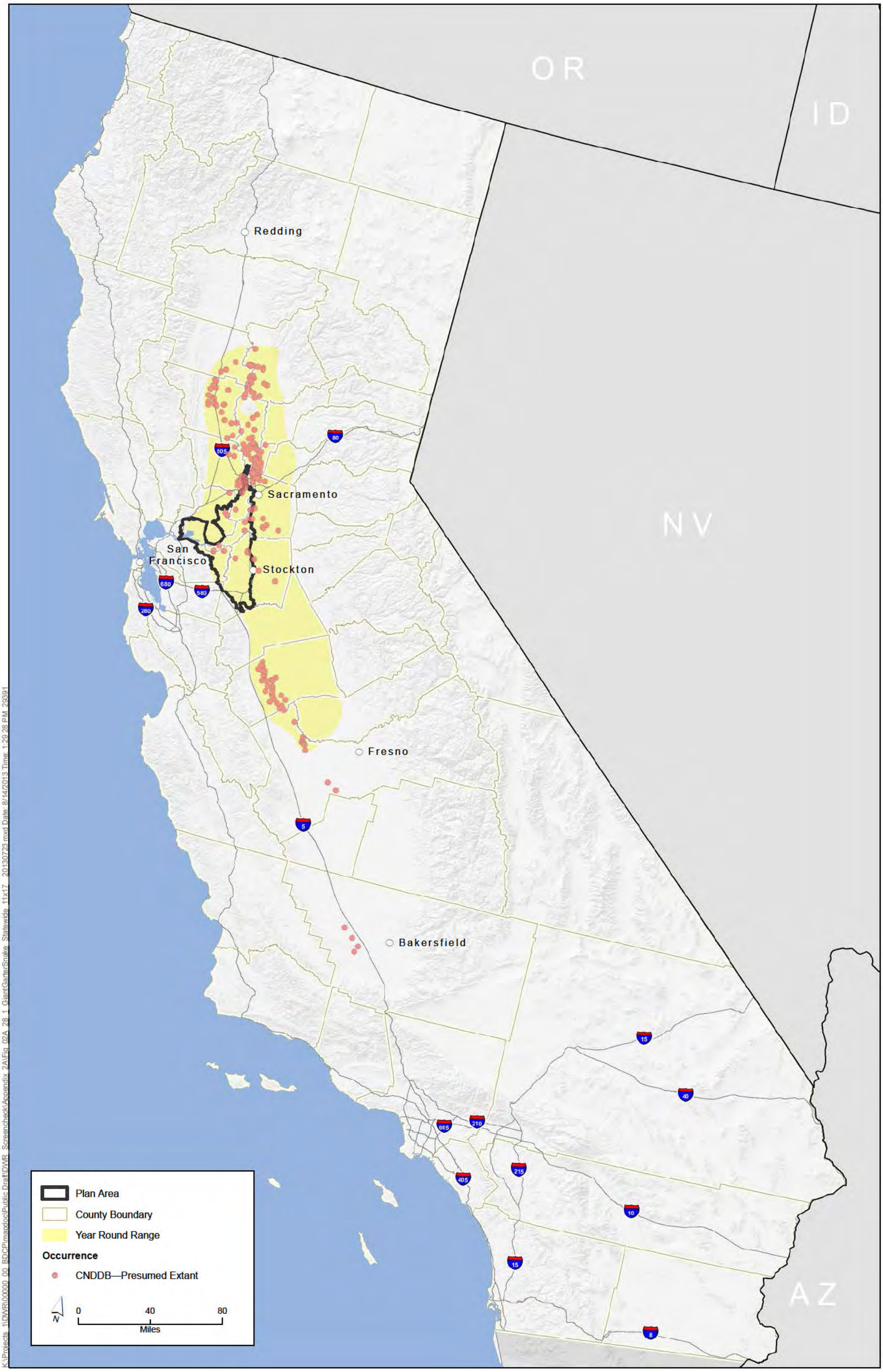
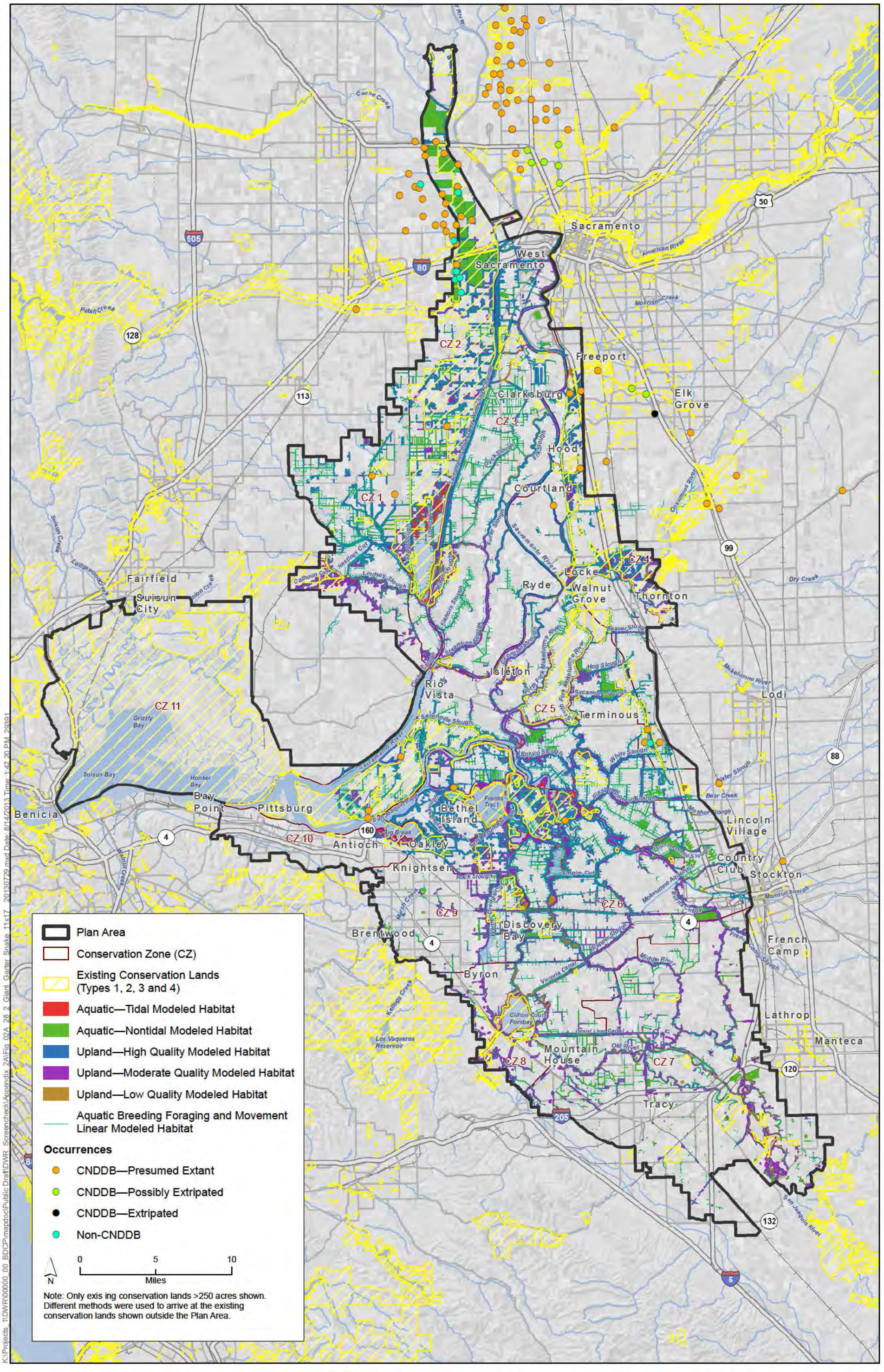


GIS Data Sources: Occurrences, CNDDB June 2013;
Range, DFG WHR 2008.

Figure 2A.28-1
Giant Garter Snake Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and Hansen 2006-2009.

Figure 2A.28-2
Giant Garter Snake Habitat Model and Recorded Occurrences

Appendix 2A.29
Western Pond Turtle (*Actinemys marmorata*)

2A.29.1 Legal Status

The western pond turtle previously included two subspecies, the northwestern pond turtle (*Actinemys marmorata marmorata*) and the southwestern pond turtle (*Actinemys marmorata pallida*). Both subspecies were petitioned for federal listing as endangered or threatened on January 29, 1992. In 1993, the U.S. Fish and Wildlife Service (USFWS) determined that there was insufficient information to propose listing of the species. Recent phylogenetic research combines the two subspecies into a single species (*A. marmorata*) (Bury and Germano 2008; Spinks and Shaffer 2005). The western pond turtle is a California Species of Special Concern.

2A.29.2 Species Distribution and Status

2A.29.2.1 Range and Status

The western pond turtle occurs in the Pacific states of North America from Baja California Norte, north through Washington, and possibly into southernmost British Columbia, Canada (Bury and Germano 2008). Elevation range for the species extends from near sea level to 4,690 feet (1,430 meters) (Jennings and Hayes 1994).

Outside California, occurrences east of the Cascade-Sierra Nevada crest include the Truckee, Carson, and East Walker Rivers in Nevada; Drews Creek and Canyon Creek in Lake County, Oregon; and introduced occurrences along the Deschutes River at Bend in Deschutes County, Oregon (Jennings and Hayes 1994; Stebbins 2003).

In California, this species historically occurred in most Pacific slope drainages between the Oregon and Mexican borders and in only two drainages on the desert slope: the Mojave River (San Bernardino County) and Andreas Canyon (Riverside County) (Jennings and Hayes 1994). Occurrences east of the crest of the Sierra Nevada include Susanville in Lassen County (Stebbins 2003) (Figure 2A.29-1).

From their phylogenetic analysis, Spinks and Shaffer (2005) divide the current range into four geographically coherent clades: a northern clade extending from Washington State to San Luis Obispo County; a San Joaquin Valley clade; a Santa Barbara clade in Santa Barbara and Ventura counties; and a southern clade south of the Tehachapi Mountains and west of the Transverse Range south to Baja California.

2A.29.2.2 Population Trends

Most populations throughout the range have exhibited some declines. Bury and Germano (2008) report continued declines in the northern and southernmost portions of the range, but not in the core of the range from central California to southern Oregon. Hays et al. (1999) also report stable populations in southern Oregon while northern Oregon populations have suffered severe declines.

Most populations in the state of Washington have been extirpated; however, there has been some progress through implementation of the *Western Pond Turtle Recovery Plan* (Hays et al. 1999).

In California, Jennings and Hayes (1994) consider the western pond turtle as endangered from the Mokelumne River south and threatened elsewhere within the state. Spinks and Shaffer (2005), however, found the north-south split between clades to be bounded by the Fresno River, over 100 miles south of the Mokelumne, and suggest that management of the species should observe all four mitochondrially distinct clades (Spinks et al. 2010). Spinks and Shaffer (2005) assert that increased conservation attention should be given to the central and southern California populations because a larger proportion of genetic variation is found there than in the northern clade, and because those populations are thought to be in decline. Loss of habitat is the most significant factor in western pond turtle declines. Over 90% of the historical wetlands in California have been drained, filled, or diked to support agricultural and urban development (Frayer et al. 1989). In the Central Valley, pond turtles were exploited for food from the 1890s to the 1920s, which is believed to have played an important role in population declines in the San Francisco area and Central Valley (Storer 1930; Hays et al. 1999; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009). Nonetheless, despite significant population declines, populations in the Central Valley continue to persist in many areas and appear to have sufficient recruitment to maintain numbers (Germano and Bury 2001).

2A.29.2.3 Distribution and Status in the Plan Area

While there are relatively few occurrence records in the California Natural Diversity Database (CNDDB) from the Plan Area (Figure 2A.29-2) (California Department of Fish and Game 2011), it is likely that this species is underreported and under-represented in the CNDDB. Western pond turtles are common in the Suisun Marsh (Feliz pers. comm.) and the Sacramento–San Joaquin River Delta (Delta) (Patterson pers. comm. 2012a). The species may occur along most of the slower-moving sloughs and other natural watercourses and in artificial channels and other water bodies in the Plan Area where essential habitat elements (streamside cover, logs and other debris for basking, and adjacent upland habitats) are present.

Systematic surveys for plants, birds, and turtles were conducted by the California Department of Water Resources (DWR) in the south Delta in 2001, and western pond turtles were observed to be nearly continuous along river and slough banks and in-channel islands throughout this area. In addition, hatchling and juvenile turtles were captured incidentally during surveys for giant garter snakes in the agricultural ditches of the Delta islands. Western pond turtles have also been observed from public roadways along internal water distribution systems, which are cut off from natural tidal hydrology. It is assumed that western pond turtles are present at other pond and ditch systems in Suisun Marsh and the Delta.

2A.29.3 Habitat Requirements and Special Considerations

The western pond turtle, although primarily found in natural aquatic habitats, also inhabits impoundments, irrigation ditches, and other artificial and natural water bodies (Ernst et al. 1994). The species is usually found in stagnant or slow-moving freshwater habitats, but brackish habitats are also used (Ernst et al. 1994). This species is uncommon in high-gradient streams, most likely due

to low water temperatures, high current velocity, and low food resources, which may limit their local distribution (Jennings and Hayes 1994).

The aquatic habitat may comprise either mud or rocky substrates and usually contains some vegetation (Ernst et al. 1994). Habitat value often seems to be positively correlated with the number of available basking sites (Jennings and Hayes 1994). Turtles seem to avoid areas lacking in significant refugia (Holland 1994). Basking sites may be rocks, logs, vegetation, terrestrial islands in the aquatic habitat, and human-made debris (Holland 1994). Hatchlings forage in shallow water areas with dense submergent or short emergent vegetation, where small aquatic organisms are likely to be in abundance. Western pond turtles also inhabit the irrigation canals in agricultural areas, including ditches servicing rice agriculture (Hansen pers. comm.). While rice fields probably confer little advantage for adult western pond turtles, mature rice provides valuable cover and foraging habitat for hatchlings.

Upland habitats are also important to western pond turtles for nesting, overwintering, and overland dispersal (Holland 1994). Nesting sites may be as far as 400 meters (1,312 feet) or more from the aquatic habitat, although usually the distance is much less and generally around 100 meters (328 feet) (Jennings and Hayes 1994; Slavens 1995). Nesting sites typically have a southern or western aspect, with slopes of 0 to 46% and compact, dry soils (Holland 1994; Bury et al. 2001). When turtles choose to overwinter in upland habitats, individuals typically leave the aquatic habitat in late fall, moving as far as 500 meters (1,640 feet) from the aquatic habitat (Holland 1994). Turtles typically burrow into duff (leaf litter) and/or soil, where they remain during the winter months (Holland 1994). For reasons not entirely clear, western pond turtles may move into upland habitats for variable intervals at other times of the year, during which times they may be found burrowed into duff or under shrubs (Rathbun et al. 1993; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.4 Life History

2A.29.4.1 Description

The western pond turtle (Holman and Fritz 2001; Obst 2003; McCord and Joseph Ouni 2006) is a medium-sized aquatic turtle. Previously assigned to the genus *Clemmys*, Feldman and Parham (2002) have also proposed taxonomic realignments that would place *A. marmorata* within the genus *Emys*; current literature may refer to this taxon under either generic name. The carapace (upper portion of shell) color ranges from brown to black (Holland 1994). The carapace may be unmarked or covered with small, fine dark spots or lines (Holland 1994; Stebbins 2003). Adult size ranges from 8.9 to 21.6 centimeters (3.5 to 8.5 inches) straight-line carapace length (Stebbins 2003) and as large as 24.1 centimeters (9.5 inches) (Lubcke and Wilson 2007). The plastron (lower portion of shell) contains six pairs of yellowish shields, usually with dark blotches (Stebbins 2003). The head usually contains spots or a network of black coloring (Stebbins 2003). Adult females have a more domed, taller carapace, as compared to males, which have a more flattened, lower profile carapace (Holland 1994). Males also have larger, thicker tails than females (Holland 1994). Juveniles have a uniformly brown or olive carapace, with yellow markings along the edge of the marginals (the ring of shields encircling the carapace) and a tail nearly as long as the carapace (Stebbins 2003; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.4.2 Reproduction

Field observations indicate that copulation occurs in May, June, and late August (Holland 1988). Oviposition (egg-laying) may occur as early as late April in central California (Rathbun et al. 1993) to late July, with most occurring in June and July (Holland 1994). Western pond turtles may also double-clutch, potentially resulting in an extended breeding season (Scott et al. 2008). A gravid (pregnant) female approaches the nesting site, empties the contents of her bladder onto the soil, excavates a 90- to 125-millimeter (3.5- to 4.9-inch)-deep nest chamber, and deposits 1 to 13 hard-shelled eggs (Holland 1994; Jennings and Hayes 1994). Incubation time ranges from 80 to more than 100 days in California (Holland 1994). In northern California, hatchling western pond turtles (which are about the size of a quarter) overwinter inside the nest chamber and emerge the following spring (Holland 1994). The terrestrial movements of postemergent hatchlings are poorly understood (Holland 1994), although it is known that at least some move quickly to aquatic habitats (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.4.3 Basking

Western pond turtles spend considerable time basking in order to thermoregulate, preferring body temperatures between 24 and 32°C (75 and 90°F). Turtles seem to avoid body temperatures above 34°C (93°F) and usually cease basking at body temperatures well below their critical thermal maximum of 40°C (104°F). Individuals often bask above the water level on emergent logs, rocks, vegetation, or other objects. Turtles may also bask at the surface, and sometimes in vegetation where water temperatures may be 10 to 15°C (18 to 27°F) warmer than the water immediately below (Holland 1994). This type of aquatic basking may occur when air temperatures become too high for aerial basking. Western pond turtles also spend considerable time foraging, which occurs during the day or night (Holland 1994). Intraspecific (within-species) aggressive interactions, in the form of open-mouth gestures and shoving or bumping to secure positions on basking sites, are also common among western pond turtles (Holland 1994; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.4.4 Movements and Home Ranges

Adults sometimes engage in extended overland movements, which may be in response to drought or normal movements to aquatic habitats within a home range (Holland 1994). In one study, a turtle was observed making an overland movement of 5 kilometers (3.1 miles), although in all other cases, overland movements were less than 3 kilometers (1.9 miles) (Holland 1994). Such overland movements may be responses to an environmental stress such as drought or may be part of an individual's normal movements within a home range, which may consist of a series of ponds (Holland 1994). In lotic (stream) habitats, individuals move along the watercourse from pool to pool. During the course of one summer, Bury (1972) found average male, female, and juvenile linear movements were 354, 169, and 142 meters (1,161, 554, and 466 feet), respectively. In that study, adult males had the largest home ranges (0.98 hectare [2.42 acres]), followed by juveniles (0.36 hectare [0.89 acres]) and adult females (0.25 hectare [0.62 acres]) (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.4.5 Foraging Behavior and Diet

Western pond turtles are generalist feeders, with most food being obtained by opportunistic foraging or scavenging (Ernst et al. 1994). Known food items include algae, various plants, crustaceans, various types of insects, spiders, fish, frogs, tadpoles, and birds (Pope 1939 in Ernst et al. 1994; Evenden 1948 in Ernst et al. 1994; Carr 1952; Holland 1985; Bury 1986). Scavenging carrion of various vertebrate species may be a locally and/or seasonally important part of the diet (Holland 1994). Neustophagia, (a form of filter feeding) may be used to obtain abundant small invertebrate prey such as Daphnia (Ernst et al. 1994; Holland 1994; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.5 Threats and Stressors

2A.29.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation produce small populations that are increasingly isolated and limited in space. This reduces movement of individuals and genetic exchange between populations. Small, isolated populations are highly susceptible to extinction caused by catastrophic or stochastic events. Isolation limits the ability of the population to recolonize areas with suitable habitat where western pond turtles may have been present in the past.

Agricultural practices such as discing and intensive livestock grazing and trampling have degraded many remaining vernal pools and wetland habitats, as have off-road vehicle use and contaminated runoff.

Roads can create a barrier to dispersal movements of western pond turtle and can isolate populations. Contaminants from road materials, leaks, and spills could further degrade aquatic habitats used by this species.

Corridors from aquatic habitat to historical and long-term nesting sites can be blocked by roads and development. Movement of adult females to and from the nesting locations and the movement of hatchlings from the nest to the aquatic site can be impeded and affected (Jennings and Hayes 1994; Yolo Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency County 2009).

2A.29.5.2 Exotic Species

Nonnative invasive species are a threat to western pond turtles. Bullfrogs and exotic large predatory fish (e.g., largemouth bass) compete with western pond turtles for invertebrate prey and are known to eat hatchlings and small juveniles. Carp alter or eliminate emergent vegetation required as microhabitat by hatchlings (Holland 1994). Exotic turtles, including painted turtles, snapping turtles, and sliders, may compete with pond turtles for food and basking sites. These exotic turtles also may harbor and transmit diseases, such as upper respiratory diseases, to pond turtles (Holland 1994). Cattle trample and eat aquatic vegetation that serves as habitat for hatchlings and may crush nests. Domestic dogs sometimes kill or injure turtles (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.29.5.3 Flooding and Irrigation

Turtle nests may be inundated during floods and during irrigation of agricultural fields. The egg shells absorb water and can crack or explode from internal pressure (Feldman 1982). Therefore, nest success and recruitment may be reduced in flood-prone or active agricultural areas.

2A.29.5.4 Predation

Predation is a major mortality factor for western pond turtles. Hatchlings and turtle eggs are particularly vulnerable (Holland 1994). Raccoons (*Procyon lotor*), bullfrogs (*Rana catesbeiana*), largemouth bass (*Micropterus salmoides*), gray fox (*Urocyon cineroargenteus*), coyote (*Canis latrans*), and feral and domestic dogs (*Canis familiaris*) are known to be major predators of western pond turtles (Holland 1994). Other known predators include osprey (*Pandion haliaetus*), bald eagle (*Haliaetus leucocephalus*), river otter (*Lutra canadensis*) (Manning 1990 in Holland 1994), and mink (*Mustela vison*) (Holland 1994). Numerous other fish, amphibian, bird, and mammal species are suspected to prey on the species (Holland 1994). Raccoons, in particular, are known to depredate nests, sometimes destroying all nests in an entire communal nesting area (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009). In urban areas, litter and pet food can increase the presence of some predators, potentially leading to increased predation on turtles.

2A.29.6 Relevant Conservation Efforts

Conservation efforts for the western pond turtle are largely limited to those proposed under habitat conservation plans, including those that overlap with the Plan Area. These include preservation of occupied and potentially occupied habitats, management of watercourses and water bodies to protect existing populations and encourage reestablishment of populations, and restoration or enhancement of channel, riparian, and adjacent upland habitats to benefit pond turtles. The western pond turtle is a covered species under several permitted plans, including the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County 2006) and the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000); and is proposed for coverage under the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), and *Butte Regional Habitat Conservation Plan and Natural Community Conservation Plan* (Butte County Association of Governments 2011).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the western pond turtle as a Maintain species (CALFED Bay-Delta Program 2000). This means that CALFED will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects on the species created by CALFED restoration actions. To the extent practicable, CALFED will improve species habitat conditions.

The California Department of Fish and Wildlife (CDFW) recently commissioned the U.S. Forest Service's Redwood Sciences Laboratory to prepare a conservation strategy for the western pond turtle in California.

2A.29.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.29.7.1 GIS Model Data Sources

The western pond turtle model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture 2005), Central Valley Levees 2001 (California Department of Water Resources 2001), National Hydrography Dataset (U.S. Geological Survey 1999) and land use survey of the Delta and Suisun Marsh area-version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable western pond turtle habitat in the Plan Area according to three life requisite parameters: aquatic habitat, upland nesting and overwintering habitat, and dispersal habitat. Vegetation types were assigned based on the species' requirements as described above and the assumptions described below.

2A.29.7.2 Aquatic Habitat Model Description

Modeled aquatic habitat for the western pond turtle includes the land cover types and conditions listed below.

- Perennial streams, excluding the Sacramento River
- Large water delivery and irrigation channels
- Aquatic habitat in the Delta, which includes the following types from the BDCP composite vegetation layer.
    - Tidal freshwater emergent wetland–all types
    - Tidal perennial aquatic types–all types
    - Nontidal perennial aquatic types–all types
    - Nontidal freshwater perennial emergent wetland
        - American bulrush (*Schoenoplectus* [formerly *Scirpus*] *americanus*)
        - Common reed (*Phragmites australis*)
        - Flooded managed wetland
        - Hardstem bulrush (*Schoenoplectus acutus*)
        - Mixed *Schoenoplectus*/floating aquatics (*Hydrocotyle–Eichhornia*) complex
        - Mixed *Schoenoplectus*/submerged aquatics (*Egeria–Cabomba–Myriophyllum* spp.) complex

- Mixed *Schoenoplectus* mapping unit
- Narrow-leaf cattail (*Typha angustifolia*)
- Perennial pepperweed (*Lepidium latifolium*)
- *Schoenoplectus acutus* (*Typha latifolia*)–*Phragmites australis*
- *Schoenoplectus acutus*–*Typha angustifolia*
- *Schoenoplectus acutus* pure
- *Schoenoplectus acutus*–*Typha latifolia*

- Aquatic habitat in the Yolo Basin and Suisun Marsh, which includes the following types from the BDCP composite vegetation layer.
  - Freshwater drainage
  - Slough
  - Ditch
  - *Schoenoplectus* (*californicus* or *acutus*)/*Rosa*
  - *Schoenoplectus* (*californicus* or *acutus*)/wetland herb
  - *Schoenoplectus* (*californicus* or *acutus*)–*Typha* spp.
  - *Schoenoplectus americanus* (generic)
  - *Schoenoplectus americanus*/*Lepidium*
  - *Schoenoplectus americanus*/*Potentilla*
  - *Schoenoplectus californicus*/*S. acutus*
  - *Schoenoplectus maritimus*
  - *Schoenoplectus maritimus*/*Salicornia* (formerly *Sarcocornia*)
  - *Typha angustifolia*/*Distichlis*
  - *Typha angustifolia*/*S. americanus*
  - *Typha* species (generic)
  - Bulrush- cattail fresh water marsh not formally defined (NFD) super alliance
  - *Schoenoplectus americanus*/*S. Californicus*–*S. acutus*
  - *Schoenoplectus maritimus*/*Sesuvium*
  - *Typha angustifolia*/*Phragmites*
  - *Typha angustifolia*/*Polygonum*–*Xanthium*–*Echino*
  - *Typha angustifolia* (dead stalks)
- Canals and ditches associated with agriculture and managed wetlands as mapped in the national hydrologic dataset (U.S. Geological Survey 1999)

The national hydrologic dataset (NHD) (U.S. Geological Survey 1999), represented by linear features in geographic information systems (GIS), was used to map the canal and ditch aquatic habitat used

by western pond turtles. This dataset is comprehensive and includes most canals and ditches in the Plan Area, regardless of whether they hold water perennially or seasonally. Because western pond turtles require perennial water, only a subset of the mapped NHD canals and ditches are likely to provide suitable habitat.

Mapping all perennial features was not feasible, so an alternative approach was developed (Patterson pers. comm. 2012b). First, grids of 9 square kilometers were placed over each restoration opportunity area and then 15% of the grids were randomly selected for mapping. Aerial photographs were overlain with the NHD layer so that each NHD feature could be mapped as suitable or non-suitable. The criteria for suitable features are listed below.

- Perennial feature.
- Minimum width of 3 meters.
- Presence of emergent vegetation and/or open water that appears dense or deep enough to provide cover.
- Proximity to upland basking habitat.

The average percent suitability for all restoration opportunity areas was approximately 35% (Patterson pers. comm. 2012b). The 35% suitability was applied to the quantitative results of the adverse and beneficial effects analyses as described in Table 5.J-1, *Quantitative Effects Analysis Methods and Assumptions,* in Appendix 5.J, *Effects on Natural Communities, Wildlife, and Plants*.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Additional detail regarding crop types was available for cultivated lands and was incorporated into the mapping. In the new analysis areas, the following natural communities were assumed to provide aquatic habitat for the western pond turtle.

- Nontidal freshwater perennial emergent wetland
- Nontidal perennial aquatic
    - Nontidal perennial aquatic–water
- Tidal perennial aquatic
    - Tidal perennial aquatic-water
- Valley/foothill riparian
- Bulrush–cattail freshwater marsh NFD super alliance

Additional areas mapped as upland nesting and overwintering (within 200 meters of aquatic habitat) habitat include the following vegetation types.

- Alkali seasonal wetland complex
- Grasslands
    - Pasture
    - Upland annual grasslands & forbs formation

- Managed Wetlands
  - *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
  - Vernal pools
- Nontidal freshwater perennial emergent wetland
  - Cultivated annual graminoid
- Other natural seasonal wetland

2A.29.7.3 Assumptions

- **Assumption:** Western pond turtle aquatic habitat is restricted to the habitat and vegetation described in Section 2A.29.7.2, *Aquatic Habitat Model Description.*

  Rationale: Western pond turtles reside in stagnant or slow-moving water in aquatic habitats (Ernst et al. 1994). The Sacramento River and the associated open water bays west of Sherman Island and west of the State Route (SR) 160 bridge along the San Joaquin River are excluded from the model because, with perhaps the exception of low-velocity backwater areas, flow velocities are considered to be too high to provide habitat. Aquatic habitat on islands in the bay (e.g., Kimble Island, Brown Island, and Winters Island) is also excluded. The GIS layer was developed to characterize these bodies of water and was used to exclude them from consideration as habitat for the western pond turtle. Perennial stock ponds and other open water habitats provide aquatic habitat when located near suitable upland areas. Western pond turtles are associated with freshwater emergent and perennial aquatic types that are associated with open water habitats where they find cover and food resources.

2A.29.7.4 Upland Nesting and Overwintering Habitat Model Description

Modeled nesting and overwintering habitat in the Delta for the western pond turtle includes the following types from the BDCP composite vegetation layer within 200 meters (1,640 feet) of aquatic habitat, including the aquatic habitat derived from the NHD dataset.

- Grassland–all types (including levees)
- Valley/foothill riparian–all types
- Vernal pool complex
  - California annual grasslands
  - Ruderal herbaceous grasses and forbs
  - Italian ryegrass (*Lolium multiflorum*)

Nesting and overwintering habitat in the Yolo Basin and Suisun Marsh from the BDCP composite vegetation layer.

- Valley oak alliance–riparian
- Fremont cottonwood–valley oak–willow (ash–sycamore) riparian forest NFD association
- *Salix laevigata/S. lasiolepis*

- *Salix lasiolepis*/*Quercus agrifolia*
- *Fraxinus latifolia*
- Mixed willow super alliance
- Annual grasses generic
- Annual grasses/weeds
- Perennial grass
- Pasture
- Upland annual grasslands and forbs formation
- *Lolium* (generic)
- *Lolium*/*Rumex*
- *Hordeum*/*Lolium*
- Medium upland graminoids
- Short upland graminoids

Areas mapped include the following vegetation types (within 200 meters of aquatic):

- Alkali seasonal wetland complex
- Grassland
- Pasture
- Upland annual grasslands and forbs formation
- *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
- Vernal pools
- Cultivated annual graminoid
- Vernal pool complex

2A.29.7.5 Assumptions

- **Assumption:** Western pond turtle upland nesting and overwintering habitat is restricted to habitat and vegetation types located within 200 meters of aquatic habitat as described in Section 2A.29.7.4, *Upland Nesting and Overwintering Habitat Model Description.*

  Rationale: The western pond turtle is primarily aquatic and travels across upland habitat to reproduce, disperse, aestivate, and overwinter (Jennings and Hayes 1994). Females leave the aquatic habitat to find an upland location to nest. Proximity of nesting site to aquatic habitat is dependent on availability, and the nest site is generally within 200 meters (656 feet) of the aquatic habitat, but can be up to 400 meters (1,312 feet) away (Storer 1930; Jennings and Hayes 1994). Holland (1994) reported overwintering sites up to 500 meters (1,640 feet) from the aquatic habitat; however, the vast majority of nesting occurs much closer to aquatic habitat, especially in areas like the Suisun Marsh and the Delta where suitable upland habitat is limited in most areas to thin strips of grassy vegetation along roadsides and levees. Thus, a distance of 200 meters from aquatic habitat was selected to capture habitats used for feeding, reproduction,

and overwintering in the model. Agricultural, urban, disturbed, orchard, and vineyard land cover types are not considered to support nesting or overwintering habitat because they are subject to regular disturbances that could destroy nests or overwintering sites.

2A.29.7.6 Dispersal Habitat Model Description

Modeled dispersal habitat includes all types described as aquatic habitat and upland nesting and overwintering habitat within 3 kilometers (1.86 miles) of aquatic habitat, and the following habitat components.

Dispersal habitat within 3 kilometers of aquatic habitat in the Delta from the BDCP composite vegetation layer.

- Agriculture–all types
- Managed wetland–all types
- Other natural seasonal wetland–all types (only during extended periods of inundation)

Dispersal habitat within 3 kilometers of aquatic habitat in the Yolo Basin and Suisun Marsh from the BDCP composite vegetation layer.

- *Conium maculatum*
- *Distichlis* (generic)
- *Distichlis spicata*
- *Distichlis*/annual grasses
- *Distichlis*/*Cotula*
- *Distichlis*/*Juncus*
- *Distichlis*/*Lotus*
- *Distichlis*/*S. americanus*
- *Distichlis*/*S. maritimus*
- *Distichlis*/*Salicornia*
- *Distichlis–Juncus–Triglochin–Glaux*
- Flooded managed wetland
- *Lepidium* (generic)
- *Lepidium*/*Distichlis*
- Medium wetland graminoids
- Medium wetland herbs
- *Polygonum–Xanthium–Echinochloa*
- *Polypogon monspeliensis* (generic)
- *Salix laevigata*/*S. lasiolepis*
- Short wetland herbs

- Tall wetland graminoids
- *Juncus balticus*
- *Juncus balticus*/*Conium*
- *Juncus balticus*/*Lepidium*
- *Juncus balticus*/*Potentilla*
- Medium upland graminoids
- Pasture
- *Phragmites australis*
- *Phragmites*/*Schoenoplectus*
- *Phragmites*/*Xanthium*
- Rice
- Short upland graminoids
- Short wetland graminoids
- Tall wetland herbs
- Upland annual grasslands and forbs formation
- Wetland herbs

2A.29.7.7 Assumptions

- **Assumption:** Western pond turtle dispersal habitat is restricted to habitat and vegetation types located within 3 kilometers of aquatic and overwintering habitat as described in Section 2A.29.7.6, *Dispersal Habitat Model Description.*

  Rationale: Adults sometimes engage in extended overland movements in response to stresses such as drought , or as normal movements within a home range, which may consist of a series of ponds (Holland 1994). In one study, a turtle was observed making an overland movement of 5 kilometers (3.1 miles), although in all other cases, overland movements were less than 3 kilometers (1.9 miles) (Holland 1994). Some of the seasonal wetland types and rice noted above may also be used as aquatic habitat during periods of inundation, particularly by juvenile pond turtles (Hansen pers. comm.). However, because of the shallow water and seasonal inundation, adults are more likely to use these habitats for dispersal purposes, and thus they are included here as dispersal habitat.

2A.29.8 Recovery Goals

A USFWS recovery plan has not been prepared for this species and no recovery goals have been established.

2A.29.9 References Cited

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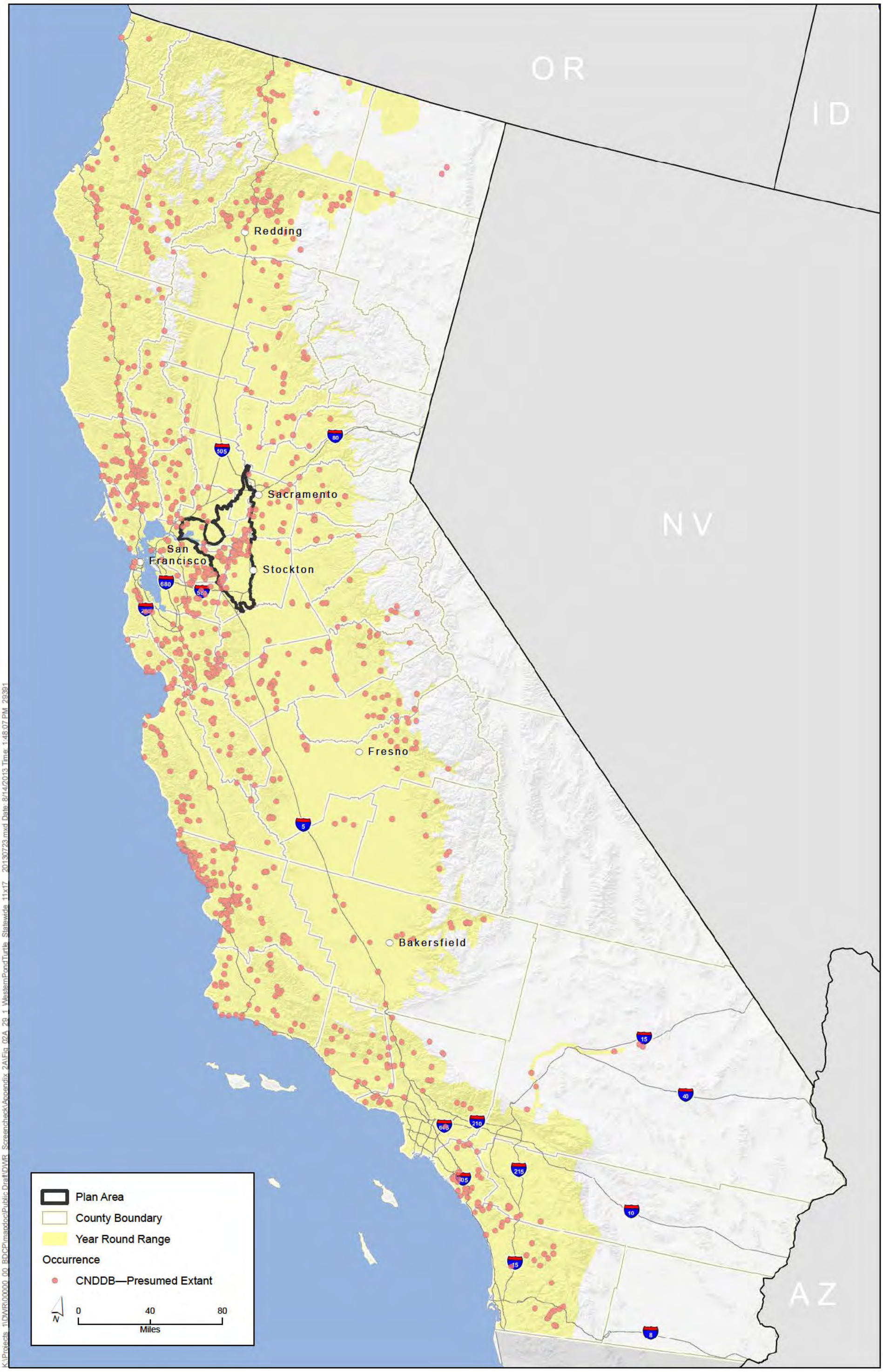
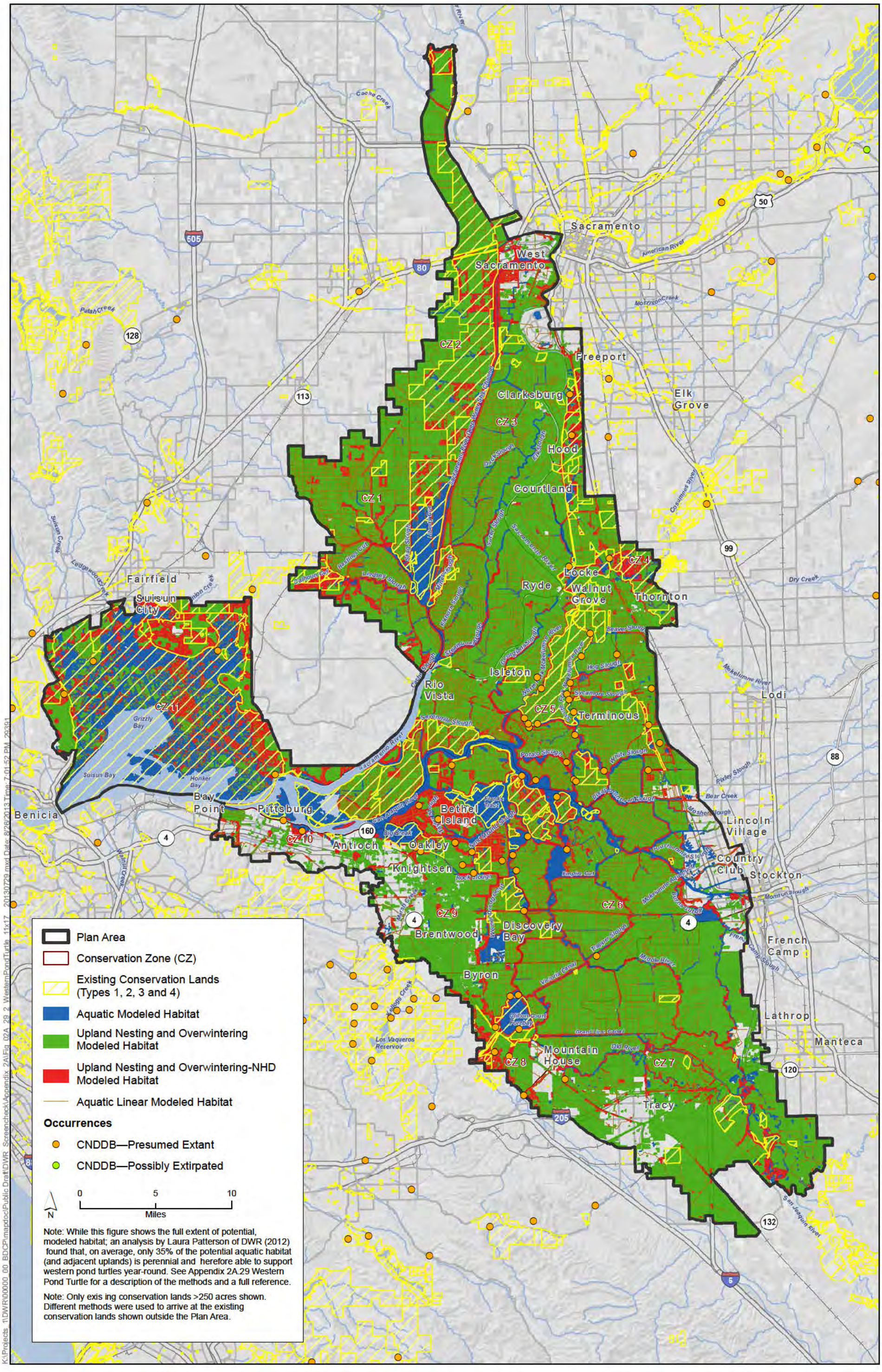


GIS Data Sources: Occurrences, CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.29-1
Western Pond Turtle Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013; National Hydrological Dataset, USGS 1999.

Figure 2A.29-2
Western Pond Turtle Habitat Model and Recorded Occurrences

K:\Projects 1\DWR\00000_00 BDCP\mapdoc\Public Draft\DWR Screencheck\Appendix 2A\Fig 02A 29 2 WesternPondTurtle 11x17 20130729.mxd Date: 8/26/2013 Time: 7:01:52 PM 29391

Appendix 2A.30
California Red-Legged Frog (*Rana draytonii*)

2A.30.1 Legal Status

The California red-legged frog (*Rana draytonii*) was federally listed as threatened pursuant to the federal Endangered Species Act in 1996 (61 *Federal Register* [FR]25813) and is designated as a species of special concern in California (Jennings and Hayes 1994). A recovery plan was prepared for this species by the U.S. Fish and Wildlife Service (USFWS) in 2002 (U.S. Fish and Wildlife Service 2002), and a 5-year review was initiated in 2011 (76 FR 30377).

Critical habitat was initially designated for this species in 2001, which was subject to legal challenges and resulted in substantial modifications and a final ruling in 2006 (71 FR 19244). Further subsequent challenges resulted in additional modifications and a new final ruling in 2010 (75 FR 12816). Critical Habitat Unit ALA-2 overlaps with the Plan Area in the northeastern corner of Alameda County. Critical Habitat Unit SOL-1 overlaps with the Plan Area along the western edge of Suisun Marsh in Solano County.

2A.30.2 Species Distribution and Status

2A.30.2.1 Range and Status

The historical range of the California red-legged frog generally extends south along the coast from the vicinity of Point Reyes National Seashore, Marin County, California, and inland from the vicinity of Redding, Shasta County, California, southward along the interior Coast Ranges and Sierra Nevada foothills to northwestern Baja California, Mexico (U.S. Fish and Wildlife Service 2007) (Figure 2A.30-1). While there are a few historical records from several Central Valley locales (Jennings and Hayes 1994), Fellers (2005) considers persistent occupancy in the lowlands of the Central Valley unlikely due to extensive annual flooding.

The current range is generally characterized based on the current known distribution. USFWS (2007) notes that while the California red-legged frog is still locally abundant in portions of the San Francisco Bay area and the central coast, only isolated populations have been documented elsewhere within the species' historical range, including the Sierra Nevada, northern Coast Ranges, and northern Transverse Ranges.

USFWS (2002) estimates that the species has lost approximately 70% of its former range, with severe declines occurring primarily in the Central Valley and southern California (Jennings and Hayes 1994). Prior to recent discoveries at isolated locations in the Sierra Nevada (Placer, Nevada, Yuba, and El Dorado Counties) and two populations in the southern Transverse and Peninsular Ranges, the species was considered extirpated from the Sierra Nevada and southern Transverse and Peninsular Ranges.

Sizable populations continue to exist only in coastal drainages and associated pond habitats between Point Reyes and Santa Barbara (Jennings and Hayes 1994).

The principal factors contributing to the decline of the California red-legged frog are loss of habitat due to urban development, conversion of native habitats to agricultural lands, introduction of nonnative predators, and pesticide use (Fisher and Shaffer 1996; Hobbs and Mooney 1998; Davidson et al. 2002). Habitat loss and fragmentation result in small, isolated populations, which reduce individual movements and genetic exchange between populations.

2A.30.2.2 Distribution and Status in the Plan Area

In the Plan Area, the California red-legged frog has been detected only in aquatic habitats within the grassland landscape west and southwest of Clifton Court Forebay and in the vicinity of Brentwood and Marsh Creek along the west-central edge of the Plan Area, and in some upland sites in the vicinity of Suisun Marsh (Figure 2A.30-2). These areas represent the easternmost edge of the current range of California red-legged frog within the Coast Ranges. While there are several recent detections of the species in the Sierra Nevada foothills, the California red-legged frog is not known to occur in the agricultural habitats of the Central Valley. The California Natural Diversity Database (CNDDB) reports several extant occurrences from approximately Marsh Creek and Clifton Court Forebay and the western edge of the Suisun Marsh (California Department of Fish and Game 2011). Occupied habitats are characterized by grassland foothills with stock ponds and slow-moving perennial drainages. The species is not known to occur, nor is it expected to occur, elsewhere in the Plan Area.

2A.30.3 Habitat Requirements and Special Considerations

Storer (1925) and Hayes and Jennings (1988) describe aquatic breeding habitat requirements for California red-legged frog as cold water pond habitats (including stream pools) with emergent and submergent vegetation, providing suitable cover for young and adults and ensuring successful reproduction. Optimal habitats are described as deep-water ponds or pools at least 2.3 feet (0.7 meters) deep along low-gradient streams with dense stands of overhanging willows and a fringe of cattails between the willow roots and overhanging willow limbs. Note, however, that the lack of wetland or other shallow streamside vegetation does not necessarily preclude the presence of California red-legged frog. Hayes and Jennings (1988) also note that there may be a current preference for pools along intermittent streams rather than backwater pools along perennial streams possibly due to predator avoidance, particularly bullfrogs (*Lithobates catesbeianus*). The California red-legged frog uses a variety of aquatic habitats that meet these requirements, including permanent and ephemeral ponds, perennial and intermittent streams, seasonal wetlands, springs, seeps, marshes, dune ponds, lagoons, and human-made aquatic features (U.S. Fish and Wildlife Service 2007).

In addition to aquatic breeding habitat, the California red-legged frog also requires upland nonbreeding habitat used for cover, aestivation, and migration and other movements. Nonbreeding cover habitat may include nearly any areas within 1 to 2 miles (1.6 to 3.2 kilometers) of a breeding site that stays moist and cool through the summer, and can include vegetated areas with coyote bush (*Baccharis pilularis*), California blackberry thickets (*Rubus ursinus*), and root masses associated with willows (*Salix* spp.) and California bay trees (*Umbellularia californica*) (Fellers and Kleeman 2007). Potential cover habitat includes all aquatic, riparian, and upland areas that provide cover,

such as animal burrows, boulders or rocks, organic debris such as downed trees or logs, and industrial debris; agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay stacks may also be used (61 FR 25813). Incised stream channels with portions narrower and depths greater than 18 inches (46 centimeters) also may provide important summer sheltering habitat (61 FR 25813). Accessibility to cover habitat is essential for the survival of red-legged frogs within a watershed and can be a factor limiting frog populations. Movement corridors may include annual grasslands, riparian corridors, woodlands, and sometimes active agricultural lands (Fellers and Kleeman 2007).

2A.30.4 Life History

2A.30.4.1 Description

California red-legged frogs are brown to reddish brown with prominent dorsolateral folds (Jennings and Hayes 1994; Stebbins 2003). Adult size ranges from 85 to 138 millimeters (3.4 to 5.4 inches) in length from the snout to urostyle (frog homologue to pelvic bone) (Jennings and Hayes 1994). The dorsal surface is distributed with dark spots, occasionally with light centers (Storer 1925). The amount of red coloration present is variable; some individuals have no such coloration, and others may have red pigment distributed all over the dorsal and ventral surfaces of the body (Jennings and Hayes 1994). A dark mask bordered by a whitish jaw stripe is also usually present (Stebbins 2003).

2A.30.4.2 Activity

Juvenile frogs are active diurnally and nocturnally, while adult frogs are primarily nocturnal (Hayes and Tenant 1985). Local climate influences the California red-legged frog's seasonal activity period (Storer 1925). In coastal areas with mild climates, individuals are rarely inactive; however, at inland sites with colder winters individuals may become inactive for longer intervals (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.30.4.3 Seasonal Movements

California red-legged frogs are most likely to make overland movements through upland habitats at night during wet weather (U.S. Fish and Wildlife Service 2002; Bulger et al. 2003; Fellers and Kleeman 2007). During the course of a wet season, movements up to 1.6 kilometers (1 mile) are possible (U.S. Fish and Wildlife Service 2002). During dry weather, the subspecies tends to remain very close to a water source and are typically within 60 meters (about 200 feet) of water (U.S. Fish and Wildlife Service 2002; Bulger et al. 2003; Fellers and Kleeman 2007). However, overland dispersal of the California red-legged frogs sometimes occurs in response to receding water during the dry season potentially necessitating greater dispersal distances (U.S. Fish and Wildlife Service 2002). California red-legged frogs have been known to disperse distances up to 2.9 kilometers (1.8 miles) from the breeding site to sites within the stream system (U.S. Fish and Wildlife Service 2002; Fellers and Kleeman 2007). Note, however, that Jennings and Hayes (1994) suggest that, in general, adult California red-legged frogs do not appear to move large distances from their aquatic habitat. This is consistent with recent results from Tatarian (2008), who reported average terrestrial movement in Contra Costa County of 24.4 plus or minus 20.7 meters (range: 1 to 71 meters) (80 plus or minus 68 feet [range: 3.3 to 233 feet]) and average aquatic movement of

107.2 plus or minus 152.1 meters (range: 11 to 661.4 meters) (352 plus or minus 499 feet [range: 36 to 2,170 feet]).

2A.30.4.4 Reproduction

Breeding occurs between late November and late April (Jennings and Hayes 1994) and most frogs lay their eggs in March (U.S. Fish and Wildlife Service 2002). Males move to breeding sites 2 to 4 weeks before female arrival (Storer 1925). A pair moves into amplexus (breeding position), and the female moves the pair to the oviposition (egg-laying) site, where she deposits 2,000 to 6,000 eggs to an emergent vegetation brace (Storer 1925; Jennings and Hayes 1994). Hatching occurs in 20 to 22 days, depending on water temperature (U.S. Fish and Wildlife Service 2002). Thereafter, tadpoles require 11 to 20 weeks to complete metamorphosis (Storer 1925).

2A.30.4.5 Diet

Invertebrates account for most prey taken by California red-legged frogs, although vertebrates such as Pacific tree frogs (*Hyla regilla*) and California mice (*Peromyscus californicus*) account for over half the prey consumed by larger frogs (U.S. Fish and Wildlife Service 2002).

2A.30.4.6 Predators

California red-legged frogs are subject to predation by a number of native and nonnative species. Native predators include raccoons (*Procyon lotor*), garter snakes (*Thamnophis* spp.), great blue herons (*Ardea herodias*), American bitterns (*Botaurus lentiginosus*), red-shouldered hawks (*Buteo lineatus*), and black-crowned night herons (*Nycticorax nycticorax*) (U.S. Fish and Wildlife Service 2002; Fellers and Kleeman 2007). Nonnative predators include crayfish, bullfrogs (*Lithobates catesbeianus*) and various fish species (U.S. Fish and Wildlife Service 2002).

2A.30.5 Threats and Stressors

2A.30.5.1 Urbanization and Habitat Fragmentation

Habitat loss, degradation, and fragmentation are significant factors in declining populations of California red-legged frogs. Conversion of lands to agricultural and urban uses, overgrazing, mining, recreation, and timber harvesting have all contributed to habitat losses and disturbances. Urbanization often fragments habitat and creates barriers to dispersal (U.S. Fish and Wildlife Service 2002). Road densities generally increase as a consequence of urbanization. Roads can create significant barriers to frog dispersal (Reh and Seitz 1990) and reduce population densities due to mortality caused by automobile strikes (Fahrig et al. 1995; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.30.5.2 Agricultural Crop Conversion

The conversion of natural lands to agricultural uses, such as stands of monotypic row crops, can alter habitats to the extent that they become uninhabitable for California red-legged frogs (U.S. Fish and Wildlife Service 2002). Fisher and Shaffer (1996) suggest that intense farming in the San Joaquin Valley has resulted in drastic declines in California red-legged frog populations, resulting

from little suitable habitat. Pesticides, herbicides, and other agrochemicals are known to be toxic to various life stages of ranid frogs (Hayes and Jennings 1986). Pesticide drift has also been suggested as a potential cause of declining populations of four species of ranids in California, including California red-legged frogs (Davidson et al. 2002; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.30.5.3 Exotic Species

Exotic predatory fish and bullfrogs also pose significant threats to California red-legged frogs. Hayes and Jennings (1986) noted that locations in which exotic fish were present contained few California red-legged frogs. Bullfrogs have been implicated in the decline of the subspecies in several studies (Fisher and Shaffer 1996; Kiesecker and Blaustein 1998; Lawler et al. 1999), and Moyle (1973) indicated that bullfrogs might have been the most important factor in the extirpation of California red-legged frogs from the Central Valley floor. Bullfrogs depredate and out-compete California red-legged frogs due to their larger size, more varied diet, and longer breeding season (Hayes and Jennings 1986; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.30.5.4 Water Diversions and Impoundments

Water diversions and impoundments have altered habitats and made them less suitable for many ranid species (Jennings 1996). The creation of reservoirs through dam construction in the Central Valley and southern California has directly eliminated, fragmented, or isolated populations of California red-legged frogs (U.S. Fish and Wildlife Service 2002). Smaller impoundments and water diversions can also preclude or inhibit dispersal (U.S. Fish and Wildlife Service 2002) and reduce high flows required to maintain deep holes in streams (Rathbun pers. comm.). The stock ponds and small reservoirs formed by smaller impoundments and water diversions often contain exotic fishes and bullfrogs that prey on red-legged frogs (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.30.5.5 Grazing

In some locales, California red-legged frogs appear to thrive in areas with managed grazing, and grazing may actually improve habitat conditions at sites where stock ponds have been constructed (U.S. Fish and Wildlife Service 2002). However, unmanaged cattle trample and eat emergent riparian vegetation, resulting in severe habitat disturbances (Gunderson 1968 in U.S. Fish and Wildlife Service 2002; Duff 1979 in U.S. Fish and Wildlife Service 2002), causing increases in water temperatures (Van Velson 1979 in U.S. Fish and Wildlife Service 2002). These effects diminish habitat value for California red-legged frogs and improve conditions for bullfrogs and exotic predatory fish (U.S. Fish and Wildlife Service 2002). Grazing in riparian areas can result in the loss of willows, which are associated with the greatest densities of California red-legged frogs (Jennings 1988). High stocking rates can also result in increased erosion in the watershed (Lusby 1970 in U.S. Fish and Wildlife Service 2002; Winegar 1977 in U.S. Fish and Wildlife Service 2002) and sedimentation in the stream (Gunderson 1968 in U.S. Fish and Wildlife Service 2002), which in turn can alter primary productivity and fill interstitial spaces of the streambed substrate with fine alluvium. This fill impedes water flow, reduces dissolved oxygen levels, and restricts waste removal (Chapman 1988 in U.S. Fish and Wildlife Service 2002; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

2A.30.6 Relevant Conservation Efforts

Since the listing of the California red-legged frog, numerous conservation efforts have been undertaken by various federal, state, and local governments and private organizations to minimize impacts and establish preserves and protective policies to ensure the viability of this species (U.S. Fish and Wildlife Service 2002). These include the establishment of federal guidelines to assess habitat and determine presence/absence of the species (U.S. Fish and Wildlife Service 2005), the designation of critical habitat, and various protections of occupied habitat on public and private lands. The recovery plan (U.S. Fish and Wildlife Service 2002) outlines a series of guidelines that recommend specific actions designed to protect California red-legged frogs and their habitat.

The California red-legged frog is a covered species in the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County 2006) and the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000); and it is proposed as a covered species in the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the California red-legged frog as a Maintain species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects on the species created by program restoration actions. To the extent practicable, the program will improve species habitat conditions.

The Solano Land Trust has contributed to restoration efforts by enhancing California red-legged frog habitat on its lands. These lands overlap or are directly adjacent to the Plan Area west of Suisun Marsh (west of Interstate 680 [I-680]). Lynch Canyon is a 1,039-acre property located in Solano County, just northwest of Interstate 80 (I-80) between American Canyon Road and State Route (SR) 12. Solano Land Trust has owned the site since 1996, and the site provides a perpetual agricultural and open space buffer along I-80 between the cities of Fairfield, Vallejo, and Benicia. California red-legged frogs were observed in the Lynch Canyon watershed in 1998 during a survey for the Lynch Canyon Resource Management Plan. In 2000, riparian exclusion zones were created by fencing Lynch Creek. The conservation program funded installation of approximately 11,000 linear feet of fence to protect the Lynch Canyon reservoir, the wet meadow, all of the North Fork from I-80 to the reservoir, and all of the South Fork of Lynch Creek.

2A.30.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.30.7.1 GIS Model Data Sources

The California red-legged frog model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture

2005), and land use survey of the Sacramento–San Joaquin River Delta (Delta), Suisun Marsh area-version 3 (California Department of Water Resources 2007) and the National Hydrography Dataset (U.S. Geological Survey 1999). Using these data sets, the model maps the distribution of suitable California red-legged frog habitat in the Plan Area according to the species' two primary life requisites: aquatic breeding habitat and upland cover and dispersal habitat. Vegetation types were assigned to a suitability category based on the species requirements as described above and the assumptions described below.

2A.30.7.2 Aquatic Habitat Model Description

Aquatic habitat for the California red-legged frog includes the following land cover types and conditions in the area south and west of SR 4 from Antioch (Bypass Road to Balfour Road to Brentwood Boulevard) to Byron Highway; then south and west along the county line to Byron Highway; then west of Byron Highway to Interstate 205, (I-205), north of I-205 to Interstate 580 (I-580), and west of I-580. Habitat also occurs along the western edge of Suisun Marsh, west of I-680. Habitat in the California Aqueduct and the Delta Mendota Canal is not included the model.

- Perennial and intermittent streams
- Aquatic habitat types from the BDCP composite vegetation layer
    - Managed wetland
        - *Schoenoplectus* (formerly known as *Scirpus*) spp. in managed wetlands
        - *Polygonum amphibium*
    - Nontidal freshwater perennial emergent
        - Broad-leaf cattail (*Typha latifolia*)
        - American bulrush (*Schoenoplectus americanus*)
        - Mixed *Schoenoplectus* mapping unit
        - *Schoenoplectus acutus* pure
        - *Schoenoplectus acutus* (*Typha latifolia*)–*Phragmites australis*
    - Tidal freshwater emergent wetland
        - Mixed *Schoenoplectus* mapping unit
        - Mixed *Schoenoplectus*/floating aquatics (*Hydrocotyle*–*Eichhornia*) complex
        - Mixed *Schoenoplectus*/submerged aquatics (*Egeria*–*Cabomba*–*Myriophyllum* spp.) complex
        - Hardstem bulrush (*Schoenoplectus acutus*)
        - *Schoenoplectus acutus* pure
        - *Schoenoplectus acutus*–*Typha angustifolia*
        - *Schoenoplectus acutus*–*Typha latifolia*
        - *Schoenoplectus acutus*–(*Typha latifolia*)–*Phragmites australis*
        - California bulrush (*Schoenoplectus californicus*)

- *Schoenoplectus californicus–Eichhornia crassipes*
- *Schoenoplectus californicus–Schoenoplectus acutus*
- American bulrush (*Schoenoplectus americanus*)
- Narrow-leaf cattail (*Typha angustifolia*)
- *Typha angustifolia–Distichlis spicata*

○ Perennial aquatic

- Floating primrose (*Ludwigia peploides*)
- *Ludwigia peploides*
- Generic floating aquatics
- Water hyacinth (*Eichhornia crassipes*)
- Pondweed (*Potamogeton* spp.)
- Milfoil–waterweed (generic submerged aquatics)
- Brazilian waterweed (*Egeria–Myriophyllum*) submerged
- *Hydrocotyle ranunculoides*
- Algae
- Water

2A.30.7.3 Assumptions

- **Assumption:** California red-legged frog habitat in the Plan Area is geographically constrained to areas described in Section 2A.30.7.2, *Habitat Model Description*.

  Rationale: In the Plan Area, the California red-legged frog has been detected only in aquatic habitats in the grassland landscape west of Clifton Court Forebay, near Brentwood and Marsh Creek along the west-central edge of the Plan Area, and along the western edge of Suisun Marsh, west of I-680. These areas represent the easternmost edge of the current range of California red-legged frog in the Coast Ranges. The species is not known to occur, nor is it expected to occur, elsewhere in the Plan Area. Optimal habitats are described as deep-water ponds or pools along low-gradient streams with dense stands of overhanging willows and a fringe of cattails between the willow roots and overhanging willow limbs. The California red-legged frog uses a variety of aquatic habitats that meet these requirements, including permanent and ephemeral ponds including stock ponds, perennial and intermittent streams, seasonal wetlands, springs, seeps, marshes, dune ponds, lagoons, and human-made aquatic features (U.S. Fish and Wildlife Service 2007).

2A.30.7.4 Upland Cover and Dispersal Habitat Model Descriptions

Upland cover and dispersal habitat for the California red-legged frog is confined to the area south and west of SR 4 from Antioch (Bypass Road to Balfour Road to Brentwood Boulevard) to Byron Highway; then south and west along the county line to Byron Highway; then west of Byron Highway to I-205, north of I-205 to I-580, and west of I-580. Habitat also occurs along the western edge of

Suisun Marsh, west of I-680. Modeled upland cover and dispersal habitat is limited to lands within 1 mile of aquatic habitat.

Upland cover and dispersal habitat from the BDCP composite vegetation layer includes the following components.

- Grassland–all types
- Valley/foothill riparian–all types
- Vernal pool complex
    - California annual grasslands
    - Ruderal herbaceous grasses and forbs
    - Italian ryegrass (*Lolium multiflorum*)

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most newly mapped areas, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural communities were assumed to provide upland cover and dispersal habitat for California red-legged frog.

- Alkali seasonal wetland (Conservation Zone 8 only)
- Grassland (Conservation Zone 8 only)

2A.30.7.5 Dispersal Habitat

Modeled upland dispersal habitat also includes agricultural lands within the area described above and within 1 mile of the aquatic habitat, except for agricultural lands in Conservation Zones 7 and 8, where dispersal is bounded on the west by Byron Highway. There is no known, high-value breeding habitat east of that significant boundary.

Upland dispersal habitat from the BDCP composite vegetation layer includes the following component.

- Agricultural land–all types

2A.30.7.6 Assumptions

- **Assumption:** California red-legged frog requires upland nonbreeding habitat within 2 miles of breeding habitat used for cover, aestivation, and migration and other movements

  Rationale: The California red-legged frog also requires upland nonbreeding habitat used for cover, aestivation, and migration and other movements. Nonbreeding cover habitat may include nearly any areas within 1 to 2 miles (1.6 to 3.2 kilometers) of a breeding site that stays moist and cool through the summer (Fellers and Kleeman 2007). Potential cover habitat includes all aquatic, riparian, and upland areas that provide cover, such as animal burrows, boulders or rocks, organic debris such as downed trees or logs, and industrial debris; agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay stacks may also be used

(61 FR 25813). Movement corridors may include annual grasslands, riparian corridors, woodlands, and sometimes active agricultural lands (Fellers and Kleeman 2007).

2A.30.8 Recovery Goals

The recovery plan for the California red-legged frog (U.S. Fish and Wildlife Service 2002) identifies five recovery criteria:

- Protection of suitable habitat, *in perpetuity*, within each of the defined core areas. Protection of habitat would include impacts upstream that could make habitat unsuitable.
- Documentation that existing populations are stable through a 15-year monitoring program. This program should include representative precipitation cycles.
- Distribution of existing populations, allowing stable metapopulations despite fluctuations in local populations.
- Reestablishment of frogs in at least one area of historical occurrence for each core area.
- Additional habitat needed for connectivity of existing and reestablished populations, reestablishment, and dispersal has been determined and is protected and managed for red-legged frogs.

2A.30.9 References

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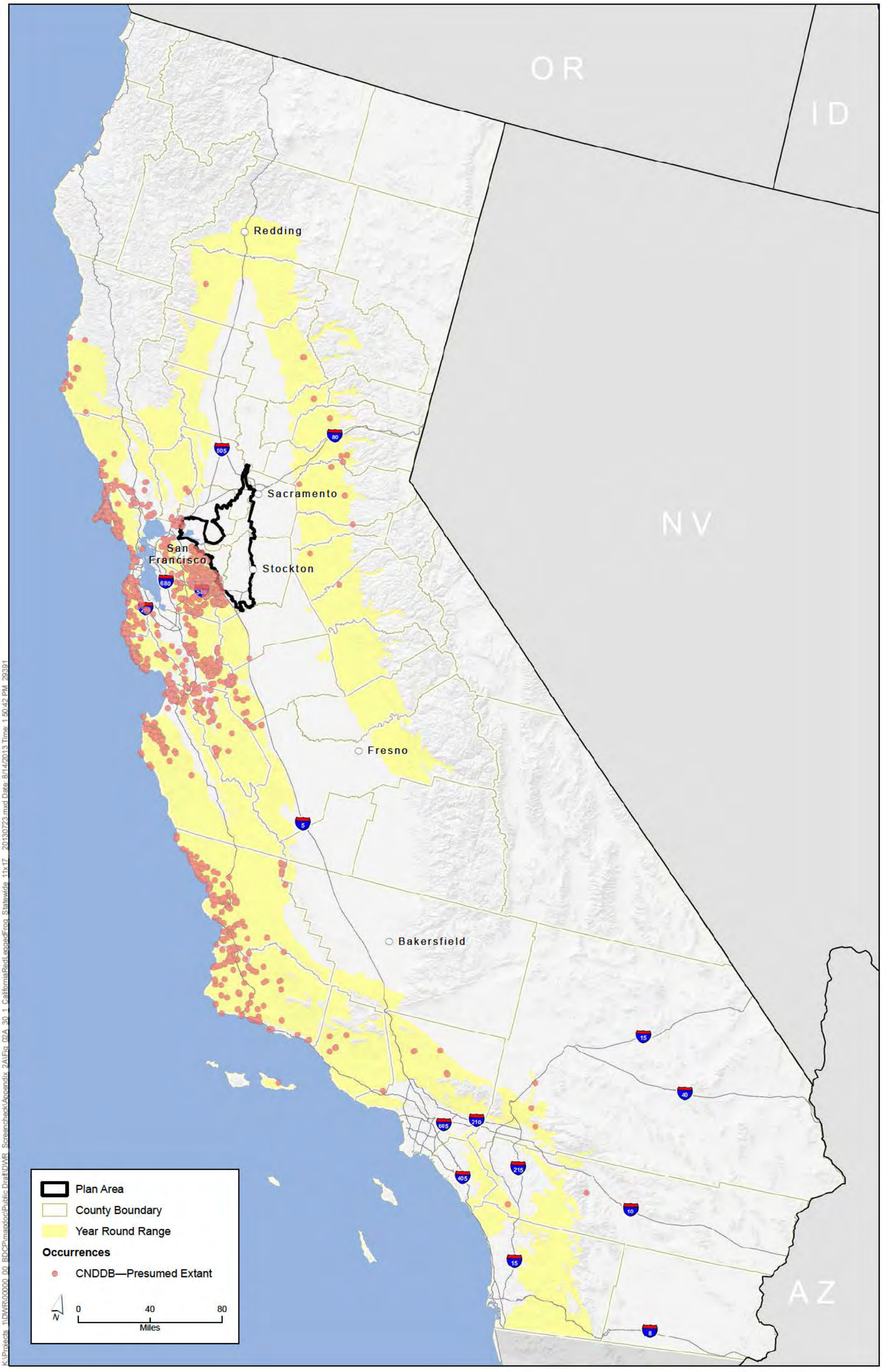
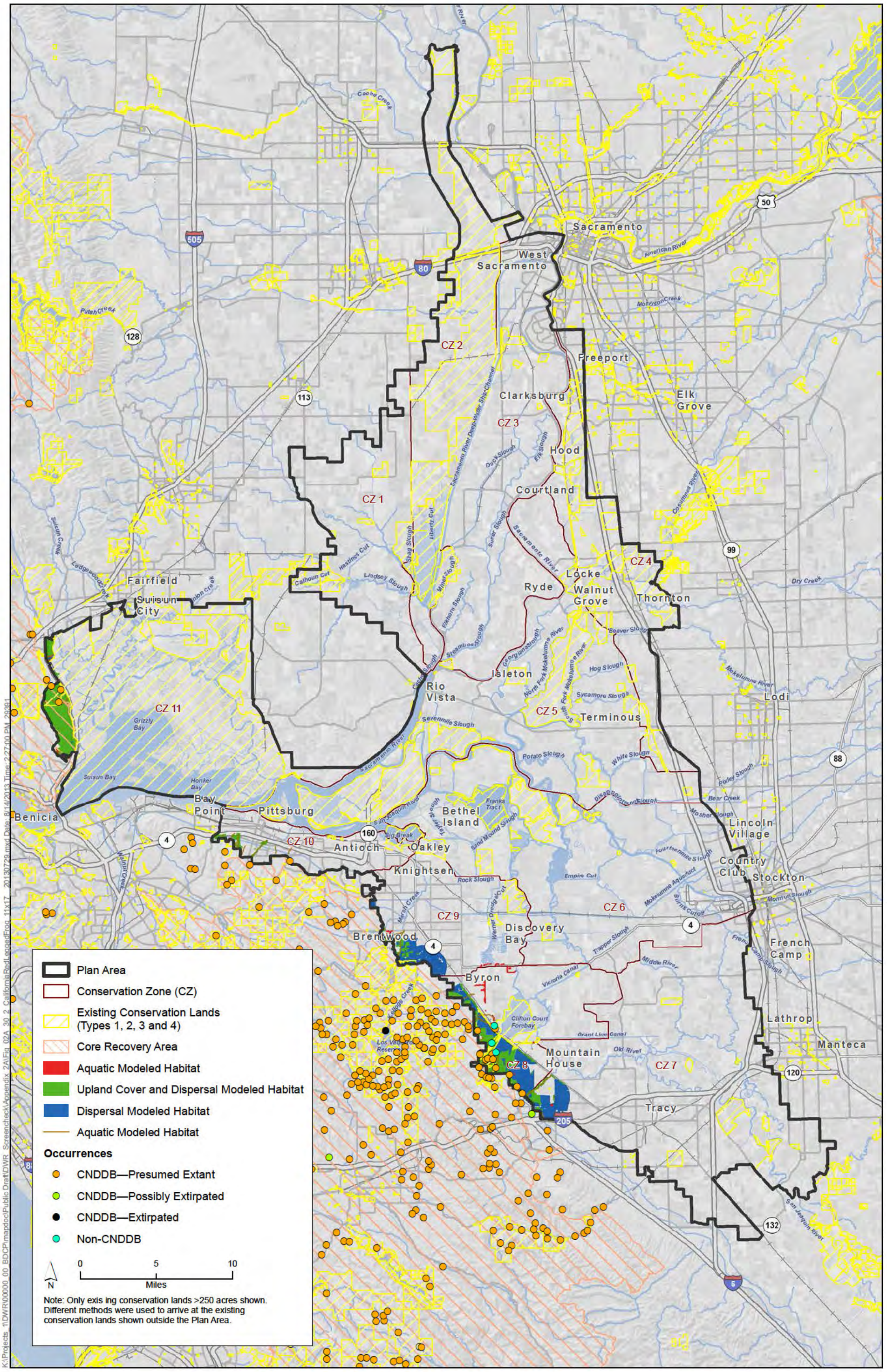


GIS Data Sources: Occurrences CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.30-1
California Red-Legged Frog Statewide Range and Recorded Occurrences



K:\Projects_1\DWR\00000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix_2A\Fig_02A_30_2_CaliforniaRedLeggedFrog_11x17_20130729.mxd Date: 8/14/2013 Time: 2:27:00 PM 29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.30-2
California Red-Legged Frog Habitat Model and Recorded Occurrences

Appendix 2A.31

California Tiger Salamander (*Ambystoma californiense*)

2A.31.1 Legal Status

The California tiger salamander (*Ambystoma californiense*) is federally listed range-wide as a threatened species (69 *Federal Register* (FR) 47212) and in Sonoma and Santa Barbara Counties as endangered (65 FR 57242, 68 FR 13498). The Central Valley distinct population segment (DPS), the Santa Barbara County DPS, and the Sonoma County DPS are state listed as threatened as of August 2010.

On September 22, 2005, the U.S. Fish and Wildlife Service (USFWS) designated approximately 199,109 acres (80,576 hectares) of critical habitat for the Central Valley DPS. The critical habitat is located in 19 California counties (70 FR 49380). In a December 2005 Final Rule, USFWS designated but excluded approximately 17,418 acres (7,049 hectares) of critical habitat for the Sonoma County DPS, stating that interim conservation strategies and measures being implemented by local governing agencies with land use authority over the area, along with economic exclusions authorized under Section 4(b)(2) of the federal Endangered Species Act, would be greater than would be achieved through critical habitat (70 FR 74138). On May 6, 2009, USFWS announced settlement of a lawsuit that challenged its 2005 final decision on proposed critical habitat for the Sonoma County population. In the settlement, USFWS agreed to once again propose as critical habitat the same 74,223 acres (30,037 hectares) of the Santa Rosa Plain that it had originally proposed in August 2005 as critical habitat.

2A.31.2 Species Distribution and Status

2A.31.2.1 Range and Status

The California tiger salamander is endemic to California (Barry and Shaffer 1994; Loredo et al. 1996). Historically, the species occurred throughout the grassland and woodland areas of the Sacramento and San Joaquin River Valleys and surrounding foothills, and in the lower elevations of the central Coast Ranges (Barry and Shaffer 1994) (Figure 2A.31-1). The species is found in a relatively xeric landscape where its range is limited by its aestivation and winter breeding habitat requirements, which are generally defined as open grassland landscapes with ephemeral pools and with burrowing squirrels and pocket gophers (Barry and Shaffer 1994).

Within the coastal range, the species currently occurs from southern San Mateo County south to San Luis Obispo County, with isolated populations in Sonoma and northwestern Santa Barbara Counties (California Department of Fish and Game 2011). In the Central Valley and surrounding Sierra Nevada foothills, the species occurs from northern Yolo County southward to northwestern Kern County and northern Tulare and Kings Counties (California Department of Fish and Game 2011).

The California tiger salamanders still occur throughout much of their historical range (Trenham et al. 2000) and can be common at localities where the species still occurs. Total adult population size is unknown, but populations are thought to be declining as a result of habitat loss. An estimated 80%

of the species' historical natural aquatic (i.e., vernal pool) habitat has been lost (Holland 1998) and the species has been eliminated from 55 to 58% of historical breeding sites (Barry and Shaffer 1994). Shaffer et al. (1993) also estimated that as much as 75% of the historical grassland habitat in the Central Valley used by the California tiger salamander has been lost.

2A.31.2.2 Distribution and Status in the Plan Area

Several occurrences are reported in the Plan Area immediately west of Clifton Court Forebay (Figure 2A.31-2) (California Department of Fish and Game 2011). Current occupancy of some of these sites was confirmed by larval surveys conducted between 2009 and 2011 by the California Department of Water Resources (DWR), as described below. There are numerous additional occurrences in vernal pool and pond habitats in the grassland foothills immediately west of the Plan Area between Corral Hollow and south of Antioch. Potential habitat exists in vernal pool habitats in Yolo and Solano Counties west of Liberty Island and in the vicinity of Stone Lakes in Sacramento County.

Over 200 vernal pools were surveyed for amphibian species in the vicinity of Clifton Court Forebay and Stone Lakes National Wildlife Refuge in 2009 (California Department of Water Resources 2009). No California tiger salamander eggs were found. An additional 28 vernal pools were surveyed later in the same year in Sacramento, San Joaquin, and Contra Costa Counties and no eggs were found. Three larvae were collected in 2009 at one of two sites where larval surveys were conducted in Contra Costa County. In 2010, one larva was found in the same pool as in 2009. However, no larvae were found in the other four sites surveyed. In 2011, larvae were detected at two ponds. One detection corresponded with a 2005 California Natural Diversity Database (CNDDB) record and the other possibly matched with a 1982 record. However, the 2011 surveys were limited to larval dip-netting because land access was limited. (California Department of Fish and Game 2011.)

2A.31.3 Habitat Requirements and Special Considerations

The California tiger salamander is found in annual grasslands and open woodland communities in lowland and foothill regions of central California where aquatic sites are available for breeding (U.S. Fish and Wildlife Service 2003). The species is typically found at elevations below 460 meters (1,509 feet) (68 FR 13498), although the known elevational range extends up to 1,053 meters (3,455 feet) (Jennings and Hayes 1994). Ecological characteristics of this area include dry soils, needlegrass grasslands, valley oaks, coast live oaks, and ephemerally flooded claypan vernal pools (U.S. Fish and Wildlife Service 2003).

Vernal pools and other seasonal rain pools are the primary breeding habitat of California tiger salamanders (Barry and Shaffer 1994; 68 FR 13498). However, because the species requires at least 10 weeks of pool inundation in order to complete metamorphosis of larvae (Anderson 1968a; Feaver 1971), California tiger salamanders are usually only found in the largest vernal pools (Laabs et al. 2001). The species is also known to successfully reproduce in ponds, including artificial stock ponds (Barry and Shaffer 1994; 69 FR 47212). In the East Bay Regional Park District in Contra Costa and Alameda Counties, California tiger salamanders breed almost exclusively in seasonal and perennial stock ponds (Bobzien and DiDonato 2007). However, the presence of predatory fish and bullfrogs (*Rana catesbeiana*) can affect the suitability of perennial ponds (Holomuzki

1986;Fitzpatrick and Shaffer 2004). Barry and Shaffer (1994) note that stock ponds can be productive breeding sites as long as they are drained annually, which can prevent predatory species from establishing.

Adult California tiger salamanders are terrestrial and occur most of the year (6 to 9 months) in grassland and open woodland habitats where they find cover and aestivation sites in the underground burrows of small mammals, such as California ground squirrels (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thomomys bottae*) (Storer 1925; Loredo and van Vuren 1996; Petranka 1998; Trenham 1998a). Active rodent burrow systems are considered an important component of California tiger salamander upland habitat (Seymour and Westphal 1994; Loredo et al. 1996). Loredo et al. (1996) indicate that active ground-burrowing rodent populations are probably necessary to sustain California tiger salamander populations because inactive burrow systems begin to deteriorate and collapse over time. In a 2-year radiotelemetry project in Monterey County (Hastings), Trenham (2001) found that salamanders preferentially used open grassland and isolated oaks; salamanders present in continuous woody vegetation were never more than 3 meters (10 feet) from open grassland, potentially because ground squirrels prefer to construct burrows in open habitats (Jameson and Peeters 1988 in Trenham 2001).

2A.31.4 Life History

2A.31.4.1 Description

The California tiger salamander is large and thickset, with a wide, rounded snout (69 FR 47212). Average total length of males is 20.3 centimeters (8 inches) and average total length of females is 17.3 centimeters (6.8 inches) (69 FR 47212). Dorsal coloration consists of a black background on the back and sides, interspersed with white or pale yellow spots or bars (69 FR 47212). Ventral coloration ranges from almost uniform white or pale yellow to a variegated pattern of white, pale yellow, and black (Jennings and Hayes 1994). The salamander's small eyes have black irises and protrude from their heads (Jennings and Hayes 1994). During the breeding season, the cloacal region of males becomes enlarged (Petranka 1998) and is a useful means of distinguishing sexes. Males also have larger tails with more developed fins.

2A.31.4.2 Activity Patterns

Adults emerge from upland sites on rainy nights during fall and winter rains to feed and migrate to breeding ponds (Stebbins 1989, 2003; Shaffer et al. 1993). Adults generally use the same traditional migratory routes between breeding pools and upland burrows each year (Loredo et al. 1996; Petranka 1998). Metamorphosed juveniles leave the breeding sites in late spring or early summer and migrate to small mammal burrows (Zeiner et al. 1988; Shaffer et al. 1993; Loredo et al. 1996). Like adults, juveniles may emerge from burrows to feed during nights of high relative humidity (Storer 1925; Shaffer et al. 1993) before settling in their selected upland sites for the summer months. California tiger salamanders are also active in and feed while in burrows (van Hattem 2004). While most California tiger salamanders rely on rodent burrows for shelter, some individuals may use soil crevices as temporary shelter during upland migrations (Loredo et al. 1996).

2A.31.4.3 Reproduction

California tiger salamanders breed and lay eggs in vernal pools and ponds following relatively warm rains between November and February (Shaffer and Fisher 1991). Adults engage in mass migration (however, only a portion of the adult population emerges from underground burrows to breed in any given year) during a few rainy nights and leave the breeding ponds shortly after breeding. Males usually migrate to the breeding pond before females (Twitty 1941; Shaffer et al. 1993; Loredo and van Vuren 1996; Trenham 1998b) and remain in the ponds for an average of 6 to 8 weeks, while females stay for approximately 1 to 2 weeks (69 FR 47212). Breeding activity occurs in pulses depending on rainfall patterns and wetland inundation. In drought years, insufficient water in the breeding pools may prevent breeding (Barry and Shaffer 1994). Late rains may also affect breeding opportunities and reproductive success (Trenham et al. 2000). Barry and Shaffer (1994) suggest that while local California tiger salamander populations may not breed during drought years when ephemeral pools do not fill, the longevity of adults is probably sufficient to ensure population persistence through all but the longest of droughts.

After mating, females lay eggs in the water and attach them singly or in small groups to underwater vegetation, including twigs, grass stems, or other debris (Storer 1925; Twitty 1941; Jennings and Hayes 1994). Following breeding, adults leave the pool and return to the upland habitat, emerging at night to feed during the breeding season (Shaffer et al. 1993; Loredo et al. 1996; Trenham 1998a). Eggs hatch into aquatic larvae in 2 to 4 weeks (Petranka 1998). Larvae metamorphose during the summer and migrate from the ponds at night during dry weather. The larval stage usually lasts 3 to 6 months (Petranka 1998), but individuals may remain in their breeding sites over the summer if breeding pools remain inundated (Shaffer and Trenham 2005). The longer the inundation period, the larger the larvae and metamorphosed juveniles are able to grow, and the more likely they are to survive and reproduce (Semlitsch et al. 1988; Pechmann et al. 1989; Morey 1998; Trenham 1998b).

2A.31.4.4 Movements and Spatial Considerations

The distance between occupied upland habitat and breeding sites depends on local topography and vegetation, and the distribution of California ground squirrel or other rodent burrows (Stebbins 1989). While juvenile California tiger salamanders have been observed to disperse up to 2.59 kilometers (1.6 miles) from breeding pools to upland areas (Austin and Shaffer 1992) and adults have been observed up to 2 kilometers (1.2 miles) from breeding ponds, most movements are closer to the breeding pond. Trenham et al. (2001) observed California tiger salamanders moving up to 670 meters (0.42 mile) between breeding ponds in Monterey County. Similarly, Shaffer and Trenham (2005) found that 95% of California tiger salamanders resided within 640 meters (0.4 mile) of their breeding pond at Jepson Prairie in Solano County.

Interconnectivity of breeding sites may be an important factor in long-term conservation of this species in order to sustain the species' metapopulation structure, where local extinction and recolonization by migrants of other subpopulations are probably common (69 FR 47212). Thus, providing movement corridors between potential breeding sites and avoiding isolation of these sites may counterbalance the effects of normal ecological processes (e.g., drought) that may result in local extinctions by allowing for movements to new sites and facilitating recolonization (Semlitsch et al. 1996).

2A.31.4.5 Diet

Adults probably feed mainly on a variety of invertebrates, including earthworms, snails, and insects, as well as fish and small mammals (Stebbins 1972; Lindquist and Bachmann 1980). Aquatic larvae feed on littoral, benthic, and planktonic arthropods (Anderson 1968b).

2A.31.5 Threats and Stressors

2A.31.5.1 Urbanization and Habitat Fragmentation

Conversion of land to residential, commercial, and agricultural activities is considered the most significant threat to California tiger salamanders. These activities result in destruction and fragmentation of upland and/or aquatic breeding habitat and killing of individual California tiger salamanders (Twitty 1941; Hansen and Tremper 1993; Shaffer et al. 1993; Jennings and Hayes 1994; Fisher and Shaffer 1996; Launer and Fee 1996; Loredo et al. 1996; Davidson et al. 2002).

Roads can fragment breeding and dispersal migratory routes in areas where they traverse occupied habitat. Features of road construction, such as solid road dividers, can further impede migration, as can other potential barriers such as berms, pipelines, and fences.

2A.31.5.2 Nonnative Predators

Exotic species, such as bullfrog, mosquitofish (*Gambusia affinis*), sunfish species (e.g., largemouth bass [*Micropterus salmoides*] and bluegill [*Lepomis macrochirus*]), catfish (*Ictalurus* spp.), and fathead minnows (*Pimephales promelas*), that live in perennial ponds—such as stock ponds—are considered to have negatively affected California tiger salamander populations by preying on larval salamanders (Anderson 1968a; Morey and Guinn 1992; Graf and Allen-Diaz 1993; Shaffer et al. 1993; Seymour and Westphal 1994; Fisher and Shaffer 1996; Lawler et al. 1999; Laabs et al. 2001; Leyse 2005).

Fisher and Shaffer (1996) suggest that elevation may be a factor in local extirpations due to exotic predators. They suggest that introduced exotics are more common in low-elevation aquatic habitats (below 200 meters [656 feet]) and that habitat modification and low levels of topographic relief may facilitate invasion by increasing opportunities for dispersal through interconnected watersheds or terrestrial habitats, or through deposition by floodwaters (Fisher and Shaffer 1996).

2A.31.5.3 Hybridization

Riley et al. (2003) examined hybridization between California tiger salamanders and an introduced congener, the tiger salamander (*Ambystoma tigrinum*). Hybridization with the barred tiger salamander (*Ambystoma tigrinum mavortium*) has been occurring since fishermen and bait shop owners began introducing the species 50 to 60 years ago, resulting in 15 to 30 generations of genetic mixing (Fitzpatrick and Shaffer 2004). The sale and use of *A. trigrinum* as bait is now illegal in California. In the Salinas Valley, Riley et al. (2003) sampled salamanders from four artificial ponds and two natural vernal pools. Based on mitochondrial DNA and two nuclear loci, Riley et al. (2003) found that hybrids were present in all six ponds, and that these hybrids were viable and fertile. Fitzpatrick and Shaffer (2004) report more nonnative alleles in large perennial ponds despite the

proximity of ephemeral ponds, perhaps attributable to the presence of open water refugia providing an extended breeding season or facilitating a paedomorphic life history strategy in which adult nonnative salamanders retain larval characteristics. Fitzpatrick and Shaffer (2007a) report evidence of hybrid vigor or increased fitness of hybrids based on early-larval survival (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

The distribution of introduced tiger salamander genes is largely confined to within 7.5 miles (12 kilometers) of introduction sites, where the transition between hybrids and natives is abrupt (Fitzpatrick and Shaffer 2007b). More research is required to explain this abrupt change in allele distribution. One possible explanation is a strong selection for certain hybrid characteristics in local populations (e.g., hybrid survival is higher in permanent ponds than in seasonal ponds) (Fitzpatrick and Shaffer 2007b). Another potential explanation is that the spread of genes is limited by salamander dispersal capabilities so that the "wave" of hybridization has only reached 12 kilometers to date. In 2009, with expanded genomic sampling, Fitzpatrick et al. (2009) document the spread of a few introduced genes 58 miles (90 kilometers) into the California tiger salamander range within a 60-year period. Meanwhile, a majority of genetic markers show little evidence of spread beyond the region where introductions occurred.

The southern boundary of the Plan Area is approximately 75 miles from the introduction sites in the Salinas Valley. Although Fitzpatrick et al. (2009) document the spread of a few introduced genes as described above, a majority of genetic markers in the 2009 study show little evidence of spread beyond the region where introductions first occurred. These hybrid populations have been documented approximately 30 and 50 miles, respectively, from the southern boundary of the Plan Area. The closest nonnative barred salamander population is documented in San Benito County, approximately 55 miles from the southern boundary of the Plan Area.

It is unlikely that hybridization or nonnative alleles occur in California tiger salamander populations found in the Plan Area and hybridization does not appear to be a serious threat at this time. It is reasonable to assume that there would be a small percentage of nonnative alleles found in California tiger salamander populations in the Plan Area during the 50-year permit term.

Based on current understanding of California tiger salamander hybridization, Fitzpatrick et al. (2009) believe that genetic purity is an impractical conservation goal, and such a goal would present the statistical challenge of evaluating genetic purity for the California tiger salamander. The genetic influence of introduced barred tiger salamanders beyond the Salinas Valley is negligible for most markers, such that there remains a sharp distinction between mostly pure native populations and the admixed populations of the Salinas Valley.

2A.31.5.4 Pesticides

Pesticides, hydrocarbons, and other pollutants are all thought to negatively affect breeding habitat, while rodenticides and gases used in burrowing mammal control (e.g., chlorophacinone, diphacinone, strychnine, aluminum phosphide, carbon monoxide, and methyl bromide) are considered toxic to adult salamanders (Salmon and Schmidt 1984). California ground squirrel and pocket gopher control operations may have the indirect effect of reducing the availability of upland burrows for use by California tiger salamanders (Loredo-Prendeville et al. 1994).

2A.31.6 Relevant Conservation Efforts

Critical habitat has been designated in 19 counties in central California (70 FR 49380). However, there are no critical habitat units in the Plan Area. A critical habitat unit initially planned for East Contra Costa County was rejected because the *East Contra Costa County Habitat Conservation Plan/Natural Communities Conservation Plan* (under which the California tiger salamander is a covered species) was permitted and operable and is expected to sufficiently address conservation of the species within that area. Occupied sites in the Plan Area are also in the East Contra Costa County Habitat Conservation Plan/Natural Communities Conservation Plan Area (East Contra Costa County 2006).

A conservation strategy for the Santa Rosa Plains population of California tiger salamanders and other sensitive species has been finalized (U.S. Fish and Wildlife Service 2005); however, the local implementing agencies have to date been unsuccessful in adopting implementing ordinances or acquiring funding. The plan establishes conservation areas throughout the plan area and guidance regarding preserve acquisition and management, habitat enhancement, and mitigation.

Several other habitat conservation plans that address the California tiger salamander are either in progress or are operational. Plans that overlap or are near the Plan Area and include the California tiger salamander as a covered species are the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (Contra Costa County 2006), the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), the *Yolo Natural Heritage Program Plan Habitat Conservation Plant/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011), the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), and the *Butte Regional Habitat Conservation Plan and Natural Community Conservation Plan* (Butte County Association of Governments 2011). Each does or will include conservation measures to protect and restore populations and habitat for this species.

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the California tiger salamander as a Maintain (CALFED Bay-Delta Program 2000). This means that the program will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects to the species created by program restoration actions. To the extent practicable, the program will improve species habitat conditions.

East Bay Regional Parks District has established protections of California tiger salamanders and California red-legged frogs on lands in the vicinity of the Los Vaqueros watershed, west of the Plan Area in Contra Costa and Alameda Counties. Actions focus on protection of breeding sites, maintaining an intact landscape and protecting movement corridors, and managing grazing regimes.

In June 2009, East Bay Municipal Utility District and USFWS finalized the largest environmental safe harbor agreement awarded to a single landowner. The 30-year agreement covers 28,000 acres of San Joaquin, Amador and Calaveras Counties (U.S. Fish and Wildlife Service 2009).

2A.31.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.31.7.1 GIS Model Data Sources

The California tiger salamander model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture 2005), and land use survey of the Sacramento–San Joaquin River Delta (Delta) and Suisun Marsh area-version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable California tiger salamander habitat in the Plan Area according to the species' two primary life requisite parameters: aquatic breeding and terrestrial/aestivation cover, and aestivation habitat. Vegetation types were assigned based on the species' requirements as described above and the assumptions described below.

2A.31.7.2 Terrestrial Cover and Aestivation Habitat Model Description

Modeled terrestrial cover and aestivation habitat is defined as all grassland types with a minimum patch size of 100 acres (40.5 hectares) located west of the Yolo Basin but including the Tule Ranch Unit of the California Department of Fish and Wildlife (CDFW) Yolo Basin Wildlife Area; east of the Sacramento River between Freeport and Hood-Franklin Road; east of Interstate 5 (I-5) between Twin Cities Road and the Mokelumne River; and in the area south and west of State Route (SR) 4 from Antioch (Bypass Road to Balfour Road to Brentwood Boulevard) to Byron Highway; then south and west along the county line to Byron Highway; then west of Byron Highway to Interstate 205 (I-205), north of I-205 to Interstate 580 (I-580), and west of I-580. These geographically described areas were developed into a habitat constraint geographic information system (GIS) layer to limit the qualifying terrestrial habitat extents. Grasslands associated with south Montezuma Hills and Potrero Hills were also included. Grassland strips solely occurring atop levees and not adjacent to grassland areas were excluded. The excluded grassland strips were manually selected and developed into a GIS layer by visually reviewing grassland strips that occurred atop the levees, and comparing them to 2005 aerial photographs (U.S. Department of Agriculture 2005). These identified locations were removed from the habitat model. Patches of grassland that were below the 100-acre minimum patch size but were contiguous with grasslands outside of the Plan Area boundary were included.

Terrestrial covered and aestivation habitat includes the following types from the BDCP composite vegetation layer.

- Grassland
    - Ruderal herbaceous grasses and forbs
    - California annual grasslands–herbaceous
    - *Bromus diandrus–Bromus hordeaceus*
    - Italian ryegrass (*Lolium multiflorum*)

- *Lolium mulitflorum–Convolvulus arvensis*
- Degraded vernal pool complex–California annual grasslands
- Degraded vernal pool complex–ruderal herbaceous grasses and forbs
- Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
- Degraded vernal pool complex–vernal pools
- Annual grasses generic
- Annual grasses/weeds
- *Bromus* spp./*Hordeum*
- *Hordeum*/*Lolium*
- *Lolium* (generic)
- *Lotus corniculatus*
- Medium upland graminoids
- Medium upland herbs
- Perennial grass
- Short upland graminoids
- Upland annual grasslands and forbs formation
- Upland herbs

- Alkali seasonal wetland complex
  - *Distichlis spicata*–annual grasses

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. For California tiger salamander, in the new analysis areas, the following natural communities were assumed to provide terrestrial cover and aestivation habitat.

- Alkali seasonal wetland complex (all except Conservation Zone 2)
- Grasslands (all except Conservation Zone 2)
  - Upland annual grasslands & forbs formation

2A.31.7.3 Assumptions

- **Assumption:** California tiger salamander terrestrial cover and aestivation habitat in the Plan Area is geographically constrained to areas described in Section 2A.31.7.2, *Terrestrial Cover and* Aestivation *Habitat Model Description***.**

  Rationale: Habitat for the California tiger salamander includes vernal pools and seasonal and perennial ponds including artificial stock ponds in a grassland landscape (Barry and Shaffer

1994; 69 FR 47212; Bobzien and DiDonato 2007). Because the mapping of aquatic breeding habitats in the Plan Area is incomplete, this element cannot be effectively used to model the extent of suitable habitat for this species. Thus, grasslands are used to more generally describe the extent of suitable habitat. Minimum patch size is 100 acres, which corresponds with the minimum conservation patch size identified by Trenham (2009). Grasslands located along the narrow eastern edge of Suisun Marsh that were contiguous with the larger grassland/agricultural landscape of the Montezuma Hills were reviewed and removed from the terrestrial cover and aestivation habitat component of the model because most appeared transitional to the tidal marsh wetlands that are not suitable for the California tiger salamander. The model is further constrained geographically by eliminating grasslands that are not within seasonal pool or pond/grassland landscapes, such as the central Delta. While periodic flooding may preclude the California tiger salamander from occurring in the Yolo Bypass, the vernal pool landscape on the CDFW Tule Ranch Unit and other similar areas on the CDFW Yolo Bypass Wildlife Area could potentially support this species in some years. These areas are mapped as alkali seasonal wetland complex (*Distichlis spicata*-annual grasses); however, they have a substantial grassland component. The model overestimates suitable habitat by assuming there are sufficient aquatic breeding habitats within the grassland landscape as defined.

2A.31.7.4 Aquatic Breeding Habitat Model Description

Modeled aquatic breeding habitat for the California tiger salamander includes vernal pools and seasonal and perennial ponds. Aquatic breeding habitat includes the following land cover types and conditions that are within the grassland landscape as defined above.

- Vernal pool complex
    - *Allenrolfea occidentalis* mapping unit
    - Annual grasses generic
    - Annual grasses/weeds
    - California annual grasslands–herbaceous
    - *Distichlis* (generic)
    - *Distichlis*/annual grasses
    - *Distichlis*/*S. maritimus*
    - *Distichlis spicata*
    - *Distichlis spicata*–annual grasses
    - Italian ryegrass (*Lolium multiflorum*)
    - Mix *Schoenoplectus* (formerly *Scirpus*) mapping unit
    - Ruderal herbaceous grasses and forbs
    - *Salicornia virginica* (formerly *Sarcocornia*)
    - *Salicornia*/annual grasses
    - Salt scalds and associated sparse vegetation
    - Saltgrass (*Distichlis spicata*)

- Seasonally flooded grasslands
- *Suadeda moquinii*–(*Lasthenia californica*) mapping unit
- Vernal pools

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide terrestrial cover and aestivation habitat for the California tiger salamander.

- Vernal pool complex

2A.31.7.5 Assumptions

- **Assumption:** California tiger salamander breeding habitat in the Plan Area is geographically constrained to areas described in Section 2A.31.7.4, *Aquatic Breeding Habitat Model Description*.

  Rationale: Aquatic breeding habitats are mapped to the extent data are available, but not used as a model attribute. The data for vernal pools and other seasonal wetlands and stock ponds are insufficient to effectively model California tiger salamander habitat on the basis of aquatic breeding habitat. Vernal pools and other seasonal rain pools are the primary breeding habitat of California tiger salamanders (Barry and Shaffer 1994; 68 FR 13498). California tiger salamander is also known to successfully reproduce in ponds, including artificial stock ponds (Barry and Shaffer 1994; 69 FR 47212). Stock pond habitats are used almost exclusively at occupied sites on the western edge of the Plan Area and in the hills immediately west of the Plan Area (Bobzien and DiDonato 2007). Mapping of vernal pools and other isolated seasonal wetlands and stock ponds is incomplete. In lieu of this, the vernal pool complex natural community was used to represent aquatic breeding habitat, which comprises a combination of aquatic and upland habitat that is considered suitable for the California tiger salamander. Potential habitat included within the vernal complex natural community not having concave surfaces or land uses that are incompatible with the species' habitat requirements were removed from the vernal pool complex and aquatic breeding habitat components of the model. For example, polygons falling on lands that did not have characteristic vernal pool/swale signatures that would demonstrate seasonal inundation did not qualify for this habitat type. In other instances, some other vernal pool aquatic features were located in areas that had unsuitable land uses. These features were removed by developing a GIS layer that excluded habitat from these locations. This element of the model overestimates the extent of potential breeding habitat.

2A.31.8 Recovery Goals

A USFWS recovery plan has not yet been prepared for the California tiger salamander, although USFWS (69 FR 47212) has stated its intention to do so. There are currently no recovery goals established for this species.

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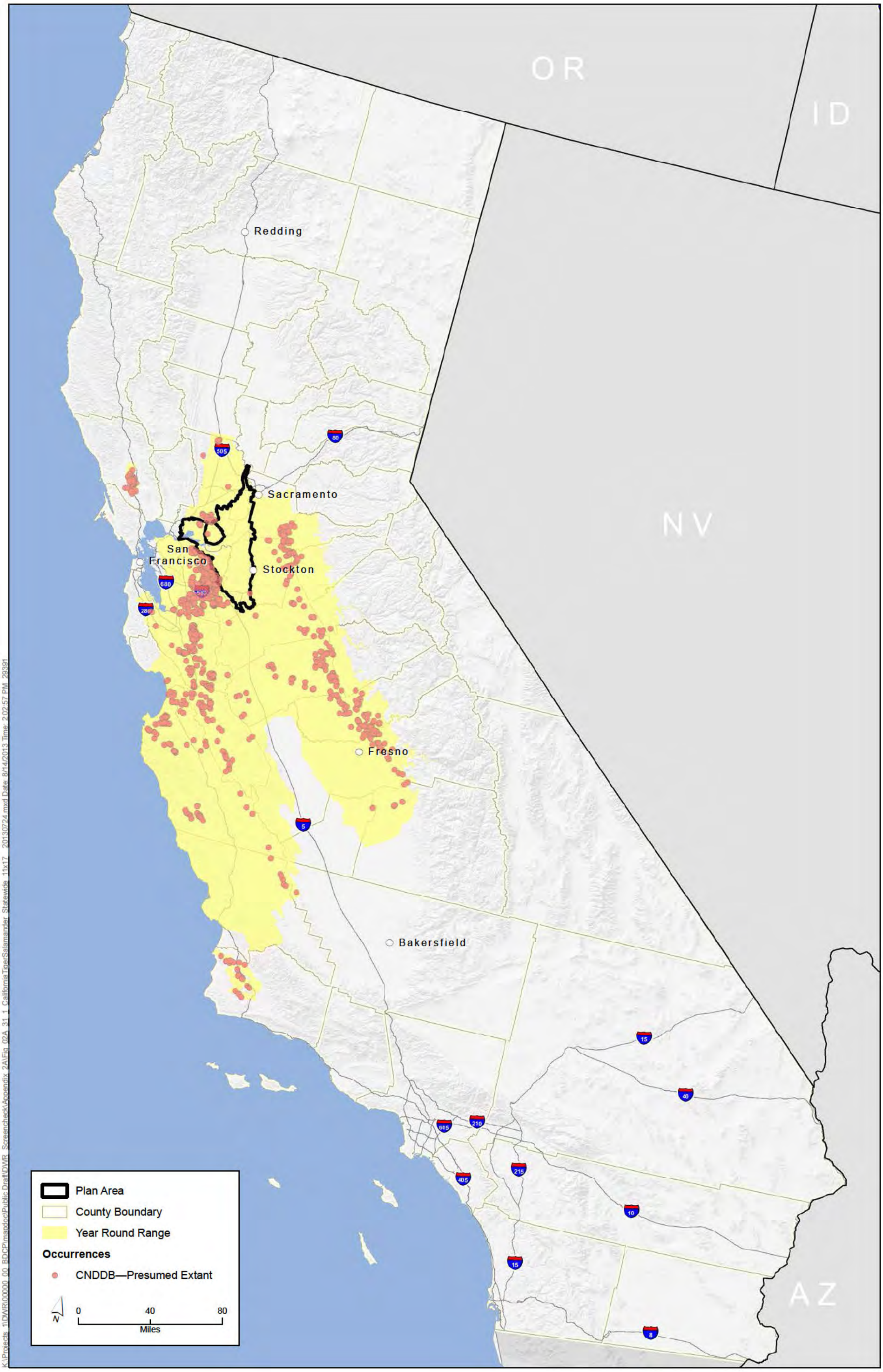
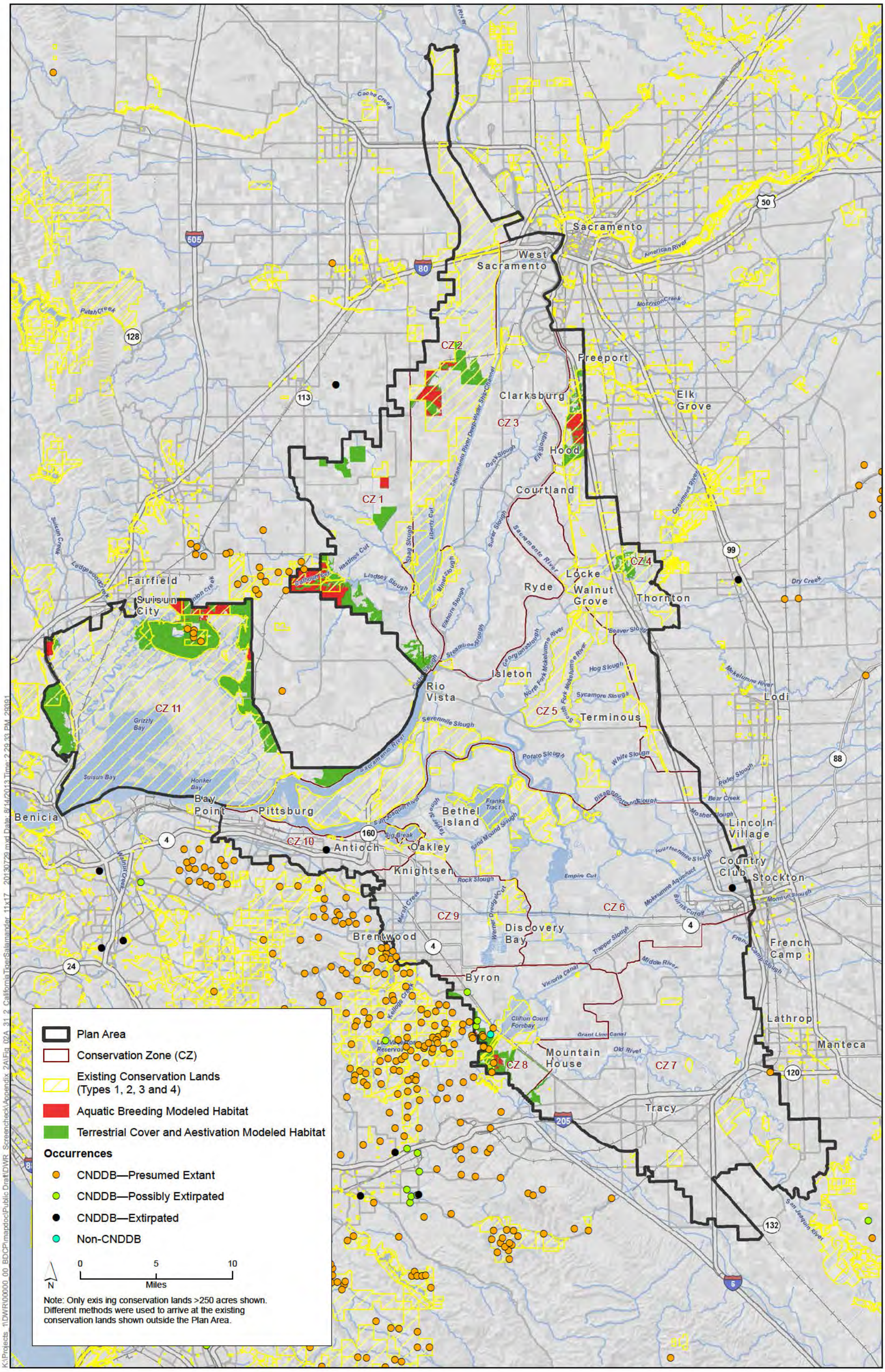


GIS Data Sources: Occurrences CNDDB June 2013; Range, DFG WHR 2008.

Figure 2A.31-1
California Tiger Salamander Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB 2013 and DHCCP 2009-2011.

Figure 2A.31-2
California Tiger Salamander Habitat Model and Recorded Occurrences

Appendix 2A.32
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)

2A.32.1 Legal Status

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) is listed as threatened under the federal Endangered Species Act (45 *Federal Register* (FR) 52803). On October 2, 2006, the U.S. Fish and Wildlife Service (USFWS), in their 5-year review, recommended for this species to be removed from the endangered species list (U.S. Fish and Wildlife Service 2006). Critical habitat was designated in the initial listing of the species (45 FR 52803); however, neither of the two sites designated as critical habitat occur in the Plan Area. The valley elderberry longhorn beetle has no state regulatory status.

2A.32.2 Species Distribution and Status

2A.32.2.1 Range and Status

The valley elderberry longhorn beetle is one of three species of *Desmocerus* in North America and one of two subspecies of *D. californicus*. The valley elderberry longhorn beetle subspecies is a narrowly defined, endemic taxon, limited to portions of the Central Valley generally below 914 meters (3,000 feet) in elevation (Figure 2A.32-1) (U.S. Fish and Wildlife Service 1999).

Historically, valley elderberry longhorn beetle presumably occurred throughout the Central Valley. Little is known about the historical abundance of valley elderberry longhorn beetle. The extensive destruction of its habitat, however, suggests that the beetle's range has been largely reduced and fragmented (U.S. Fish and Wildlife Service 1984).

Studies to assess the distribution and extent of the valley subspecies began in the late 1970s (Eya 1976), and USFWS proposed the species for listing in 1978. Since valley elderberry longhorn beetle was listed in 1980 (45 FR 52803), numerous distributional studies have been conducted (summarized in Talley et al. 2006). In August 2011, USFWS found that a 90-day petition "presents substantial or commercial information indicating that delisting the valley elderberry longhorn beetle may be warranted," and initiated a status review of the species to determine if delisting is warranted. A 12-month finding will be issued based on the status review (76 FR 51929). This initial finding was based on the number of sightings throughout the Central Valley and the reduction in primary threats to this species (habitat loss) and the USFWS 2006 5-year review for the species (U.S. Fish and Wildlife Service 1984, 2006).

Subsequent to various surveys throughout the Central Valley (Linsley and Chemsak 1972; Eya 1976; Jones & Stokes 1985, 1986, 1987a, 1987b; Barr 1991; Collinge et al. 2001), USFWS (1999) prepared a map of the presumed range of valley elderberry longhorn beetle. This map encompasses the entire California Central Valley and the Sacramento River Delta below 914 meters (3,000 feet) elevation.

Habitat occupied by valley elderberry longhorn beetle tends to form and exist in riparian corridors and on the level open ground of periodically flooded river and stream terraces and floodplains. This geomorphic setting historically has been desirable for agricultural, urban, or industrial development. As a result, much of this habitat type has been converted, through the construction of dams and levees, to land that could be developed. Although it has been estimated that 90% of California riparian habitat has been lost over the last century and a half (Smith 1980; Barr 1991; Naiman et al. 1993; Naiman and Décamps 1997), these losses are difficult to accurately quantify in terms of valley elderberry longhorn beetle habitat losses (Talley et al. 2006). Therefore, an unknown amount of riparian forest and elderberry savannah habitat has been lost and an unknown number of valley elderberry longhorn beetle populations as well (Collinge et al. 2001).

2A.32.2.2 Distribution and Status in the Plan Area

The current distribution of valley elderberry longhorn beetle inthe Plan Area is largely unknown. There are only three reported occurrences of valley elderberry longhorn beetle from the Plan Area, including one in Conservation Zone 7along Middle River north of Tracy and two occurrences in Conservation Zone 3 along small drainages between the Sacramento River and the Sacramento Deep Water Ship Channel in the vicinity of West Sacramento (Figure 2A.32-2) (California Department of Fish and Game 2012). There are additional historical occurrences from along the Sacramento River corridor and Putah Creek in Yolo County (Eya 1976; Jones & Stokes 1985, 1986, 1987a, 1987b; U.S. Fish and Wildlife Service 1984; Barr 1991; Collinge et al. 2001). Comprehensive surveys for the species or its host plant, elderberry (*Sambucus* sp.), have not been conducted and thus the population size and location of the species in the Plan Area is unknown. Distribution is typically based on the occurrence of elderberry shrubs, which are known to occur along riparian corridors throughout the Plan Area, including the Sacramento River, Stanislaus River, San Joaquin River, and along smaller natural and channelized drainages, as well as in upland habitats. The valley elderberry longhorn beetle is considered to potentially occur in all elderberry shrubs in the Plan Area with stems over 2 centimeters in diameter at ground level. The California Department of Water Resources (DWR) conducted surveys for elderberry shrubs within the conveyance planning area (the general area of the three conveyance options) in 2009 where they identified several hundred elderberry shrubs (California Department of Water Resources 2011). These shrubs were not surveyed for exit holes and no formal stem counts were conducted (California Department of Water Resources 2011).

2A.32.3 Habitat Requirements and Special Considerations

Valley elderberry longhorn beetle is endemic to moist valley oak riparian corridors in the lower Sacramento and lower San Joaquin valleys (U.S. Fish and Wildlife Service 1984). Valley elderberry longhorn beetle is closely associated with elderberry (*Sambucus* spp.). These plants are an obligate host plant for larvae and are necessary for the completion of the life cycle (Linsley and Chemsak 1972, 1997; Eng 1984; Barr 1991; Collinge et al. 2001). The two main species of elderberry used by this species are the blue elderberry (*Sambucus nigra* subsp*. caerulea,* formerly *S. mexicana*) and red elderberry (*S. racemosa*). Blue elderberry is a component of riparian habitats throughout the Central Valley. Although this shrub occasionally occurs outside riparian areas, shrubs supporting the

greatest beetle densities are located in areas where the shrubs are abundant and interspersed in significant riparian zones (Talley et al. 2006).

Talley et al. (2006) note that the inundation regime, measured as relative elevation above the river, was the primary controller of elderberry distributions across floodplains in the lower alluvial reaches of the American River, Cache Creek, Cosumnes River, and Putah Creek. Shrub frequency was found to be highest at intermediate relative elevations, with flooding affecting low elevations and water availability restricting upper elevations (Talley et al. 2006). The relative elevation value at which elderberry frequency is highest, has been found to increase with river width illustrating an interaction with the geomorphology of the river (Talley et al. 2006). At middle and upper elevations, elderberry frequency increased with limited competition (little or no canopy) and finer soil texture, which has higher water-holding capacity (Talley et al. 2006).

In a study along the American River in Sacramento County, Talley et al. (2007) found that shrub occupancy (11.2%) by valley elderberry longhorn beetle was highest in the lower alluvial plain in areas with shallow groundwater and that are relatively open, with little canopy cover and ground cover. However, the next highest rates for occupied shrubs in Talley et al.'s (2007) study were found in midelevation riparian corridors (10.5%) with high structural complexity. This riparian corridor type had elderberry shrubs occurring on the steepest slopes, beneath the densest canopy cover, and the highest ground cover of the areas analyzed (Talley et al. 2007). The lowest occupancy rates identified in the study were for nonriparian scrub habitats where only 2.9% of shrubs were occupied by valley elderberry longhorn beetle (Talley et al. 2007). Overall, the Talley et al. (2007) study along the American River found that riparian habitat was of higher value than nonriparian scrub habitats as evidenced by higher occupancy of elderberry shrubs by valley elderberry longhorn beetle.

The Talley et al. (2007) study also suggests that the dispersal distances of adult beetles from the sites at which they emerge typically are less than 50 meters. Isolated elderberry shrubs separated from contiguous habitat by extensive development are not typically considered to provide viable habitat for the valley elderberry longhorn beetle (U.S. Fish and Wildlife Service 1998; Collinge et al. 2001).

2A.32.4 Life History

2A.32.4.1 Description

The valley elderberry longhorn beetle is an atypical lepturine (the Lepturinae is a subfamily of the Cerambycidae, longhorn beetle family). Elderberry beetles are separated from all other lepturines by the form of the mandibles, which are broad and short, without internal pubescence (Linsley and Chemsak 1972). Females have a dark metallic green to black elytra and a bright red border, and males have an elytra that is predominantly red with four oblong, dark metallic spots (Talley et al. 2007). The pronotum (plate behind the head) is smooth, with confluent punctuations. The elytra are densely punctate or rugose. Adult male beetles range from 14 to 25 millimeters (0.5 to 1.0 inch) in length and females range from 19 to 25 millimeters (0.75 to 1.0 inch) (U.S. Fish and Wildlife Service 2009).

The valley elderberry longhorn beetle was described as a separate species by Fisher (1921) and was reduced to subspecific status by Doane et al. (1936). The majority of male valley elderberry

longhorn beetles can be distinguished from other subspecies by the short, suberect, pale setae (bristle or hair-like structures) on the antennae (as opposed to dark setae) and the black markings on each forewing (Linsley and Chemsak 1972). The female valley elderberry longhorn beetle cannot be distinguished morphologically from other subspecies.

2A.32.4.2 Life Cycle

Adult valley elderberry longhorn beetles live for a few days to a few weeks between mid-March and mid-May, and are most active from late April to mid-Ma y. The adult beetles feed on the elderberry foliage and possibly its flowers. During this time of activity, the beetles mate, and the female lays eggs on the living elderberry plant host. The eggs are typically placed individually or in small clusters within crevices in the bark or junctions of the stem and trunk or leaf petiole and stem. Eggs hatch within a few days and soft-bodied larvae emerge. The larvae are on the surface of the elderberry from a few minutes to several hours or a day and then bore to the center of the elderberry stems where they create a feeding gallery in the pith at the center of the stem. The larvae develop for 1 to 2 years feeding on pith. The late instar larvae chew through the inner bark, all or most of the way to the surface, then return inside plugging the holes with wood shavings. The larvae move back down the feeding gallery to an enlarged pupal chamber packed with frass. Here the larvae metamorphose into pupae between December and April (Talley et al. 2006).

The length of pupation is thought to be about one month with the emergent adult remaining in the chamber for up to several weeks. Adults complete the hole in the outer bark and emerge during the flowering season of elderberry shrubs. The exit holes are circular to oval and range in size from 4 to 10 millimeters in diameter (Talley et al. 2006).

2A.32.5 Threats and Stressors

The greatest historical threat to the valley elderberry longhorn beetle has been the elimination, loss, or modification of its habitat by urban, agricultural, or industrial development and other activities that reduce or eliminate its host plants (Talley et al. 2006). While mitigation and restoration actions do not come close to restoring the enormous amount of habitat lost in the more remote past, they appear to be adequate for current levels of impact (Talley et al. 2006). However Talley et al. (2006) observed that the quality and persistence of mitigation and restoration efforts are uncertain and that there have been declines in the total number of valley elderberry longhorn beetle-occupied sites and in the number of riparian sites. Talley et al. (2006) also noted that the information included in reports is often unusable, making assessments of mitigation and restoration success difficult.

Argentine ant (*Linepithema humile*) has been identified as a potential threat to valley elderberry longhorn beetle (Talley et al. 2006). This ant is an aggressive competitor and predator of native arthropods throughout riparian habitats in California, and has been observed preying on valley elderberry longhorn beetle larvae (Talley et al. 2006). Argentine ants have been inadvertently introduced into valley elderberry longhorn beetle mitigation sites from nursery stock and are able to proliferate there due to irrigation established for mitigation plantings (Argentine ants require moisture) (Talley et al. 2006).

The nonnative invasive European earwig is also considered to be a threat to the valley elderberry longhorn beetle through predation or by supporting higher populations of insect predators (Talley

et al. 2006), and earwig populations are also significantly larger in mitigation plantings and irrigated areas (Klasson et al. 2005).

Nonnative invasive plant species such as black locust (*Robinia pseudoacacia*), giant reed (*Arundo donax*), red sesbania (*Sesbania punicea*), Himalaya blackberry (*Rubus armeniacus*), tree of heaven (*Ailanthus altissima*), Spanish broom (*Spartium junceum*), Russian olive (*Elaeagnus angustifolia*), edible fig (*Ficus carica*), and Chinese tallowtree (*Sapium sebiferum*), may have significant indirect impacts on the valley elderberry longhorn beetle by affecting elderberry shrub vigor and recruitment (Talley et al. 2006). Ripgut brome (*Bromus diandrus*), foxtail barley (*Hordeum murinum*), Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*), and yellow starthistle (*Centaurea solstitialis*) may impair elderberry germination or establishment, or elevate fire risk (Talley et al. 2006).

Long-term data regarding site persistence, population size and dynamics, extirpation, and recolonization are lacking, as are estimates regarding the minimum self-sustaining population size, riparian forest corridor size, or habitat complex size for the valley elderberry longhorn beetle or other riparian forest organisms.

2A.32.6 Relevant Conservation Efforts

Conservation Guidelines for the Valley Elderberry Longhorn Beetle were established by USFWS in 1999 (U.S. Fish and Wildlife Service 1999). The guidelines were designed mainly to mitigate development-related impacts on valley elderberry longhorn beetle habitat. Using a formula based on stem sizes, habitat association, and presence of emergence holes, the guidelines require losses of elderberry shrubs that meet the minimum standard for potential occupancy to be mitigated through a program that identifies and secures suitable and approved mitigation land, and that includes transplanting of mature elderberry shrubs to the mitigation site. Replacement compensation uses a standardized stem replacement formula. In response to the increasing need for valley elderberry longhorn beetle mitigation, five private valley elderberry longhorn beetle mitigation banks have beenestablished between Shasta and San Joaquin Counties.

Valley elderberry longhorn beetle conservation has also been addressed in several regional conservation plans. It is a covered species under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003). It is proposed for coverage under the *South Sacramento Habitat Conservation Plan* (Sacramento County 2010), the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County 2011), and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the valley elderberry longhorn beetle as a Recovery species (CALFED Bay-Delta Program 2000). This means that the program has established a goal to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

The USFWS (2006) 5-year review for valley elderberry longhorn beetle identified over 50,000 acres of riparian habitat that has been protected in the Central Valley since 1980 (the year the species was

listed), and 5,193 acres of riparian habitat restored where over 130,000 elderberry shrubs were planted (U.S. Fish and Wildlife Service 2006).

2A.32.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.32.7.1 GIS Model Data Sources

The valley elderberry longhorn beetle model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]; aerial photography (U.S. Department of Agriculture 2005), and land use survey of the Sacramento–San Joaquin River Delta (Delta) area-version 3, land use survey of the Delta and Suisun Marsh area - version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable valley elderberry longhorn habitat in the Plan Area. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.32.7.2 Habitat Model Description

Riparian modeled habitat in the Delta includes the following types from the BDCP composite vegetation layer.

- Valley/foothill riparian–all types

Riparian modeled habitat in the Suisun Marsh and Yolo Basin includes the following riparian types from the BDCP composite vegetation layer.

- *Fraxinus latifolia*
- Fremont cottonwood–valley oak–willow (ash–sycamore) riparian forest not formally defined (NFD) alliance
- Mixed Fremont cottonwood–willow NFD alliance
- Mixed willow super alliance
- *Quercus agrifolia*
- *Salix lasiolepis*/*Quercus agrifolia*
- Valley oak alliance–riparian

Nonriparian channel and grassland modeled habitat in Suisun Marsh includes the following grassland and vernal pool complex types from the BDCP composite vegetation layer within 200 feet of streams.

- Annual grasses, generic
- Annual grasses/weed
- *Bromus* spp./*Hordeum*

- *Hordeum*/*Lolium*
- *Lolium* (generic)
- *Lotus corniculatus*
- Medium upland graminoids
- Medium upland herbs
- Perennial grass
- Short upland graminoids
- Upland annual grasslands and forbs formation
- Upland herbs
- Vernal pool complex types
    - *Distichlis* (generic)
    - *Distichlis spicata*
    - *Distichlis*/annual grasses
    - *Distichlis*/*Schoenoplectus maritimus* (formerly *Scirpus*)
    - *Salicornia virginica* (formerly *Sarcocornia*)
    - *Salicornia*/annual grasses

Nonriparian channels and grasslands modeled habitat in the Delta includes the following grassland and vernal pool complex types from the BDCP composite vegetation layer within 200 feet of streams.

- Grasslands–all types
- Vernal pool complex types
    - California annual grasslands–herbaceous
    - *Distichlis spicata*–Annual grasses
    - Ruderal herbaceous grasses and forbs
    - Italian ryegrass (*Lolium multiflorum*)

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for valley elderberry longhorn beetle:

- Valley/foothill riparian

2A.32.7.3 Assumptions

- **Assumption:** Valley elderberry longhorn beetle habitat in the Plan Area is restricted to areas and vegetative types described in Section 2A.32.7.2, *Habitat Model Description*.

  Rationale: This model identifies habitat for the valley elderberry longhorn beetle as locations where the elderberry shrub is expected to be found in the Plan Area and designates additional habitat as grasslands within 200 feet of streams. Note that elderberry shrubs are unevenly distributed along riparian corridors and adjacent upland habitats and in some areas may be lacking entirely. Thus, the model overestimates the extent of suitable habitat for valley elderberry longhorn beetle. Elderberry shrubs also occur incidentally along fence rows and in a variety of other disturbed conditions, particularly where birds may congregate and deposit seeds. This model does not include these incidental habitat areas, and thus in this respect may underestimate the distribution of potential habitat (i.e., elderberry shrubs) for the valley elderberry longhorn beetle in the Plan Area.

2A.32.8 Recovery Goals

The USFWS recovery plan for valley elderberry longhorn beetle was established in 1984 (U.S. Fish and Wildlife Service 1984). Because of the limited knowledge of the species' requirements, interim recovery objectives were restricted to the following:

- Preserve and protect known habitat sites to provide adequate conditions for the beetle.
- Survey riparian forests of the Sacramento and San Joaquin Valleys for presence of the species and incorporate findings into short- and long-term management programs.
- Determine ecological requirements and management needs of the species.
- Preserve and protect newly discovered habitat to provide suitable conditions for the species.
- Reestablish the species at rehabilitated habitat sites within the presumed historical range.
- Increase public awareness of the species through education and information programs.
- Enforce laws and regulations to protect the species.

2A.32.9 References Cited

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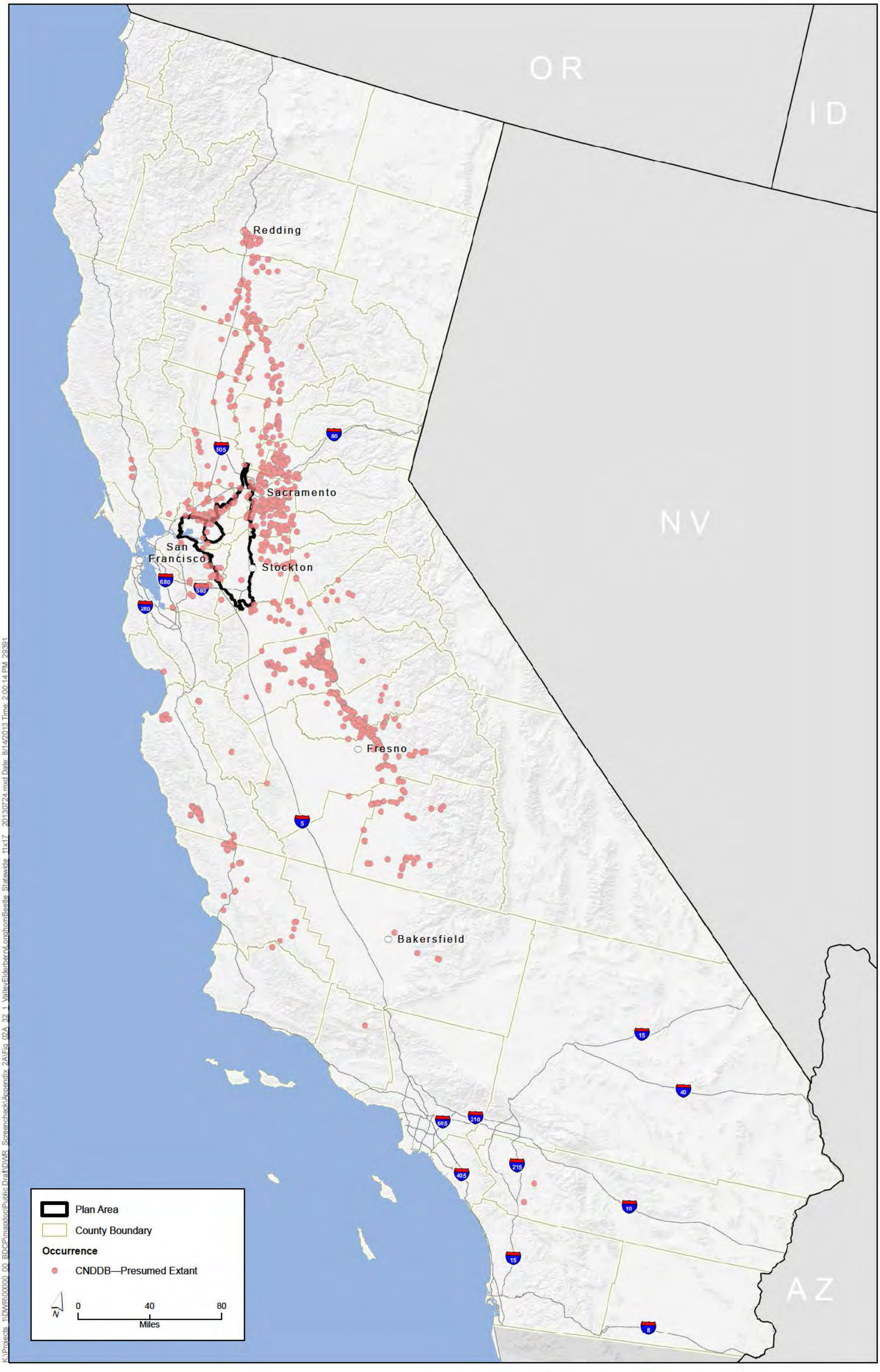
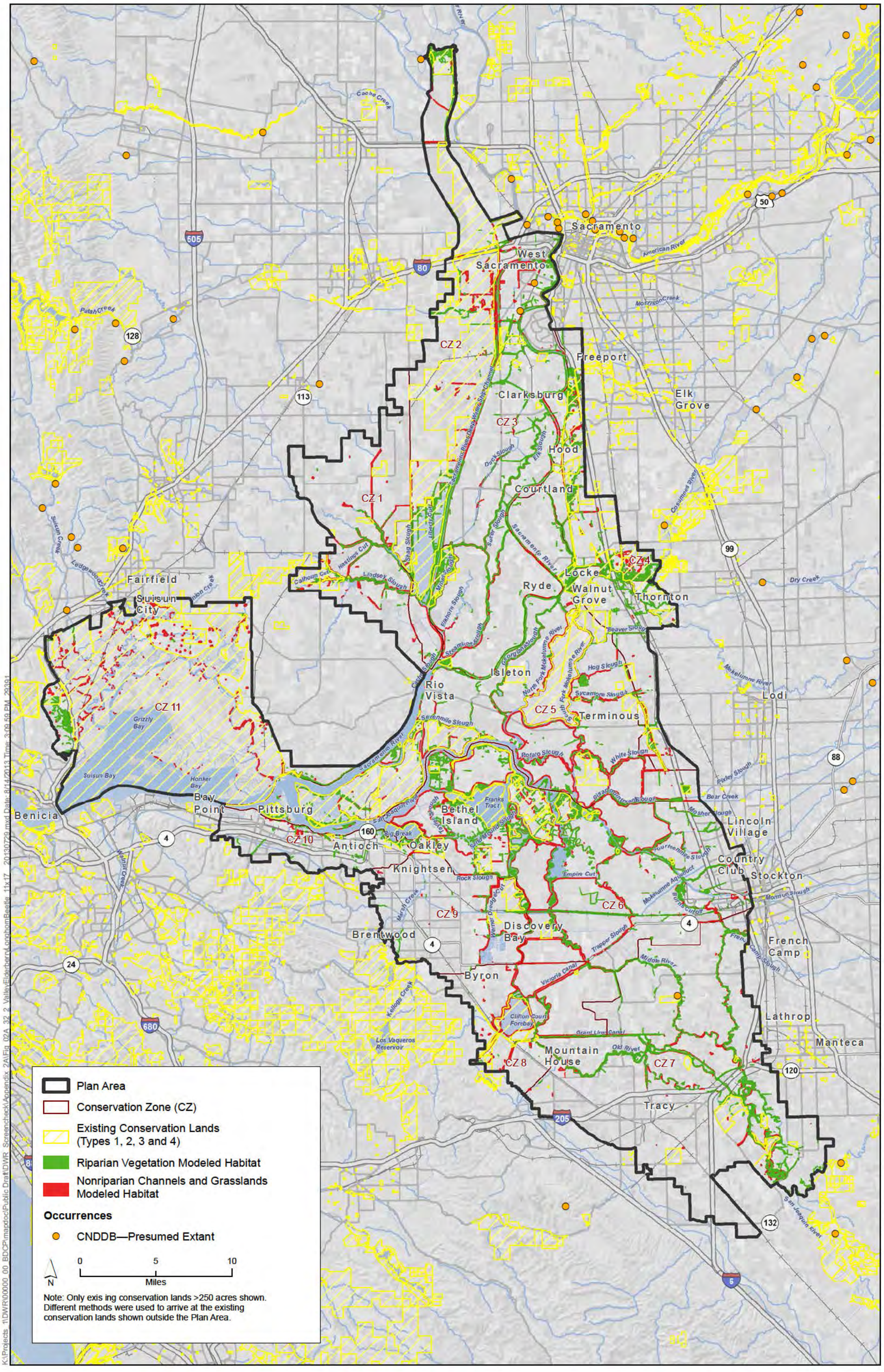


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.32-1
Valley Elderberry Longhorn Beetle Statewide Range and Recorded Occurrences



K:\Projects\1DWR\00000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix_2A\Fig_02A_32_2_ValleyElderberryLonghornBeetle_11x17_20130729.mxd Date: 8/14/2013 Time: 3:09:59 PM 29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.32-2
Valley Elderberry Longhorn Beetle Habitat Model and Recorded Occurrences

Appendix 2A.33
California Linderiella (*Linderiella occidentalis*)

2A.33.1 Legal Status

California linderiella (*Linderiella occidentalis*) is not listed under either federal or California endangered species acts. This species was addressed as a species of concern by the U.S. Fish and Wildlife Service (USFWS) (2005) *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan).

2A.33.2 Species Distribution and Status

2A.33.2.1 Range and Status

California linderiella is the most common fairy shrimp in California and is endemic to the state (Eriksen and Belk 1999). It has been reported in the Central Valley from Shasta County south to Fresno County and in the Coast and Transverse Ranges from Mendocino County south to Ventura County (Figure 2A.33-1) (Eriksen and Belk 1999; California Department of Fish and Game 2012), and it has been collected at elevations from near sea level to 3,800 feet (1,159 meters) (Eriksen and Belk 1999).

California linderiella co-occurs with vernal pool fairy shrimp (*Branchinecta lynchi*), midvalley fairy shrimp (*B. mesovallensis*), and infrequently with conservancy fairy shrimp (*B. conservatio*) (Eriksen and Belk 1999). It most often co-occurs in pools also inhabited by vernal pool fairy shrimp, in which case California linderiella are generally more numerous (Eriksen and Belk 1999).

2A.33.2.2 Distribution and Status in the Plan Area

California linderiella has been reported from several locations in the Plan Area (Figure 2A.33-2) (U.S. Fish and Wildlife Service 2005; California Department of Fish and Game 2012). In general, within the Plan Area, vernal pools that may support the species occur in Jepson Prairie in western Conservation Zone 1, in the California Department of Fish and Wildlife (CDFW) Tule Ranch Unit of the Yolo Bypass in Conservation Zone 2 Wildlife Area, in the Stone Lakes area in Conservation Zone 3, in western Conservation Zone 8 near the town of Byron, and along the eastern and northern boundary of Conservation Zone 11. California linderiella was observed in several pools in the Stone Lakes area and in the Clifton Court Forebay area during surveys conducted by the California Department of Water Resources in 2009 and 2010, respectively (Delta Habitat Conservation and Conveyance Program 2011).

2A.33.3 Habitat Requirements and Special Considerations

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters that California linderiella inhabits fill in the fall and winter during the beginning of the wet season, dry in late spring at the beginning of the dry season, and remain desiccated throughout the summer (Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from surface runoff and perched groundwater from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrologic functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons, the continuity and extent of hardpans and claypans underlying nonclay soils, the existence of a perched aquifer overlying the pans, slope, effects of vegetation on evapotranspiration rates, compaction of surface soils by grazing animals, and other factors (Marty 2005; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for California linderiella are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999; California Department of Fish and Game 2012). Common wetland plant species that co-occur with California linderiella include toad rush (*Juncus bufonius*), coyote thistle (*Eryngium* spp.), downingia (*Downingia ornatissima* and *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007).

California linderiella is a component of a larger invertebrate community (King et al. 1996; Rogers 1998; Eriksen and Belk 1999). This invertebrate community includes mostly planktonic Crustacea dependent on temporary waters, including copepods, cladocerans, and ostracods—as well as flatworms and a suite of insect species such as vernal pool haliplid beetle (*Apterliplus parvulus*), scimitar backswimmers (*Buenoa scimitra*), Ricksecker's water scavenger beetle (*Hydrochara rickseckeri*), and many others (Rogers 1998). These habitats usually support few opportunistic species that include mosquitoes and chironomid midges in the genus *Chironomus* (Rogers 1998).

2A.33.4 Life History

2A.33.4.1 Description

Like other fairy shrimp, California linderiella is entirely aquatic with a delicate elongate body, large stalked compound eyes, no carapaces, and eleven pairs of swimming legs. Males and females are generally differentiated on the basis of antennae development, thoracic projections, and brood pouch development. Live animals are off-white to grayish in color and are translucent. Unlike similar fairy shrimp in the genus Branchinecta, California linderiella tend to be slightly smaller and have distinctive red eyes. (Eriksen and Belk 1999)

2A.33.4.2 Reproduction and Growth

Like other fairy shrimp species, California linderiella are adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of the cysts to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cool, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the cysts may hatch. The egg bank in the soil may include cysts from several years of breeding (U.S. Fish and Wildlife Service 2005).

Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm (1998) found that California linderiella can reproduce in as early as 31 days following hatching with the average time being 43 days. Site-specific conditions, primarily water temperature, have been shown to affect the time to reach reproductive maturity (Helm 1998).

2A.33.4.3 Feeding

California linderiella is an omnivorous filter feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa. The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and apparently do not discriminate based on taste, as do some other crustacean groups (Eriksen and Belk 1999).

2A.33.4.4 Predation and Dispersal

Planktonic Crustacea are important in the food web, because they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1998; Bogiatto and Karnegis 2006).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Eriksen and Belk 1999).

2A.33.5 Threats and Stressors

The primary threats to vernal pool habitat and California linderiella, identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005), are described in the following subsections. Brief

summaries of the primary threats to California linderiella identified in the recovery plan are presented below.

2A.33.5.1 Random, Naturally Occurring Events

The continuing fragmentation of vernal pool crustacean habitat range-wide may result in small isolated occurrences of this species in some areas, which could make these populations vulnerable to random environmental fluctuations or variation due to annual weather patterns and availability of food and other environmental factors (U.S. Fish and Wildlife Service 2005).

2A.33.5.2 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (e.g., roads and utility projects), and recreational activities (e.g., off-highway vehicles and hiking). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

The 2005 Vernal Pool Recovery Plan identified the following threats to California linderiella.

- At the time the Vernal Pool Recovery Plan came out, 42 occurrences of California linderiella were threatened by development, and 13 occurrences were threatened by agricultural conversion.
- In the Northwestern Sacramento Valley Vernal Pool Region, California linderiella is threatened by development on private lands in Shasta and Tehama Counties.
- In the Northeastern Sacramento Valley Vernal Pool Region, the species is threatened by development on private land in Butte County.
- In the Livermore Vernal Pool Region, the species is threatened by development in Alameda County.
- In the Solano-Colusa Vernal Pool Region, the species is threatened by development where it occurs on private land in Solano County.
- In the Central Coast Vernal Pool Region, the species is threatened by development on private land in Monterey County.
- In the San Joaquin Vernal Pool Region, the species is threatened by development on private land in Stanislaus County.
- In the Southern Sierra Foothill Vernal Pool Region, the species is threatened by development and incompatible land uses on Bureau of Reclamation land in Madera County, and on private land in Madera, Merced, and Stanislaus Counties.
- In the Santa Barbara Vernal Pool Region, the species is threatened by development in Santa Barbara and Ventura Counties.

2A.33.5.3 Invasive Species

The invasions of vernal pools by waxy mannagrass (*Glyceria declinata*), a nonnative invasive aquatic grass (Gerlach et al. 2009), greatly increases the amount of decomposing biomass in vernal pools and may result in higher respiratory oxygen consumption relative to photosynthetic oxygen generation (Rogers 1998). Also, upland biomass of nonnative invasive species such as medusahead (*Elymus caput-medusae,* formerly *Taeniatherum*) can produce dense vegetation and thatch, shortening the ponding duration of some vernal pools (Marty 2005; Pyke and Marty 2005). Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*) has rapidly become a dominant nonnative invasive species of the uppermost zone of vernal pools and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

2A.33.5.4 Altered Hydrology

Human disturbances and changes in land use practices can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005).

2A.33.5.5 Climate Change

Habitat alteration may result from global climate and environmental changes, including nitrogen deposition, increase in atmospheric carbon dioxide, changes in precipitation patterns, and global warming. On a local scale, these changes may result in altering current vernal pool habitat to be more suitable to nonnative species and less suitable native species (U.S. Fish and Wildlife Service 2005).

2A.33.5.6 Grazing

Inappropriate grazing practices include complete elimination of grazing in area where nonnative grasses dominate the uplands surrounding vernal pools, and inappropriate timing or intensity of grazing. Appropriate grazing regimes help control nonnative weed plants such as Italian ryegrass and waxy mannagrass, which if unchecked can increase thatch buildup and decrease ponding durations and decrease the aquatic habitat available to California linderiella (U.S. Fish and Wildlife Service 2005; Marty 2005).

2A.33.6 Relevant Conservation Efforts

California linderiella is not listed; however, it may be protected through conservation efforts for vernal pool ecosystems in general. USFWS (2005) reports that 25 California linderiella occurrences are within existing reserves or mitigation sites.

California linderiella is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009) and the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011).

2A.33.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.33.7.1 GIS Model Data Sources

The California linderiella model uses vegetation types and associations from the following geographic information systems (GIS) data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]), LiDAR elevation data (California Department of Water Resources 2007), aerial imagery (Google 2009, 2011, 2012), and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable California linderiella habitat in the Plan Area according to the species' two habitat types: vernal pool complex and degraded vernal pool complex. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.33.7.2 Habitat Model Description

Modeled habitat for California linderiella includes vernal pool complex and degraded vernal pool complex. The methods for mapping these natural community types are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. Modeled habitat for this species also includes alkali seasonal wetlands, in Conservation Zone 8 only.

Vernal pool complex habitat represents high-value habitat for California linderiella. It consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for California linderiella includes the following vegetation subunits that were selected from the vernal pool complex natural community.

- Vernal pool complex-all vegetation types

Alkali seasonal wetland complex in Conservation Zone 8 also represents high-value habitat for this species. Modeled alkali seasonal wetland complex habitat includes all vegetation subunits from the alkali seasonal wetland natural community in Conservation Zone 8 only.

Degraded vernal pool complex in the Plan Area represents low-value habitat for California linderiella. This habitat includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools

Potential habitat without concave surfaces along the eastern border of Suisun Marsh was differentiated from other habitat using a GIS constraint layer. The methods used to identify areas without concave surfaces are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. These areas were included in the model as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for California linderiella.

- Vernal pool complex

2A.33.7.3 Assumptions

- **Assumption:** California linderiella potentially occurs in vernal pool complexes throughout the Plan Area.

  Rationale: This species is dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems (King et al. 1996; Helm 1998; Eriksen and Belk 1999). California linderiella has been reported from several locations within vernal pool complexes in the Plan Area (Figure 2A.33-2).

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide high value habitat for California linderiella.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

- **Assumption:** Mapped degraded vernal pool complex and areas without concave surfaces as indicated by LiDAR data represent low-value habitat for California linderiella.

  Rationale: Mapped degraded vernal pool complex in the Plan Area ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, disking, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. The aquatic features in this habitat generally do not hold water as long as intact and fully functional vernal pools: in many cases the features become saturated but never pond, or only pond after the largest storm events. Additionally, the aquatic features in the degraded vernal pool complex are at much lower densities than the intact vernal pool complexes. Because these features are saturated or inundated during the wet season and may have historically been located in or near areas with natural vernal pool complex, they may support individuals or small populations of species that are found in vernal pools and swales. However, they do not possess the full complement of ecosystem and community characteristics of natural vernal pools, swales, and their associated uplands and they are generally ephemeral features that are eliminated during the course of normal agricultural practices.

Areas with appropriate soil conditions and for which no concave surfaces are apparent on the LiDAR data may include features that occasionally inundate but are too small or shallow to show up on the LiDAR imagery. If present, these features are likely to occur at low densities and may be too ephemeral to support the species. However, because these areas do have the potential to support the species at low densities, they were classified as low-value habitat.

2A.33.8 Recovery Goals

For recovery of California linderiella, the overall goals identified in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity*, self-sustaining populations throughout the full ecological, geographic, and genetic range of the species and to ameliorate or eliminate threats to the species. Interim goals of the plan are to stabilize and protect populations, so that further decline in species status and range are prevented, and to conduct research to refine reclassification and recovery criteria (U.S. Fish and Wildlife Service 2005).

In general, the recovery goals for vernal pool crustaceans in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity,* self-sustaining populations throughout the full ecological, geographical, and genetic range of the species by ameliorating or eliminating the threats that caused the species to be listed (U.S. Fish and Wildlife Service 2005). Specifically, the goal of the Vernal Pool Recovery Plan is to ensure the long-term conservation of California linderiella (U.S. Fish and Wildlife Service 2005).

Interim goals of the Vernal Pool Recovery Plan are to stabilize and protect populations so further decline in species status and range are prevented, and conduct research to refine reclassification and recovery criteria (U.S. Fish and Wildlife Service 2005).

General recovery criteria for vernal pool species identified in the Vernal Pool Recovery Plan include habitat protection, adaptive habitat management and monitoring, status surveys, research, and participation and outreach, the specifics of which are stated in the recovery plan (U.S. Fish and Wildlife Service 2005).

Specific recovery criteria identified for California linderiella include the conservation of 80% of its occurrences and the protection from 85 to 95% of suitable vernal pool habitat in core recovery areas. The Jepson Prairie Core Recovery Area is the only recovery area in the Plan Area specifically identified for the recovery of California linderiella, which has a protection goal of 95%.

2A.33.9 References Cited

2A.33.9.1 Literature Cited

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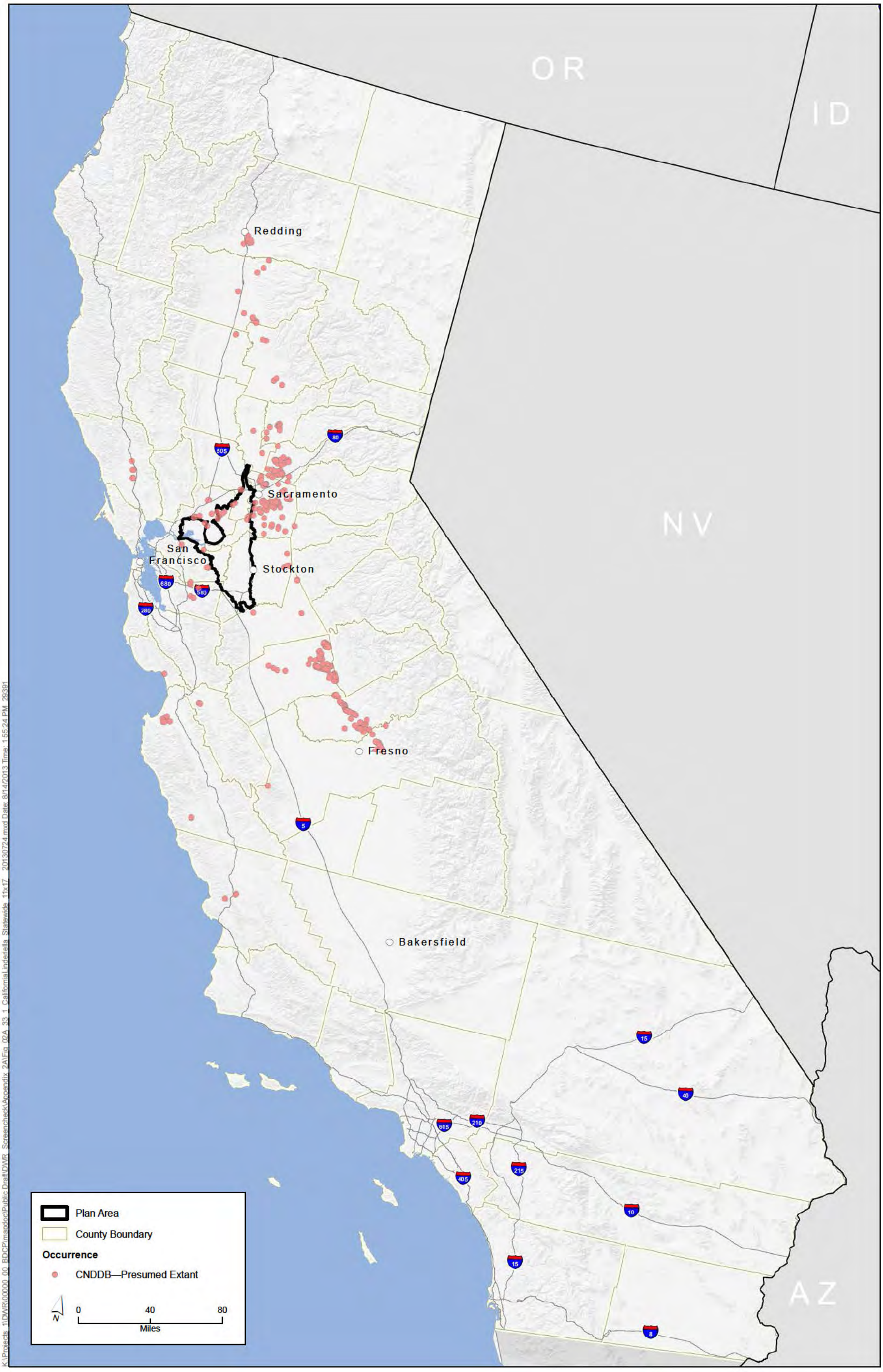
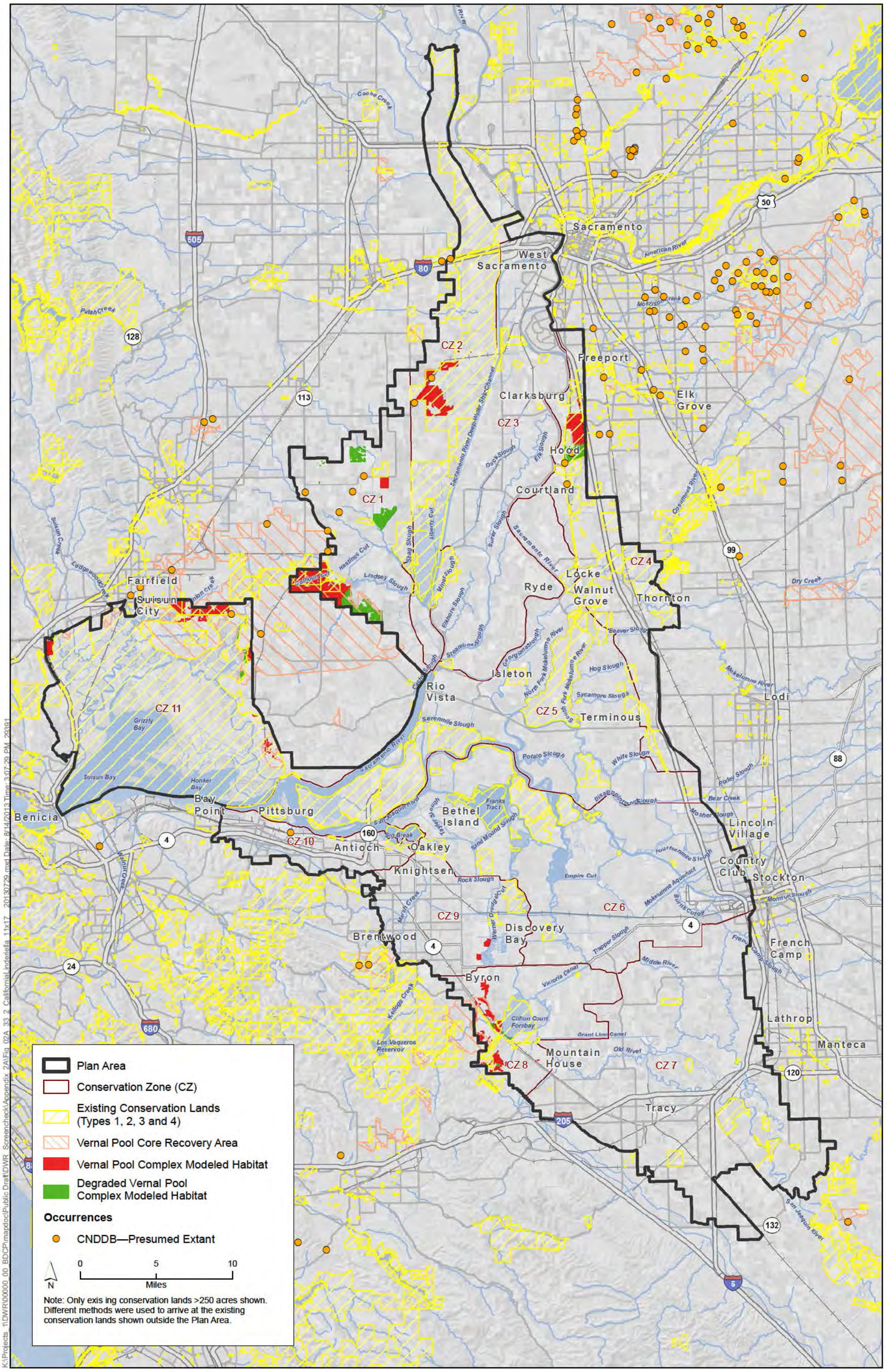


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.33-1
California Linderiella Statewide Range and Recorded Occurrences



K:\Projects_1\DWR\00000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix_2A\Fig_02A_33_2_California_linderiella_11x17_20130729.mxd Date: 8/14/2013 Time: 3:07:29 PM_29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.33-2
California Linderiella Habitat Model and Recorded Occurrences

Appendix 2A.34
Conservancy Fairy Shrimp (*Branchinecta conservatio*)

2A.34.1 Legal Status

The conservancy fairy shrimp (*Branchinecta conservatio*) was listed as endangered throughout its range under the federal Endangered Species Act on September 19, 1994 (59 *Federal Register* [FR] 48136). In September 2007, U.S. Fish and Wildlife Services (USFWS) published a 5-year review recommending that the species remain listed as endangered. In addition, on May 25, 2011, USFWS initiated a new 5-year review to determine if the species should remain listed as endangered. Revised critical habitat for vernal pool crustaceans was designated on August 11, 2005 (70 FR 46923). Critical habitat for the conservancy fairy shrimp occurs in the Plan Area in Conservation Zone 11 in the northern portion of Suisun Marsh. This species is covered by the December 15, 2005, *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005). The conservancy fairy shrimp has no state regulatory status.

2A.34.2 Species Distribution and Status

2A.34.2.1 Range and Status

The historical distribution of the conservancy fairy shrimp is not known, but the distribution of vernal pool habitats in the areas where the species is now known to occur was once more continuous and larger in area than today (U.S. Fish and Wildlife Service 2005). The species is currently known from a few isolated populations distributed over a large portion of California's Central Valley from Tehama County south to Merced County and in southern California in the Los Padres National Forest in Ventura County (Figure 2A.34-1) (U.S. Fish and Wildlife Service 2005, 2007; California Department of Fish and Game 2012).

2A.34.2.2 Distribution and Status in the Plan Area

The conservancy fairy shrimp is known to occur at three general locations in the Plan Area, which consist of four separate California Natural Diversity Database (CNDDB) records (Figure 2A.34-2) (U.S. Fish and Wildlife Service 2007; California Department of Fish and Game 2012). In general, within the Plan Area, turbid-water playas and vernal pools that may support the species occur in the Jepson Prairie in western Conservation Zone 1, in the California Department of Fish and Wildlife (CDFW) Tule Ranch Unit of the Yolo Bypass in Conservation Zone 2 Wildlife Area, in the Stone Lakes area in Conservation Zone 3, in western Conservation Zone 8 near the town of Byron, and along the eastern and northern boundary of Conservations Zone 11.

2A.34.3 Habitat Requirements and Special Considerations

Conservancy fairy shrimp have been found in vernal pools ranging in size from 323 square feet to 88 acres (30 square meters to 35.6 hectares); however, observations suggest that this species is often found in large, turbid playa pools (U.S. Fish and Wildlife Service 2005, 2007). Conservancy fairy shrimp have been collectedat elevations ranging from 16 to 5,577 feet (5 to 1,700 meters) (U.S. Fish and Wildlife Service 2005, 2007).

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters in which the conservancy fairy shrimp inhabits fill in the fall and winter during the beginning of the wet season and dry in late spring at the beginning of the dry season and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from surface runoff and perched groundwater from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons, the continuity and extent of hardpans and claypans underlying nonclay soils, the existence of a perched aquifer overlying the pans, slope, effects of vegetation on evapotranspiration rates, compaction of surface soils by grazing animals, and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

Typical turbid-water habitats for the conservancy fairy shrimp in California are large, playa-type vernal pools or long inundation smaller vernal pools (Eng et al. 1990; U.S. Fish and Wildlife Service 2007). Common wetland plant species that co-occur with conservancy fairy shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryngium* spp.), downingia (*Downingia ornatissima* and *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007).

2A.34.4 Life History

2A.34.4.1 Description

The conservancy fairy shrimp looks similar to other fairy shrimp species (U.S. Fish and Wildlife Service 2005). Conservancy fairy shrimp range in size from 14 to 27 millimeters (0.6 to 1.1 inches) (U.S. Fish and Wildlife Service 2005). Like other fairy shrimp, they are entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs (U.S. Fish and Wildlife Service 2007). Males and females are generally differentiated on the basis of antennae development (males have large antennae with processes and appendages), thoracic projections (two penes protrude from the thorax in males), and the presence of brood pouches in females (Eriksen and Belk 1999).

2A.34.4.2 Reproduction and Growth

The conservancy fairy shrimp is adapted to the environmental conditions of its ephemeral habitats. One adaptation is the ability of conservancy fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the cysts may hatch. The cyst bank in the soil may comprise cysts from several years of breeding. (U.S. Fish and Wildlife Service 2005, 2007)

In a study using large plastic pools to simulate natural vernal pools, Helm found that that the conservancy fairy shrimp can reproduce in as early as 19 days following hatching with the average being 46 days (Helm 1998). Site-specific conditions, primarily water temperature, have been shown to affect the time to reach reproductive maturity (Helm 1998).

2A.34.4.3 Feeding

The conservancy fairy shrimp is an omnivorous filter feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa. The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do other crustacean groups. (Eriksen and Belk 1999.)

2A.34.4.4 Predation and Dispersal

Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1998).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats. (Eriksen and Belk 1999.)

2A.34.5 Threats and Stressors

Threats to vernal pool habitat and species in general, including the conservancy fairy shrimp, were identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). Brief summaries of the of the primary threats to the conservancy fairy shrimp identified in the Vernal Pool Recovery Plan and addressed in the USFWS 2007 5-year review for the conservancy fairy shrimp are presented below.

2A.34.5.1 Random, Naturally Occurring Events

Because the conservancy fairy shrimp occurs in small, relatively isolated populations, the primary threats to its survival as a species are stochastic (random) events due to environmental fluctuations or variation due to annual weather patterns and availability of food and other environmental factors (U.S. Fish and Wildlife Service 2005, 2007).

2A.34.5.2 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Specific threats to the conservancy fairy shrimp identified in the 2005 Vernal Pool Recovery Plan include the following:

- In the Northeastern Sacramento Vernal Pool Region, the conservancy fairy shrimp is threatened by highway expansion on California Department of Transportation (Caltrans) land where they occur in Butte County.
- In the Solano-Colusa Region, conservancy fairy shrimp populations are protected from development on some locations at the Jepson Prairie Preserve; however, specific management and monitoring for the species is not currently conducted at these sites.
- Additional occurrences of the species on private land in this region are threatened by development, particularly in the rapidly urbanizing areas of Fairfield and Vacaville.
- In the Southern Sierra Foothills Region, the species is known from the Flying M Ranch, on University of California lands, and on the Ichord Ranch, where it is currently threatened by indirect and cumulative effects associated with the development of the University of California, Merced campus.

2A.34.5.3 Invasive Species

The invasions of vernal pools by waxy mannagrass (*Glyceria declinata*), an invasive aquatic grass (Gerlach et al. 2009), greatly increases the amount of decomposing biomass in vernal pools and may result in higher respiratory oxygen consumption relative to photosynthetic oxygen generation (Rogers 1998). Also, upland biomass of invasive species such as medusahead (*Elymus caput-medusae,* formerly *Taeniatherum*) can produce dense vegetation and thatch, shortening the ponding duration of some vernal pools (Marty 2004; Pyke and Marty 2005). Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone of vernal pools and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

2A.34.5.4 Altered Hydrology

Human disturbances and changes in land use practices can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005).

2A.34.5.5 Climate Change

Climate change is expected to have an effect on vernal pool hydrology through changes in the amount and timing of precipitation inputs to vernal pools and the rate of loss through evaporation and evapotranspiration. It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool invertebrate species. Cooling and drying trends could adversely affect the conservancy fairy shrimp through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions could increase inundation periods, which would not necessarily be a negative effect because increased inundation periods would increase available habitat for the conservancy fairy shrimp. However, increased inundation periods associated with a warming trend could also negatively affect the species by not providing cool enough temperatures for hatching or reproduction (U.S. Fish and Wildlife Service 2007).

2A.34.5.6 Grazing

Inappropriate grazing practices include complete elimination of grazing in area where nonnative grasses dominate the uplands surrounding vernal pools, and inappropriate timing or intensity of grazing. Appropriate grazing regimes help control nonnative weed plants such as Italian ryegrass and waxy mannagrass, which, if unchecked, can increase thatch buildup and decrease ponding durations, and decrease the aquatic habitat available to the conservancy fairy shrimp (U.S. Fish and Wildlife Service 2007).

2A.34.6 Relevant Conservation Efforts

The conservancy fairy shrimp was listed as endangered and critical habitat was designated as noted above. Conservancy fairy shrimp critical habitat unit 3 includes an area in the Plan Area that is north of the Potrero Hills. Throughout the range of the species, vernal pool habitats supporting populations of the conservancy fairy shrimp have been protected through a variety of other means, including preserves, refuges, and protections on private lands. Within the Solano-Colusa Vernal Pool Region, the conservancy fairy shrimp is protected on the CDFW Tule Ranch Unit of the Yolo Bypass Wildlife Area, the Burke Ranch mitigation bank, in the Jepson Prairie Preserve system, and in the Montezuma Preserve (U.S. Fish and Wildlife Service 2007).

The conservancy fairy shrimp is covered under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009),the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community

Conservation Plan Joint Powers Agency 2011) and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.34.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods.*

2A.34.7.1 GIS Model Data Sources

The conservancy fairy shrimp model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]); California Department of Water Resources 2007 LiDAR elevation data; Google 2009, 2011, and 2012 aerial imagery, and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable conservancy fairy shrimp habitat in the Plan Area according to the species' two habitat types, vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.34.7.2 Habitat Model Description

Modeled habitat for the conservancy fairy shrimp includes vernal pool complex and degraded vernal pool complex. The methods for mapping these natural community types are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. Modeled habitat for this species also includes alkali seasonal wetlands, in Conservation Zone 8 only.

High-value habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for the conservancy fairy shrimp includes the following vegetation subunits selected from the vernal pool complex natural community vegetation layer.

- Vernal pool complex–all vegetation types

Alkali seasonal wetland complex in Conservation Zone 8 also represents high-value habitat for this species. Modeled alkali seasonal wetland complex habitat includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

Degraded vernal pool complex in the Plan Area represents low-value habitat for the conservancy fairy shrimp. This habitat includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)

- Degraded vernal pool complex–vernal pools

Potential habitat without concave surfaces along the eastern border of Suisun Marsh was differentiated from other habitat using a geographic information system (GIS) constraint layer. The methods used to identify areas without concave surfaces are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. These areas were included in the model as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for the conservancy fairy shrimp:

- Vernal pool complex

2A.34.7.3 Assumptions

- **Assumption:** The conservancy fairy shrimp potentially occurs in vernal pool complexes throughout the Plan Area.

  Rationale: This species is dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The species has been found in vernal pool complexes at several locations in the Plan Area (Figure 2A.34-2). However, observations suggest that this species is found most often in large, turbid playa pools (U.S. Fish and Wildlife Service 2005, 2007). There is not sufficient data available for the Plan Area to identify the larger pools where the conservancy fairy shrimp is most likely to be found; therefore, the model includes all vernal pool complex as potential habitat.

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide high-value habitat for the conservancy fairy shrimp.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

- **Assumption:** Mapped degraded vernal pool complex and areas without concave surfaces as indicated by LiDAR data represent low-value habitat for the conservancy fairy shrimp.

  Rationale: Mapped degraded vernal pool complex in the Plan Area ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. The aquatic features in this habitat generally do not hold water as long as intact and fully functional vernal pools. In many cases the features become saturated but never pond, or only pond after the largest storm events. Additionally, the aquatic features in the degraded vernal pool complex are at much lower densities than the intact vernal pool complexes. Because these features are

saturated or inundated during the wet season and may have historically been located in or near areas with natural vernal pool complex, they may support individuals or small populations of species that are found in vernal pools and swales. However, they do not possess the full complement of ecosystem and community characteristics of natural vernal pools, swales, and their associated uplands and they are generally ephemeral features that are eliminated during the course of normal agricultural practices.

Areas with appropriate soil conditions and for which no concave surfaces are apparent on the LiDAR data may include features that occasionally inundate but are too small or shallow to show up on the LiDAR imagery. If present, these features are likely occur at low densities and may be too ephemeral to support the species. However, because these areas do have the potential to support the species at low densities, they are classified as low-value habitat.

2A.34.8 Recovery Goals

In general, the recovery goals for vernal pool crustaceans in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity,* self-sustaining populations throughout the full ecological, geographical, and genetic range of the species by ameliorating or eliminating the threats that caused the species to be listed (U.S. Fish and Wildlife Service 2005). Specifically, the goal of the Vernal Pool Recovery Plan is to delist the conservancy fairy shrimp.

Interim goals of the Vernal Pool Recovery Plan are to stabilize and protect populations so further decline in species status and range are prevented, conduct research to refine reclassification and recovery criteria, and downlist the species from endangered to threatened.

General recovery criteria for vernal pool species identified in the Vernal Pool Recovery Plan include habitat protection, adaptive habitat management and monitoring, status surveys, research, and participation and outreach, the specifics of which are summarized in the Vernal Pool Recovery Plan.

The Vernal Pool Recovery Plan also includes specific recovery criteria for the conservancy fairy shrimp. The criteria to downlist the species are the protection of 100% of the present occurrences and protect 95% of its suitable habitat in the Vina Plains, Caswell, Grassland Ecological Area, Ventura County, Jepson Prairie, Sacramento National Wildlife Refuge, Collinsville, and Madera Core Areas. The criteria to delist the species are the protection of 100% of newly discovered or reintroduced populations and reintroduction of the species into vernal pool regions and soil types from which surveys indicate that it has been extirpated. (U.S. Fish and Wildlife Service 2005)

2A.34.9 References Cited

2A.34.9.1 Literature Cited

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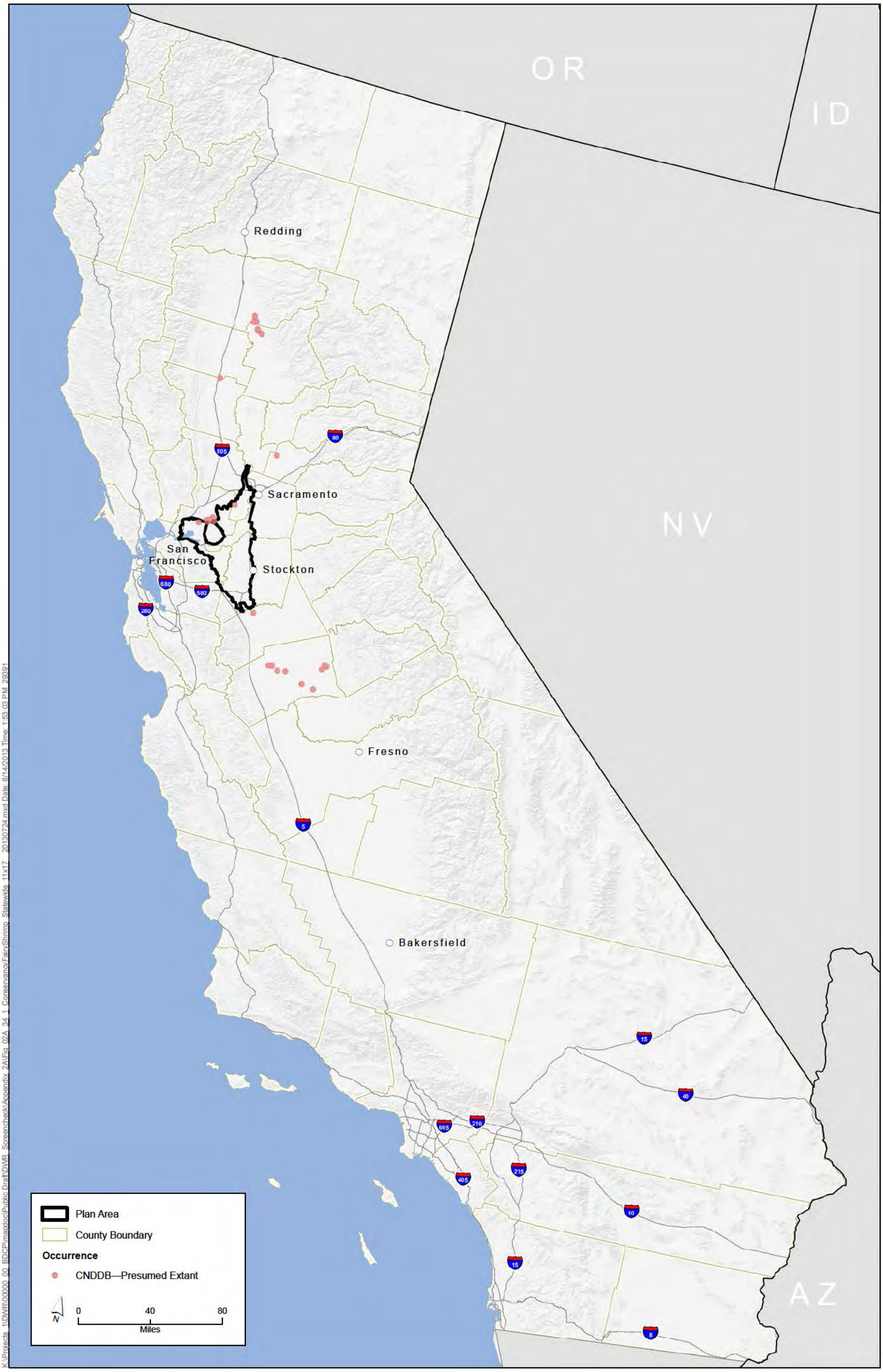
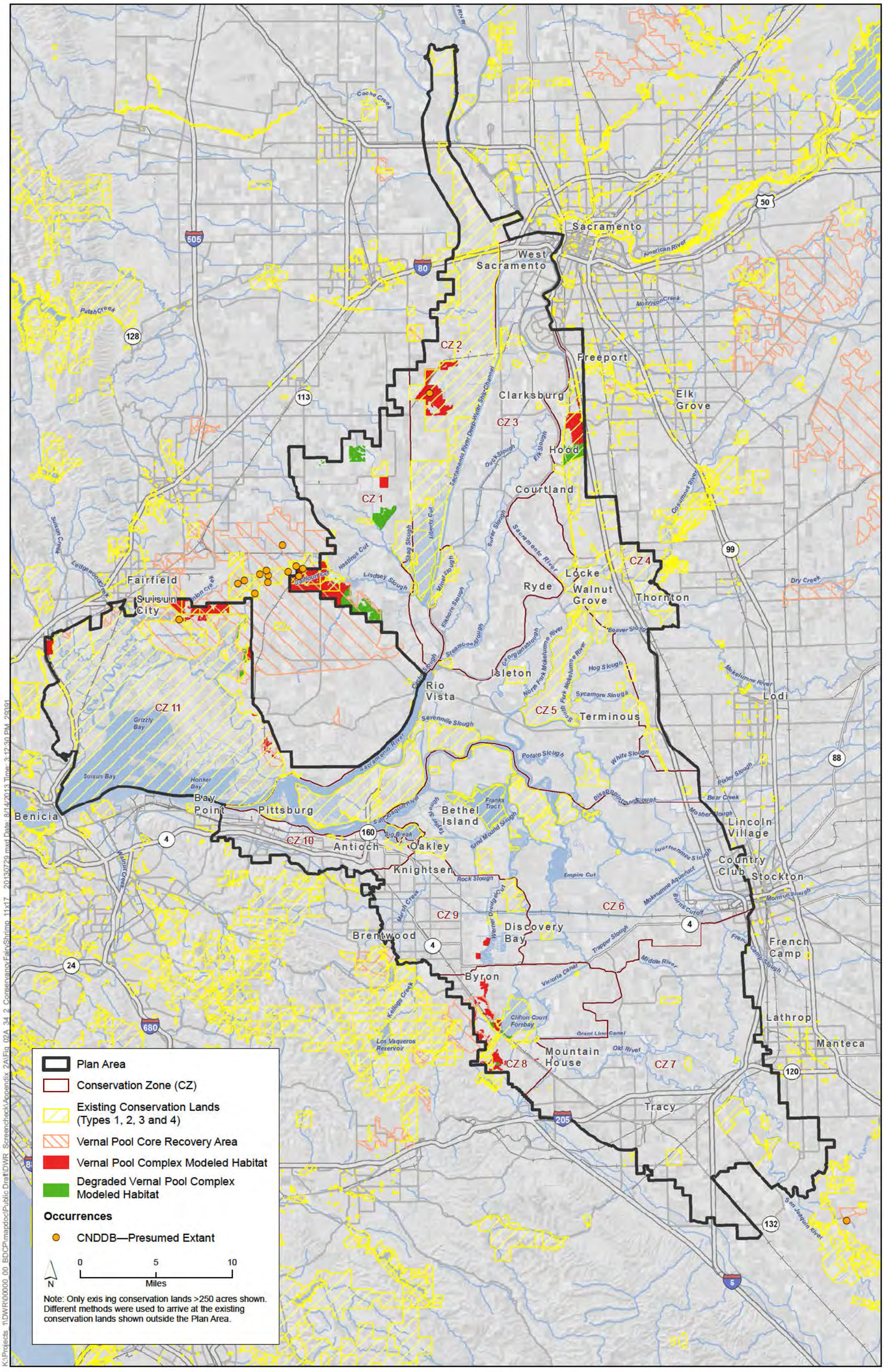


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.34-1
Conservancy Fairy Shrimp Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB 2013.

Figure 2A.34-2
Conservancy Fairy Shrimp Habitat Model and Recorded Occurrences

Appendix 2A.35
Longhorn Fairy Shrimp (*Branchinecta longiantenna*)

2A.35.1 Legal Status

The longhorn fairy shrimp (*Branchinecta longiantenna*) was federally listed as endangered by the U.S. Fish and Wildlife Service (USFWS) on September 19, 1994 (59 *Federal Register* [FR] 48136). On October 9, 2007, USFWS published a 5-year review recommending that the species remain listed as endangered (U.S. Fish and Wildlife Service 2007). On May 25, 2011, USFWS initiated a new 5-year review to determine if the species should remain listed as endangered. Revised critical habitat for vernal pool crustaceans was designated on August 11, 2005 (70 FR 46923) and critical habitat unit designations were published on February 10, 2006 (71 FR 7118). This species is covered by the December 15, 2005, *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005). The longhorn fairy shrimp has no state regulatory status.

2A.35.2 Species Distribution and Status

2A.35.2.1 Range and Status

The historical distribution of the longhorn fairy shrimp is not known, but probably did not extend into the northern portion of the Central Valley or into southern California (U.S. Fish and Wildlife Service 2005, 2007). Currently, populations are known from Contra Costa County in the north to Carrizo Plain in San Luis Obispo County in the south (Figure 2A.35-1), including populations in Alameda and Merced Counties (U.S. Fish and Wildlife Service 2007). The Contra Costa and Alameda County populations are located in the Livermore Vernal Pool Region, while known populations in Merced County are at the Kesterson National Wildlife Refuge and in a roadside ditch just north of Los Banos in the San Joaquin Vernal Pool Region (U.S. Fish and Wildlife Service 2005, 2007). Those in San Luis Obispo County are northwest of Soda Lake in the Carrizo Vernal Pool Region (both immediately outside and within the Carrizo Plain National Monument). Occurrences are rare and highly disjunct with specific pool characteristics largely unknown (U.S. Fish and Wildlife Service 2005, 2007).

2A.35.2.2 Distribution and Status in the Plan Area

The species is not known to occur in the Plan Area (Figure 2A.35-2) (California Department of Fish and Game 2012). The closest populations are in Contra Costa County (Vasco Caves Preserve) and Alameda County (Brushy Peak Preserve) just southwest of the Plan Area. These occurrences are in seasonal pools within sandstone depressions in rocky outcrops, which are not known to be present within the Plan Area.

This species also occurs in pools within alkali sink vegetation in other parts of its known range (U.S. Fish and Wildlife Service 2005, 2007; California Department of Fish and Game 2012), but it has not been detected in similar pools in the Plan Area despite at least 14 years of extensive vernal pool

surveys (U.S. Fish and Wildlife Service 2005, 2007). While they have not been detected in the Plan Area, vernal pools that may support the species occur in Jepson Prairie in western Conservation Zone 1, in the California Department of Fish and Game (CDFW) Tule Ranch Unit of the Yolo Bypass in Conservation Zone 2 Wildlife Area, in the Stone Lakes area in Conservation Zone 3, in western Conservation Zone 8 near the town of Byron, and along the eastern and northern boundary of Conservation Zone 11.

2A.35.3 Habitat Requirements and Special Considerations

Longhorn fairy shrimp in Contra Costa and Alameda Counties are primarily reported from small (sometimes no larger than 1 meter diameter), clear, sandstone outcrop pools with a pH near neutral, and very low alkalinity and conductivity. Temperatures in these pools have been measures from 10 to 18°C. In both the San Joaquin Valley and Carrizo Plain Vernal Pool Regions, the longhorn fairy shrimp is found in clear to turbid grassland pools as large as 62 meters in diameter. Water temperatures in these pools have been found to be between 10 to 28°C. The Carrizo Plain pools are located in a matrix of alkali sink and alkali scrub plant communities, and in Merced County, they have been found in alkaline grassland vernal pools.

These vernal pool habitats are subject to seasonal variations including ponding. This species has likely evolved adaptations to these variations (59 FR 48136). The longhorn fairy shrimp is capable of living in vernal pools of relatively short duration (ponding 6 to 7 weeks in winter and 3 weeks in spring) (Eriksen and Belk 1999).

2A.35.4 Life History

2A.35.4.1 Description

Longhorn fairy shrimp are generally similar to other fairy shrimp species with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs. The longhorn fairy shrimp is distinguished from other species by its elongated second antennae, which are about twice as long, relative to its body, as the second antennae of other Branchinecta species. Body size ranges from approximately 12 to 21 millimeters (0.5 to 0.8 inch). Males and females are differentiated primarily on the basis of the length of the second antennae, but also by thoracic projections and brood pouch development (U.S. Fish and Wildlife Service 2005).

2A.35.4.2 Reproduction and Growth

The longhorn fairy shrimp is a component of the planktonic crustacea in seasonal temporary pools, but nothing is known about its role in foodwebs. Like other Central Valley endemics, longhorn fairy shrimp hatch soon after winter and spring rains fill pools with water hovering around 10°C (Eriksen and Belk 1999). When reared in plastic pools that are lined with soil excavated from vernal pools, and without supplemental food, some individuals of this species reached maturation in as little as 23 days but the average time was 43 days (Helm 1998). Longhorn fairy shrimp have been reported

to co-occur in the same general area with the vernal pool fairy shrimp (*Branchinecta lynchi*), but the species does not occupy the same vernal pools (Eng et al. 1990).

2A.35.4.3 Feeding

The longhorn fairy shrimp is an omnivorous filter feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa. The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999).

2A.35.4.4 Predation and Dispersal

Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1998).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats. (Eriksen and Belk 1999.)

2A.35.5 Threats and Stressors

Threats to vernal pool habitat and species in general, including the longhorn fairy shrimp, were identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). Brief summaries of the of the primary threats to longhorn fairy shrimp identified in the Vernal Pool Recovery Plan and addressed in the USFWS 2007 5-year review of the longhorn fairy shrimp are presented below.

2A.35.5.1 Random, Naturally Occurring Events

Because the longhorn fairy shrimp occurs in four disjunct populations, the primary threats to its survival as a species are stochastic (random) events due to environmental fluctuations or variation due to annual weather patterns and availability of food and other environmental factors. If a catastrophic extirpation event occurs in any locality, the opportunities for recolonization from other source localities within the population may be reduced, with long-term impacts on the abundance and sustainability of the longhorn fairy shrimp in that population (U.S. Fish and Wildlife Service 2005, 2007).

2A.35.5.2 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other because of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Specific threats to the longhorn fairy shrimp identified in the 2005 Vernal Pool Recovery Plan include the following:

- In the Carrizo Vernal Pool Region, longhorn fairy shrimp habitat near Soda Lake is threatened by activities associated with the occasional placement of a trailer on a parcel and the construction of the associated dirt access road.
- In the Livermore Vernal Pool Region, longhorn fairy shrimp occurrences in the Altamont Pass area in Contra Costa and Alameda Counties may be threatened by ongoing and future wind energy developments. The Souza Ranch area in Contra Costa County is also threatened by wind energy and water storage projects.
- In the San Joaquin Vernal Pool Region, the longhorn fairy shrimp is protected from development on the Kesterson Unit of San Luis Wildlife Refuge; however, there are no management guidelines explicitly addressing management of the longhorn fairy shrimp at the refuge.

2A.35.5.3 Invasive Species

The invasions of vernal pools by waxy mannagrass (*Glyceria declinata*), an invasive aquatic grass (Gerlach et al. 2009), greatly increases the amount of decomposing biomass in vernal pools and may result in higher respiratory oxygen consumption relative to photosynthetic oxygen generation (Rogers 1998). Also, upland biomass of invasive species such as medusahead (*Elymus caput-medusae,* formerly *Taeniatherum*) can produce dense vegetation and thatch, shortening the ponding duration of some vernal pools (Marty 2004; Pyke and Marty 2005). Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone of vernal pools and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

2A.35.5.4 Altered Hydrology

Human disturbances and changes in land use practices can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005).

2A.35.5.5 Climate Change

Climate change is expected to have an effect on vernal pool hydrology through changes in the amount and timing of precipitation inputs to vernal pools and the rate of loss through evaporation and evapotranspiration. It is unknown at this time if climate change in California will result in a

localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool invertebrate species. Cooling and drying trends could adversely affect the longhorn fairy shrimp through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions could increase inundation periods, which would not necessarily be a negative effect because increased inundation periods would increase available habitat for the longhorn fairy shrimp. However, increased inundation periods associated with a warming trend could also negatively affect the species by not providing cool enough temperatures for the longhorn fairy shrimp to hatch or reproduce (U.S. Fish and Wildlife Service 2007).

2A.35.5.6 Grazing

Inappropriate grazing practices include complete elimination of grazing in area where nonnative grasses dominate the uplands surrounding vernal pools, and inappropriate timing or intensity of grazing. Appropriate grazing regimes help control nonnative weed plants such as Italian ryegrass and waxy mannagrass, which if unchecked can increase thatch buildup and decrease ponding durations and decrease the aquatic habitat available to the longhorn fairy shrimp (U.S. Fish and Wildlife Service 2007).

2A.35.6 Relevant Conservation Efforts

The longhorn fairy shrimp was listed as endangered and critical habitat was designated as noted above. Vernal pool habitat on the Carrizo Plain has been partially protected in the Carrizo National Monument (U.S. Fish and Wildlife Service 2007). Habitats in the San Joaquin Vernal Pool Region are protected at the Kesterson National Wildlife Refuge (U.S. Fish and Wildlife Service 2005, 2007). Known occurrences in sandstone depression pools in the Altamont area are protected in the Brushy Peak and Vasco Caves preserves which are on property owned and managed by the East Bay Regional Parks District (U.S. Fish and Wildlife Service 2007).

The longhorn fairy shrimp is covered under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County Habitat Conservancy. 2006).

2A.35.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.35.7.1 GIS Model Data Sources

The longhorn fairy shrimp model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]); California Department of Water Resources 2007 LiDAR elevation data; Google 2009, 2011, and 2012 aerial imagery, and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable

longhorn fairy shrimp habitat in the Plan Area according to the species' two habitat types, vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.35.7.2 Habitat Model Description

Modeled habitat for the longhorn fairy shrimp includes vernal pool complex and degraded vernal pool complex. The methods for mapping these natural community types are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. Modeled habitat for this species also includes alkali seasonal wetlands, in Conservation Zone 8 only.

High-value habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for the longhorn fairy shrimp includes the following vegetation subunits that were selected from the BDCP composite data for the vernal pool complex natural community.

- Vernal pool complex–all vegetation types
- Alkali seasonal wetland complex–all vegetation types (Conservation Zone 8 only)

Degraded vernal pool complex in the Plan Area represents low-value habitat for the longhorn fairy shrimp. This habitat includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools
- Vernal pool complex

Potential habitat without concave surfaces along the eastern border of Suisun Marsh was differentiated from other habitat using a geographic information system (GIS) constraint layer. The methods used to identify areas without concave surfaces are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. These areas were included in the model as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for the longhorn fairy shrimp.

- Vernal pool complex

2A.35.7.3 Assumptions

- **Assumption**: The longhorn fairy shrimp potentially occur in vernal pool complexes throughout the Plan Area.

  Rationale: Vernal pools provide the typical habitat for the longhorn fairy shrimp (U.S. Fish and Wildlife Service 2007). However, a limitation to this assumption is that the longhorn fairy shrimp is reported primarily from small, clear, sandstone outcrop pools that are not present in the Plan Area, and the species has not been found in the Plan Area. It is therefore likely that the model highly overestimates suitable habitat for the longhorn fairy shrimp in the Plan Area.

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide high value habitat for the longhorn fairy shrimp.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

- **Assumption:** Mapped degraded vernal pool complex and areas without concave surfaces as indicated by LiDAR data represent low-value habitat for the longhorn fairy shrimp.

  Rationale: Mapped degraded vernal pool complex in the Plan Area ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. The aquatic features in this habitat generally do not hold water for as long as intact and fully functional vernal pools: in many cases the features become saturated but never pond, or only pond after the largest storm events. Additionally, the aquatic features in the degraded vernal pool complex are at much lower densities than in the intact vernal pool complexes. Because these features are saturated or inundated during the wet season and may have historically been located in or near areas with natural vernal pool complex, they may support individuals or small populations of species that are found in vernal pools and swales. However, they do not possess the full complement of ecosystem and community characteristics of natural vernal pools, swales, and their associated uplands and they are generally ephemeral features that are eliminated during the course of normal agricultural practices.

  Areas with appropriate soil conditions and for which no concave surfaces are apparent on the LiDAR data may include features that occasionally inundate but are too small or shallow to show up on the LiDAR imagery. If present, these features are likely occur at low densities and may be too ephemeral to support the species. However, because these areas do have the potential to support the species at low densities, they were classified as low-value habitat.

2A.35.8 Recovery Goals

The recovery goals for the longhorn fairy shrimp in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity,* self-sustaining populations throughout the full ecological, geographical, and genetic range of the species by ameliorating or eliminating the threats that caused the species to

be listed (U.S. Fish and Wildlife Service 2005). Specifically, the goal of the Vernal Pool Recovery Plan is to delist the longhorn fairy shrimp.

Interim goals of the Vernal Pool Recovery Plan are to stabilize and protect populations so further decline in species status and range are prevented, conduct research to refine reclassification and recovery criteria, and downlist the species from endangered to threatened.

The Vernal Pool Recovery Plan also includes specific recovery criteria for the longhorn fairy shrimp. The criteria to downlist the species are protection of 100% of the present occurrences and protection of 95% of its suitable habitat in the North Carrizo Plain, South Carrizo Plain, Altamont Hills, and Grassland Ecological Area Core Areas. The criteria to delist the species are: protection of 100% of newly discovered or reintroduced populations, reintroduction of the species into vernal pool regions and soil types from which surveys indicate the species has been extirpated, and discovery or establishment of additional populations (U.S. Fish and Wildlife Service 2005).

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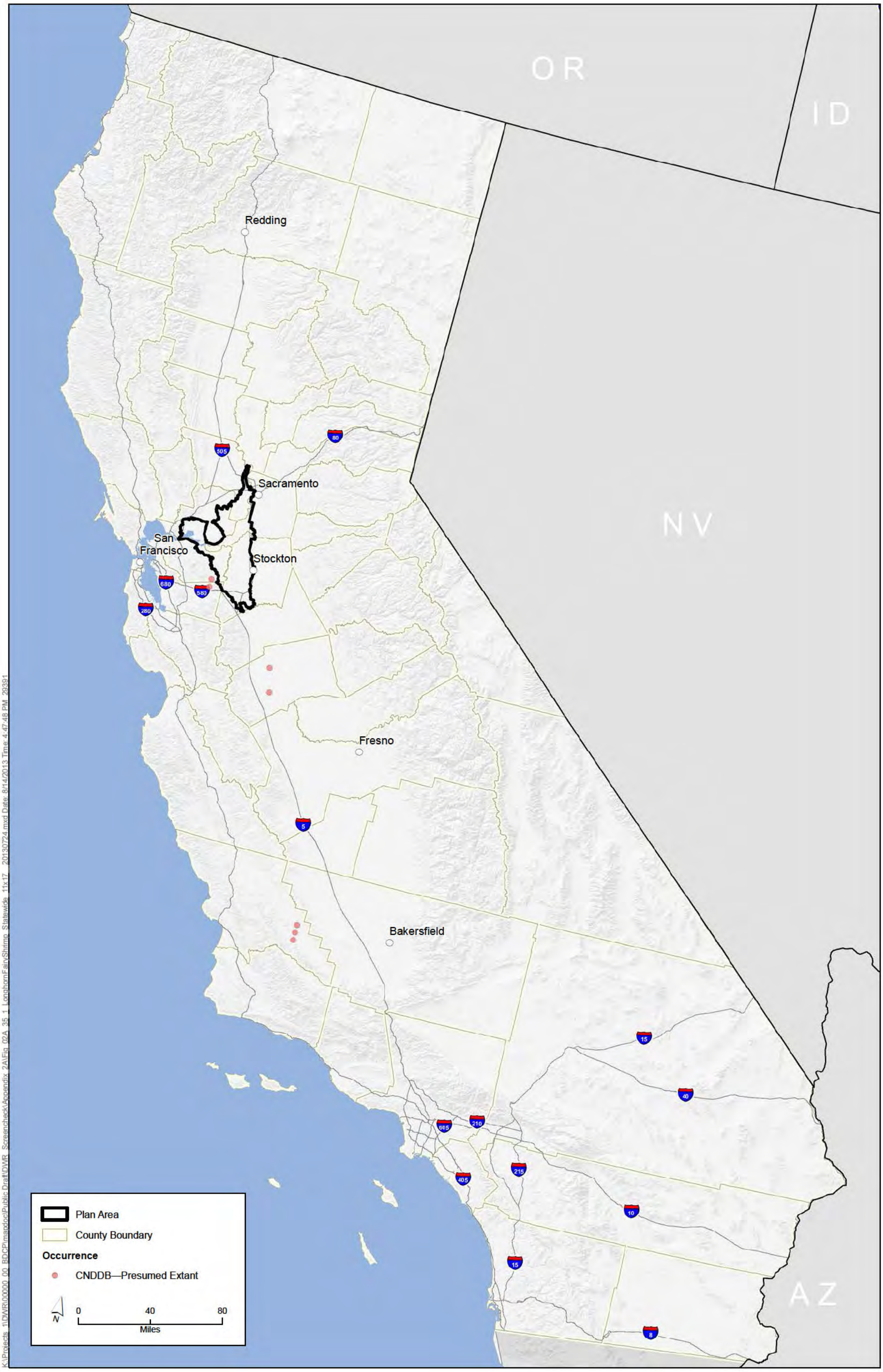
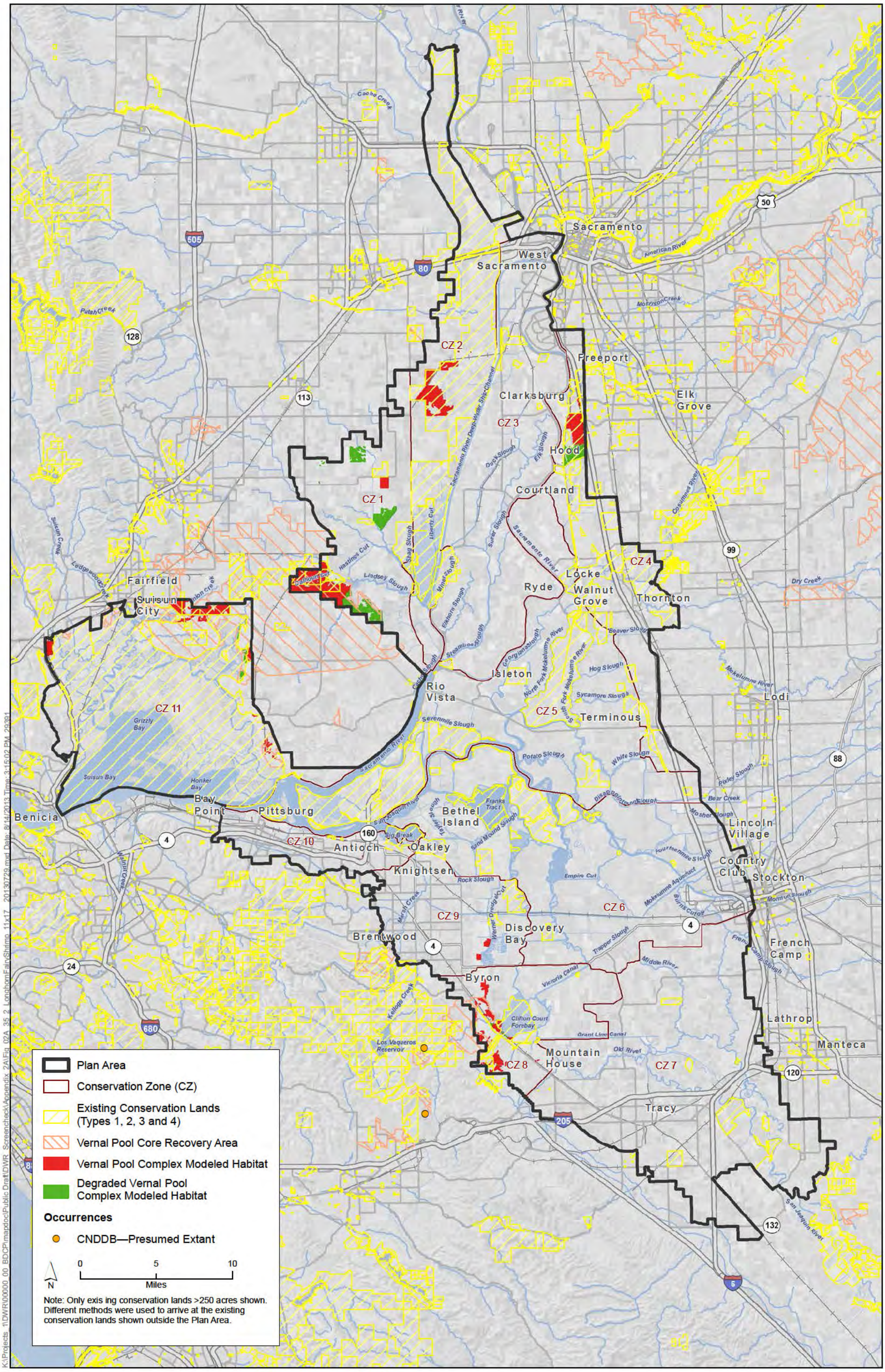


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.35-1
Longhorn Fairy Shrimp Statewide Range and Recorded Occurrences



K:\Projects_1\DWR\00000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix 2A\Fig_02A_35_2_LonghornFairyShrimp_11x17_20130729.mxd Date: 8/14/2013 Time: 3:15:02 PM 29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.35-2
Longhorn Fairy Shrimp Habitat Model and Recorded Occurrences

Appendix 2A.36
Midvalley Fairy Shrimp (*Branchinecta mesovallensis*)

2A.36.1 Legal Status

The midvalley fairy shrimp (*Branchinecta mesovallensis*) currently has no legal status under either the state or federal endangered species acts. It was petitioned for listing under the federal Endangered Species Act in 2001. In 2003, the U.S. Fish and Wildlife Service (USFWS) published a finding (68 *Federal Register* [FR] 22724) that the petition provided substantial evidence to indicate that listing may be warranted. However, in 2004, USFWS determined, following a review of available scientific and commercial information, that listing was not warranted (69 FR 3592).

2A.36.2 Species Distribution and Status

2A.36.2.1 Range and Status

The midvalley fairy shrimp is endemic to California Central Valley grassland vernal pools (Belk and Fugate 2000). All known occurrences are between central Sacramento County and northern Fresno County (Figure 2A.36-1). The species distribution is apparently limited to the Southeastern Sacramento, Southern Sierra Foothill, San Joaquin, Livermore, and Solano-Colusa Vernal Pool Regions (U.S. Fish and Wildlife Service 2005; California Department of Fish and Game 2012).

There is no reliable information on population trends for this species due to its recent description (Belk and Fugate 2000), lack of information on its historical distribution, and the extent of loss of vernal pool habitats in the Central Valley.

An unknown amount of vernal pool habitat and midvalley fairy shrimp occurrences have been lost. Attempts have been made to calculate lost vernal pool acreages (Holland 1978, 1988, 1998; Bauder and McMillan 1998). Due to increasing pressures of human populations in California and Oregon, more vernal pool habitat has been encroached upon and affected throughout the species' range.

Adequate determination of remaining midvalley fairy shrimp occurrences throughout the animal's range, as well as population trends, remains largely incomplete. Eriksen and Belk (1999) present a map of localities for the midvalley fairy shrimp with less than 30 localities represented; the greatest density of occurrences is in southern Sacramento County. This generally corresponds with the current distribution as derived from California Natural Diversity Database (CNDDB) occurrences (California Department of Fish and Game 2012). A further complication may be that midvalley fairy shrimp escape early detection particularly during dry years or during the dry season because they inhabit swales and short-lived pools to a greater extent relative to other species (Helm 1998; Belk and Fugate 2000).

2A.36.2.2 Distribution and Status in the Plan Area

Distribution and status in the Plan Area is largely unknown and based primarily on CNDDB records, which provide an incomplete and inconsistent record of occurrence for this species. Recorded

locations from the Plan Area include two locations in Conservation Zone 1, two locations in the Yolo Bypass in Conservation Zone 2, one in Conservatio Zone 8 west of Clifton Court Forebay, and one in Conservation Zone 9 near Byron (California Department of Fish and Game 2012) (Figure 2A.36-2). Midvalley fairy shrimp were observed in three pools west of Clifton Court Forebay and on the east and west sides of Byron Highway in eastern Contra Costa County during the 2011 surveys conducted by the California Department of Water Resources (DWR). Based on existing knowledge of the species' requirements, the species could potentially occur in shallow grassland vernal pools and similar seasonal wetlands wherever they occur in the Plan Area. More complete systematic surveys would be required to more accurately determine the distribution of this species in the Plan Area.

2A.36.3 Habitat Requirements and Special Considerations

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters that the midvalley fairy shrimp inhabits fill in the fall and winter during the beginning of the wet season and dry in late spring at the beginning of the dry season and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from surface runoff and perched groundwater from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrologic functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons, the continuity and extent of hardpans and claypans underlying nonclay soils, the existence of a perched aquifer overlying the pans, slope, effects of vegetation on evapotranspiration rates, compaction of surface soils by grazing animals, and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for the midvalley fairy shrimp are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999). Common wetland plant species that co-occur with the midvalley shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryngium* spp.), downingia (*Downingia ornatissima* and *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007). Midvalley fairy shrimp are often found in grass-bottomed vernal pools and puddles in the most ephemeral of seasonal wetlands (Eriksen and Belk 1999). Midvalley fairy shrimp have been found in habitats ranging from 4 to 663 square feet (0.37 to 61.6 square meters) (U.S. Fish and Wildlife Service 2005).

This species has also been reported to co-occur with the vernal pool fairy shrimp (*Branchinecta lynchi*) (Eriksen and Belk 1999). However, it is believed that this co-occurrence was a result of overland flow in a heavy precipitation event and not a result of overlapping habitat requirements (U.S. Fish and Wildlife Service 2005).

2A.36.4 Life History

2A.36.4.1 Description

The midvalley fairy shrimp looks similar to other fairy shrimp, and particularly to conservancy fairy shrimp, yet it differs by the shape of the tip of the male's second antenna and by the shape of the female's brood pouch (U.S. Fish and Wildlife Service 2005). Depending upon the rapidity of development, mature animals may vary in length from 7 to 20 millimeters (0.3 to 0.8 inch). Like other fairy shrimp, they are entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs. Males and females are generally differentiated based on antennae development (males have large antennae with processes and appendages), thoracic projections (two penes protrude from the thorax in males), and the presence of brood pouches in females (Eriksen and Belk 1999).

2A.36.4.2 Reproduction and Growth

During the dry phase of their habitat, the anostracans survive as diapausing cysts (resting eggs) in and on the substrate (Sars 1896, 1898; Eriksen and Belk 1999; Rogers and Fugate 2001). When the habitat inundates from seasonal rainfall, some of the cysts hatch, and the nauplii (early larval form of anostraca) swim into the upper water column (Eriksen and Belk 1999). Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found that midvalley fairy shrimp can reproduce in as early as 16 days following hatching with the average being 43 days (Helm 1998). Site-specific conditions, primarily water temperature, have been shown to affect time to reach reproductive maturity (Helm 1998).

2A.36.4.3 Feeding

The midvalley fairy shrimp is an omnivorous filter feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa. The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999).

2A.36.4.4 Predation and Dispersal

Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1998).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in

mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats. (Eriksen and Belk 1999.)

2A.36.5 Threats and Stressors

Threats to vernal pool habitat and species in general, including the midvalley fairy shrimp, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005). In addition, the Vernal Pool Recovery Plan identified several threats specific to the midvalley fairy shrimp. Brief summaries of the primary threats to the midvalley fairy shrimp identified in the Vernal Pool Recovery Plan are presented below.

2A.36.5.1 Random, Naturally Occurring Events

The continuing fragmentation of midvalley fairy shrimp habitat range-wide may result in small, isolated occurrences of this species in some areas, which could make these populations vulnerable to random environmental fluctuations or variation due to annual weather patterns and availability of food and other environmental factors (U.S. Fish and Wildlife Service 2005).

2A.36.5.2 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Specific threats to midvalley fairy shrimp habitat identified in the 2005 Vernal Pool Recovery Plan include the following:

- Continued conversion of the grassland-vernal pool ecosystem matrix to urban or agricultural uses, and associated hydrologic changes, is the largest threat to survival of the midvalley fairy shrimp.
- Although midvalley fairy shrimp are protected where they co-exist with listed species, none of those listed species, except vernal pool fairy shrimp, have been found to co-occur with midvalley fairy shrimp in the same vernal pools. Additionally, the co-occurrence with vernal pool fairy shrimp is believed to be a result of overland flow in a heavy precipitation event and not a result of overlapping habitat requirements.

2A.36.5.3 Invasive Species

The invasions of vernal pools by waxy mannagrass (*Glyceria declinata*), an invasive aquatic grass (Gerlach et al. 2009), greatly increases the amount of decomposing biomass in vernal pools and may result in higher respiratory oxygen consumption relative to photosynthetic oxygen generation

(Rogers 1998). Also, upland biomass of invasive species such as medusahead (*Elymus caput-medusae,* formerly *Taeniatherum*) can produce dense vegetation and thatch, shortening the ponding duration of some vernal pools (Marty 2004; Pyke and Marty 2005). Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone of vernal pools and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

2A.36.5.4 Altered Hydrology

Human disturbances and changes in land use practices can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005).

2A.36.5.5 Climate Change

Habitat alteration may result from global climate and environmental changes, including nitrogen deposition, increase in atmospheric carbon dioxide, changes in precipitation patterns, and global warming. On a local scale, these changes may result in altering current vernal pool habitat to be more suitable to nonnative species and less suitable native species (U.S. Fish and Wildlife Service 2005).

2A.36.5.6 Grazing

Inappropriate grazing practices include complete elimination of grazing in area where nonnative grasses dominate the uplands surrounding vernal pools, and inappropriate timing or intensity of grazing. Appropriate grazing regimes help control nonnative weed plants such as Italian ryegrass and waxy mannagrass, which, if unchecked, can increase thatch buildup and decrease ponding durations and decrease the aquatic habitat available to the midvalley fairy shrimp (U.S. Fish and Wildlife Service 2005; Marty 2005).

2A.36.6 Relevant Conservation Efforts

The midvalley fairy shrimp is not listed; however, it may be protected through conservation efforts for vernal pool ecosystems in general. USFWS (2005) reports that of 53 midvalley fairy shrimp locations (as of 2003) 22 (41.5%) are on protected lands, including two national wildlife refuges, several vernal pool mitigation banks, a California Department of Fish and Game (CDFW) ecological reserve, and several Nature Conservancy conservation easements.

The midvalley fairy shrimp is covered under the approved *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County Habitat Conservancy 2006). Further, the species is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation

Plan/Natural Community Conservation Plan Joint Powers Agency 2011) and *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010).

2A.36.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.36.7.1 GIS Model Data Sources

The midvalley fairy shrimp model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]); California Department of Water Resources 2007 LiDAR elevation data; Google 2009, 2011, and 2012 aerial imagery , and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable midvalley fairy shrimp habitat in the Plan Area according to the species' two habitat types, vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.36.7.2 Habitat Model Description

Modeled habitat for the midvalley fairy shrimp includes vernal pool complex and degraded vernal pool complex. The methods for mapping these natural community types are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. Modeled habitat for this species also includes alkali seasonal wetlands, in Conservation Zone 8 only.

High-value habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for the midvalley fairy shrimp includes the following vegetation subunits that were selected from the BDCP composite date for the vernal pool complex natural community.

- Vernal pool complex-all vegetation types

Alkali seasonal wetland complex in Conservation Zone 8 also represents high-value habitat for this species. Modeled alkali seasonal wetland complex habitat includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

Degraded vernal pool complex in the Plan Area represents low-value habitat for the midvalley fairy shrimp. This habitat includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)

- Degraded vernal pool complex–vernal pools

Potential habitat without concave surfaces along the eastern border of Suisun Marsh was differentiated from other habitat using a GIS constraint layer. The methods used to identify areas without concave surfaces are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Other Natural Community Mapping*. These areas were included in the model as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for the midvalley fairy shrimp.

- Vernal pool complex.

2A.36.7.3 Assumptions

- **Assumption:** The midvalley fairy shrimp potentially occurs in vernal pool complexes throughout the Plan Area.

  Rationale: The midvalley fairy shrimp is endemic to California Central Valley grassland vernal pools (Belk and Fugate 2000). Distribution and status in the Plan Area is largely unknown and based primarily on CNDDB records, which provide an incomplete and inconsistent record of occurrence for this species. Therefore, the model conservatively assumes that all vernal pool complexes in the Plan Area potentially support this species.

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide high-value habitat for the midvalley fairy shrimp.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

- **Assumption:** Mapped degraded vernal pool complex and areas without concave surfaces as indicated by LiDAR data represent low-value habitat for the midvalley fairy shrimp.

  Rationale: Mapped degraded vernal pool complex in the Plan Area ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling, to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. The aquatic features in this habitat generally do not hold water for as long as intact and fully functional vernal pools: in many cases the features become saturated but never pond, or only pond after the largest storm events. Additionally, the aquatic features in the degraded vernal pool complex are at much lower densities than in the intact vernal pool complexes. Because these features are saturated or inundated during the wet season and may have historically been located in or near areas with natural vernal pool complex, they may support individuals or small populations of species that are found in vernal pools and swales. However, they do not possess

the full complement of ecosystem and community characteristics of natural vernal pools, swales, and their associated uplands and they are generally ephemeral features that are eliminated during the course of normal agricultural practices.

Areas with appropriate soil conditions and for which no concave surfaces are apparent on the LiDAR data may include features that occasionally inundate but are too small or shallow to show up on the LiDAR imagery. If present, these features are likely to occur at low densities and may be too ephemeral to support the species. However, because these areas do have the potential to support the species at low densities, they were classified as low-value habitat.

2A.36.8 Recovery Goals

In general, the recovery goals for vernal pool crustaceans in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity,* self-sustaining populations throughout the full ecological, geographical, and genetic range of the species by ameliorating or eliminating the threats that caused the species to be listed (U.S. Fish and Wildlife Service 2005). Specifically, the goal of the Vernal Pool Recovery Plan is to ensure the long-term conservation of the midvalley fairy shrimp (U.S. Fish and Wildlife Service 2005).

Interim goals of the Vernal Pool Recovery Plan are to stabilize and protect populations so further decline in species status and range are prevented, and conduct research to refine reclassification and recovery criteria (U.S. Fish and Wildlife Service 2005).

General recovery criteria for vernal pool species identified in the Vernal Pool Recovery Plan include habitat protection, adaptive habitat management and monitoring, status surveys, research, and participation and outreach, the specifics of which can be found in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005).

The Vernal Pool Recovery Plan also includes specific recovery criteria for the conservation of the midvalley fairy shrimp. These criteria include the protection of 80% of occurrences throughout its range and protection of 85 to 95% of suitable habitat in seven core areas (U.S. Fish and Wildlife Service 2005).

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2A.36.9.1 Literature Cited

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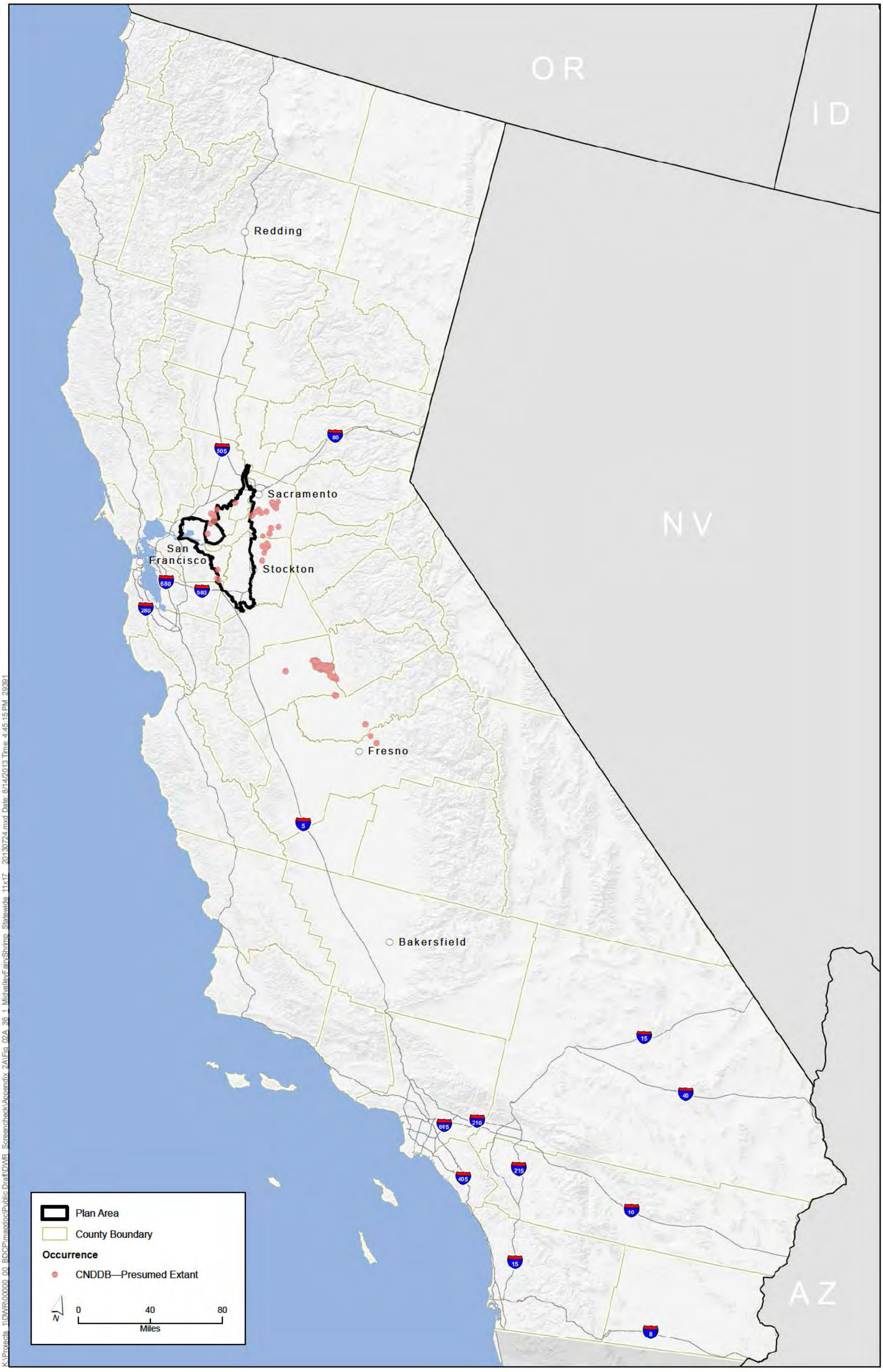
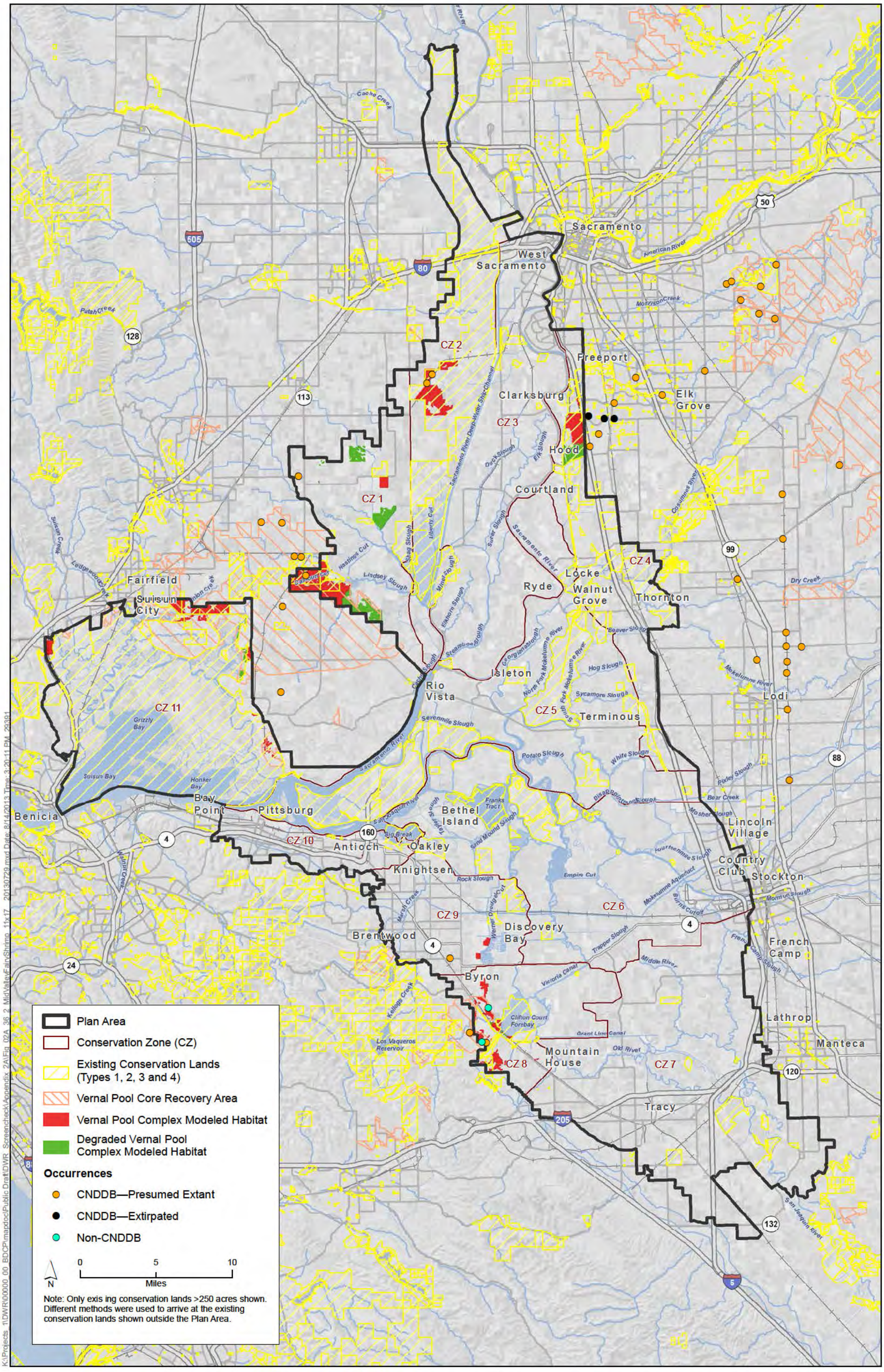


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.36-1
Midvalley Fairy Shrimp Statewide Range and Recorded Occurrences



K:\Projects_1\DWR\00000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix 2A\Fig_02A_36_2_MidValleyFairyShrimp_11x17_20130729.mxd Date: 8/14/2013 Time: 3:20:11 PM 29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.36-2
Midvalley Fairy Shrimp Habitat Model and Recorded Occurrences

Appendix 2A.37
Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

2A.37.1 Legal Status

The vernal pool fairy shrimp (*Branchinecta lynchi*) is listed as threatened under the federal Endangered Species Act throughout its range (59 *Federal Register* [FR] 48136). In September 2007, the U.S. Fish and Wildlife Service (USFWS) published a 5-year review recommending that the species remain listed as threatened. In addition, on May 25, 2011, USFWS initiated a new 5-year review to determine if the species should remain listed as endangered. Revised critical habitat for vernal pool crustaceans was designated on August 11, 2005 (70 FR 46923). Critical habitat for vernal pool fairy shrimp occurs in the Plan Area in Conservation Zone 8, just west of Clifton Court Forebay, and in Conservation Zone 11 at the northern edge of Suisun Marsh. This species is covered by the December 15, 2005, *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005). The vernal pool fairy shrimp has no state regulatory status.

2A.37.2 Species Distribution and Status

2A.37.2.1 Range and Status

The vernal pool fairy shrimp was identified in 1990 (Eng et al. 1990). There is little information on the historical range of the species; however, the vernal pool fairy shrimp is currently known to occur in a wide range of vernal pool habitats in the southern and Central Valley areas of California, and in two vernal pool habitats in the Agate Desert area of Jackson County, Oregon (U.S. Fish and Wildlife Service 2005). It has the largest geographical range of listed fairy shrimp in California, but is seldom abundant (Eng et al. 1990). The species is currently found in fragmented habitats across the Central Valley of California from Shasta County to Tulare and Kings Counties, in the central and southern Coast Ranges from Napa County to Los Angeles County, and inland in western Riverside County, California (Figure 2A.37-1) (U.S. Fish and Wildlife Service 2005, 2007; California Department of Fish and Game 2012). Additional occurrences have been in Jackson County, Oregon. In California, it occurs in a wide range of vernal pools (Eng et al. 1990; Eriksen and Belk 1999; California Department of Fish and Game 2012).

2A.37.2.2 Distribution and Status in the Plan Area

The vernal pool fairy shrimp has been reported from several locations in the Plan Area (Figure 2A.37-2) (U.S. Fish and Wildlife Service 2005, 2007; California Department of Fish and Game 2012). In general, in the Plan Area, vernal pools that may support the species occur in Jepson Prairie in western Conservation Zone 1, in the California Department of Fish and Wildlife (CDFW) Tule Ranch Unit of the Yolo Bypass in Conservation Zone 2 Wildlife Area, in the Stone Lakes area in Conservation Zone 3, in western Conservation Zone 8 near the town of Byron, and along the eastern and northern boundary of Conservation Zone 11.. Other potential vernal pool habitat occurs along the eastern boundary of the Plan Area near Stone Lakes (Figure 2A.37-2). Seven occurrences of the

vernal pool fairy shrimp were observed in the south Stone Lakes area and occurrences were found in three locations in the Clifton Court Forebay during 2009 surveys conducted by the California Department of Water Resources (DWR). A comprehensive survey of vernal pools or habitat for vernal pool fairy shrimp has not been conducted in the Plan Area.

2A.37.3 Habitat Requirements and Special Considerations

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters that the vernal pool fairy shrimp inhabits fill in the fall and winter during the beginning of the wet season and dry in late-spring at the beginning of the dry season, and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from surface runoff and perched groundwater from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors including the hydrologic conductivity of the surface soil horizons, the continuity and extent of hardpans and claypans underlying nonclay soils, the existence of a perched aquifer overlying the pans, slope, effects of vegetation on evapotranspiration rates, compaction of surface soils by grazing animals, and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for the vernal pool fairy shrimp are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999). Common wetland plant species that co-occur with vernal pool fairy shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryngium* spp.), downingia (*Downingia ornatissima* and *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007). Vernal pool fairy shrimp have also occasionally been found in degraded vernal pool habitats and artificially created seasonal pools (Helm 1998). Vernal pool fairy shrimp commonly co-occur with other fairy shrimp and vernal pool tadpole shrimp (*Lepidurus packardi*) (U.S. Fish and Wildlife Service 2005).

2A.37.4 Life History

2A.37.4.1 Description

The vernal pool fairy shrimp looks similar to other fairy shrimp species (U.S. Fish and Wildlife Service 2005). Depending on the rapidity of development, mature animals may vary in length from 11 to 25 millimeters (0.4 to 1.0 inch) (U.S. Fish and Wildlife Service 2005). Like other fairy shrimp, they are entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs (U.S. Fish and Wildlife Service 2007). Males and females are generally differentiated based on antennae development (males have large antennae with processes and

appendages), thoracic projections (two penes protrude from the thorax in males), and the presence of brood pouches in females (Eriksen and Belk 1999).

2A.37.4.2 Reproduction and Growth

Vernal pool fairy shrimp are adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of vernal pool fairy shrimp cysts to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the cysts may hatch. The cyst bank in the soil may comprise cysts from several years of breeding (U.S. Fish and Wildlife Service 2005, 2007). Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found that vernal pool fairy shrimp can reproduce in as early as 18 days following hatching with the average being 40 days (Helm 1998). Site-specific conditions, primarily water temperature, have been shown to affect time to reach reproductive maturity (Helm 1998).

2A.37.4.3 Feeding

The vernal pool fairy shrimp is an omnivorous filter feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa. The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups. (Eriksen and Belk 1999.)

2A.37.4.4 Predation and Dispersal

Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1998).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Eriksen and Belk 1999).

2A.37.5 Threats and Stressors

Threats to vernal pool habitat and species in general, including vernal pool fairy shrimp, were identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005, 2007). In addition,

the Vernal Pool Recovery Plan identified several threats specific to vernal pool fairy shrimp. Within the entire range of the species, more than half of the known populations of vernal pool fairy shrimp are threatened by development or agricultural conversion. Several populations are found on military bases, and although not an immediate threat, military activities can result in alteration of pool characteristics, including introduction of nonnative plant species (U.S. Fish and Wildlife Service 2005, 2007). Brief summaries of the primary threats to vernal pool fairy shrimp identified in the Vernal Pool Recovery Plan and addressed in the USFWS 2007 5-year review for vernal pool fairy shrimp are presented below.

2A.37.5.1 Random, Naturally Occurring Events

The continuing fragmentation of vernal pool fairy shrimp habitat range-wide may result in small isolated occurrences of this species in some areas, which could make these populations vulnerable to random environmental fluctuations or variation due to annual weather patterns and availability of food and other environmental factors (U.S. Fish and Wildlife Service 2005, 2007).

2A.37.5.2 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Specific threats to vernal pool fairy shrimp habitat identified in the 2005 Vernal Pool Recovery Plan include the following:

- In the Carrizo Vernal Pool Region, vernal pool habitats known to contain vernal pool fairy shrimp are currently located on federal land at the Camp Roberts Military Base and at the Carrizo National Monument. Although these areas are not immediately threatened by development, Camp Roberts may be threatened by military activities that alter historical vernal pool characteristics and introduce nonnative plant species.
- In the Central Coast Region, the vernal pool fairy shrimp is known only from federal land on the Fort Hunter Liggett Military Reservation. Training and maintenance activities on this military base also have the potential to degrade some historical wetland habitats that are inhabited by fairy shrimp.
- In the Livermore Vernal Pool Region, the vernal pool fairy shrimp is located primarily on private land, where it is threatened by development, including expansion of the Byron Airport.
- In the Northeastern Sacramento Valley Vernal Pool Region, most of the known occurrences are located on California Department of Transportation (Caltrans) rights-of-way and are thus threatened by various future road improvement projects in this region, particularly the future expansion of State Route (SR) 99. Additional populations are threatened by commercial and residential development projects.
- Some occurrences on private land in the Northwestern Sacramento Vernal Pool Region may be threatened by agricultural conversion or development.

- In the Southern Sacramento Vernal Pool Region, the vernal pool fairy shrimp is threatened by urban development. Both Sacramento and Placer Counties are currently developing habitat conservation plans to address growth in the region.
- In the San Joaquin Valley Region, the vernal pool fairy shrimp is found primarily on private land where it is threatened by direct habitat loss, including urban development and agricultural conversion.
- In the Solano-Colusa Region, the vernal pool fairy shrimp is threatened by development on the private property where it occurs.
- In the Southern Sierra Foothills Region, the species is threatened by the University of California, Merced campus, which will likely also contribute to significant growth in the region, resulting in additional loss of vernal pool crustacean habitat. Agricultural conversion and flood control projects on Bureau of Reclamation land also threaten the species in this region.
- In Oregon, vernal pool fairy shrimp occurring on the Agate Desert are threatened by commercial and industrial development, agricultural conversion, and utility projects. Over 40% of the vernal pool habitat remaining in Oregon has been degraded.

2A.37.5.3 Invasive Species

The invasions of vernal pools by waxy mannagrass (*Glyceria declinata*), an invasive aquatic grass (Gerlach et al. 2009), greatly increases the amount of decomposing biomass in vernal pools and may result in higher respiratory oxygen consumption relative to photosynthetic oxygen generation (Rogers 1998). Also, upland biomass of invasive species such as medusahead (*Elymus caput-medusae,* formerly *Taeniatherum*) can produce dense vegetation and thatch, shortening the ponding duration of some vernal pools (Marty 2004; Pyke and Marty 2005). Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone of vernal pools and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

2A.37.5.4 Altered Hydrology

Human disturbances and changes in land use practices can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005).

2A.37.5.5 Climate Change

Climate change is expected to have an effect on vernal pool hydrology through changes in the amount and timing of precipitation inputs to vernal pools and the rate of loss through evaporation and evapotranspiration. It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool invertebrate species. Cooling and drying trends could adversely affect vernal pool fairy shrimp through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions could increase inundation periods, which would not necessarily be a negative effect because increased inundation periods would increase available

habitat for vernal pool fairy shrimp. However, increased inundation periods associated with a warming trend could also negatively affect the species by not providing cool enough temperatures for vernal pool fairy shrimp to hatch or reproduce (U.S. Fish and Wildlife Service 2007).

2A.37.5.6 Inappropriate Grazing or Lack of Grazing

Inappropriate grazing practices include complete elimination of grazing in area where nonnative grasses dominate the uplands surrounding vernal pools, and inappropriate timing or intensity of grazing. Appropriate grazing regimes help control nonnative weed plants such as Italian ryegrass and waxy mannagrass, which, if unchecked, can increase thatch buildup, decrease ponding durations, and decrease the aquatic habitat available to the vernal pool fairy shrimp (U.S. Fish and Wildlife Service 2007).

2A.37.6 Relevant Conservation Efforts

A total of 597,821 acres, occupying 30 units, has been designated as critical habitat in California (70 FR 46923). Critical habitat immediately north of the Potrero Hills, and in the area west of Clifton Court Forebay in east Contra Costa County is partially within the Plan Area. Approximately 13,000 acres of vernal pool habitats, including mitigation banks, have been set aside for vernal pool fairy shrimp specifically as terms and conditions of Section 7 consultations (U.S. Fish and Wildlife Service 2007). Throughout the range of the species, vernal pool habitats supporting populations of vernal pool fairy shrimp have been protected through a variety of other means, including preserves, refuges, and protections on private lands. In the Solano-Colusa Vernal Pool Region, vernal pool fairy shrimp are protected in the Jepson Prairie Ecosystem, including the Tule Ranch unit of the CDFW Yolo Bypass Wildlife Area (Tule Ranch, CDFW Calhoun Cut Ecological Reserve, Burke Ranch, Jepson Prairie Preserve, and Montezuma Wetlands Mitigation owned by the Solano County Open Space and Farmland Conservancy (U.S. Fish and Wildlife Service 2005, 2007). Known occurrences in sandstone depression pools in the Altamont area are protected in the Brushy Peak and Vasco Caves preserves that are on property owned and managed by the East Bay Regional Parks District (U.S. Fish and Wildlife Service 2007).

The vernal pool fairy shrimp is covered under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), and the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County Habitat Conservancy 2006). In addition, the species is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011) that are under development, and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.37.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.37.7.1 GIS Model Data Sources

Vernal pool fairy shrimp model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]); California Department of Water Resources 2007 LiDAR elevation data; Google 2009, 2011, and 2012 aerial imagery, and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable vernal pool fairy shrimp habitat in the Plan Area according to the species' two habitat types, vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.37.7.2 Habitat Model Description

Modeled habitat for the vernal pool fairy shrimp includes vernal pool complex and degraded vernal pool complex. The methods for mapping these natural community types are described in Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. Modeled habitat for this species also includes alkali seasonal wetlands, in Conservation Zone 8 only.

High-value habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly impacted by agricultural or development practices. Modeled vernal pool complex habitat for the vernal pool fairy shrimp includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex–all vegetation types

Alkali seasonal wetland complex in Conservation Zone 8 also represents high-value habitat for this species. Modeled alkali seasonal wetland complex habitat includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

Degraded vernal pool complex in the Plan Area represents low-value habitat for the vernal pool fairy shrimp. This habitat includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools

Potential habitat without concave surfaces along the eastern border of Suisun Marsh was differentiated from other habitat using a geographic information system (GIS) constraint layer. The methods used to identify areas without concave surfaces are described in Appendix 2.B, *Vernal Pool*

Complex Mapping and Modifications to Natural Community Mapping. These areas were included in the model as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for the vernal pool fairy shrimp.

- Vernal pool complex

2A.37.7.3 Assumptions

- **Assumption:** The vernal pool fairy shrimp potentially occurs in vernal pool complexes throughout the Plan Area.

  Rationale: This species is dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems (King et al. 1996; Helm 1998; Eriksen and Belk 1999). Vernal pool fairy shrimp have been reported from several locations within vernal pool complexes in the Plan Area (Figure 2A.37-2).

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide high-value habitat for the vernal pool fairy shrimp.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

- **Assumption:** Mapped degraded vernal pool complex and areas without concave surfaces as indicated by LiDAR data represent low-value habitat for the vernal pool fairy shrimp.

  Rationale: Mapped degraded vernal pool complex in the Plan Area ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. The aquatic features in this habitat generally do not hold water for as long as intact and fully functional vernal pools: in many cases the features become saturated but never pond, or only pond after the largest storm events. Additionally, the aquatic features in the degraded vernal pool complex are at much lower densities than in the intact vernal pool complexes. Because these features are saturated or inundated during the wet season and may have historically been located in or near areas with natural vernal pool complex, they may support individuals or small populations of species that are found in vernal pools and swales. However, they do not possess the full complement of ecosystem and community characteristics of natural vernal pools, swales, and their associated uplands and they are generally ephemeral features that are eliminated during the course of normal agricultural practices.

  Areas with appropriate soil conditions and for which no concave surfaces are apparent on the LiDAR data may include features that occasionally inundate but are too small or shallow to show

up on the LiDAR imagery. If present, these features are likely occur at low densities and may be too ephemeral to support the species. However, because these areas do have the potential to support the species at low densities, they were classified as low-value habitat.

2A.37.8 Recovery Goals

In general, the recovery goals for vernal pool crustaceans in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity,* self-sustaining populations throughout the full ecological, geographical, and genetic range of the species by ameliorating or eliminating the threats that caused the species to be listed (U.S. Fish and Wildlife Service 2005). Specifically, the goal of the Vernal Pool Recovery Plan is to delist vernal pool fairy shrimp.

Interim goals of the Vernal Pool Recovery Plan are to stabilize and protect populations so further decline in species status and range are prevented, and conduct research to refine reclassification and recovery criteria (U.S. Fish and Wildlife Service 2005).

General recovery criteria for vernal pool species identified in the Vernal Pool Recovery Plan include habitat protection, adaptive habitat management and monitoring, status surveys, research, and participation and outreach, the specifics of which are summarize in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005).

The Vernal Pool Recovery Plan also includes specific recovery criteria for the vernal pool fairy shrimp. These criteria include the protection of 80% of species occurrences throughout its range and protection of 85% of its suitable habitat in 38 core areas. In addition, the species would be reintroduced into vernal pool regions and soil types from which surveys indicate that it has been eradicated (U.S. Fish and Wildlife Service 2005).

2A.37.9 References Cited

2A.37.9.1 Literature Cited

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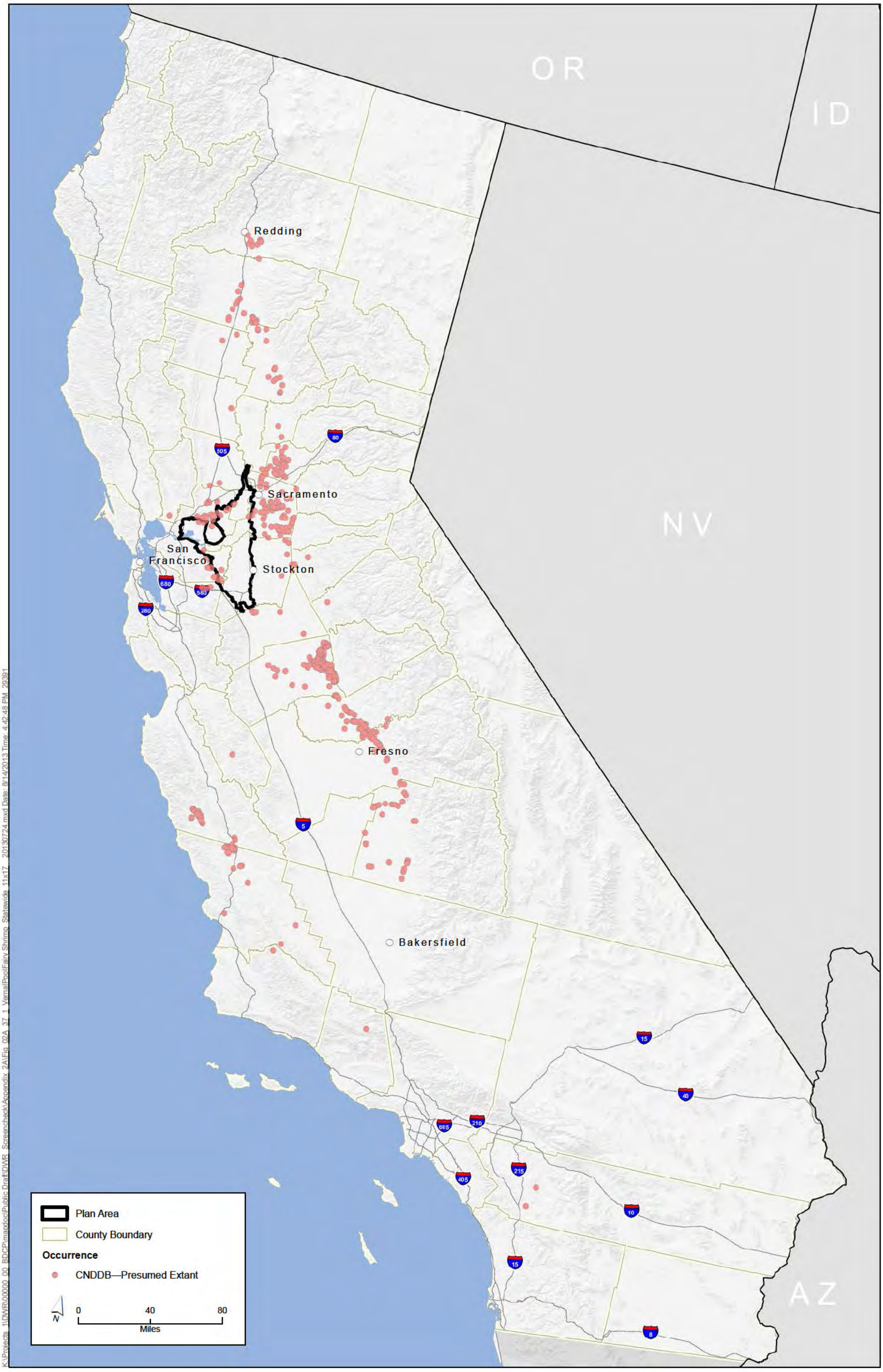
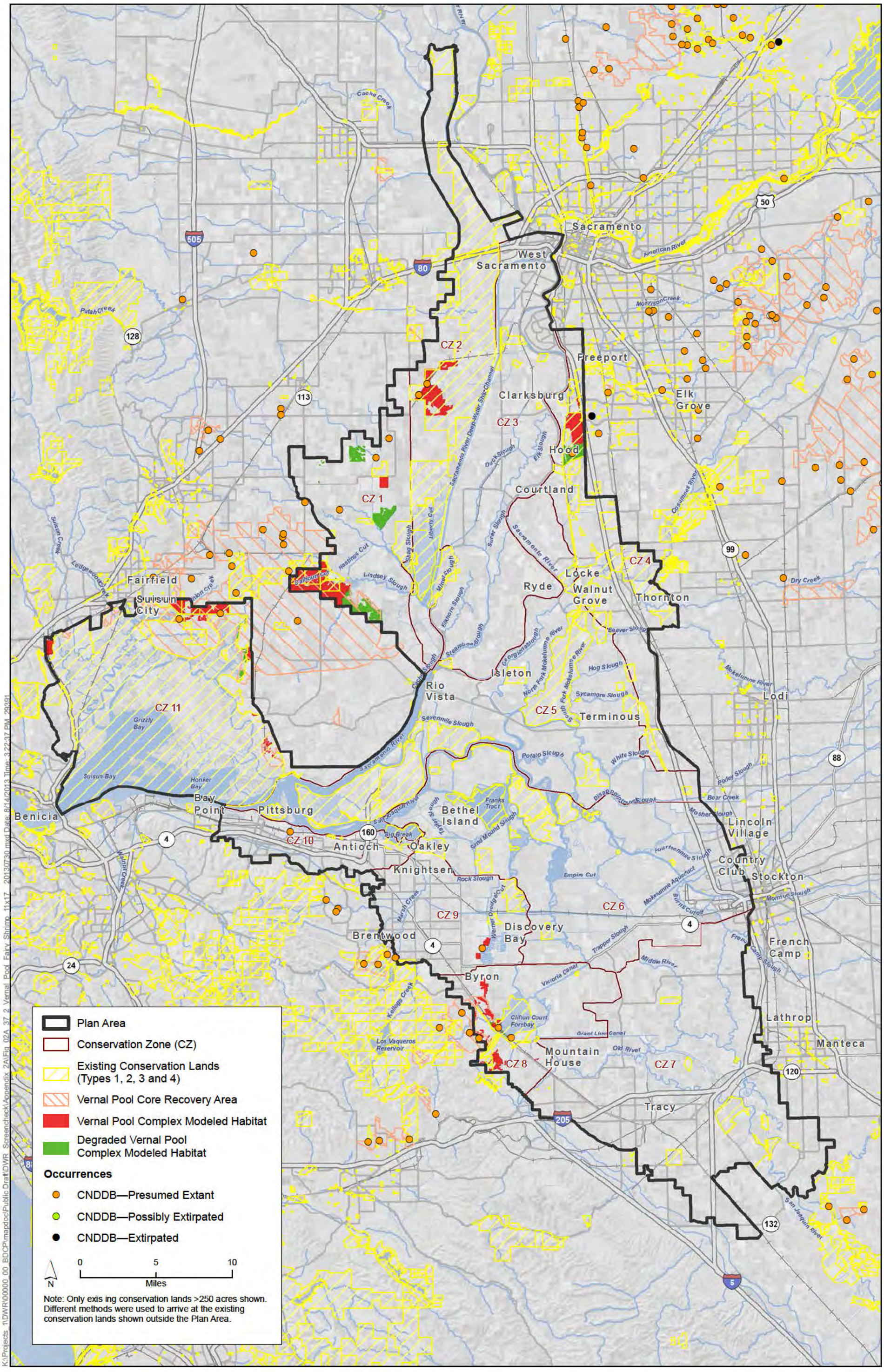


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.37-1
Vernal Pool Fairy Shrimp Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.37-2
Vernal Pool Fairy Shrimp Habitat Model and Recorded Occurrences

Appendix 2A.38
Vernal Pool Tadpole Shrimp (*Lepidurus packardi*)

2A.38.1 Legal Status

The vernal pool tadpole shrimp (*Lepidurus packardi*) was listed as endangered throughout its range under the federal Endangered Species Act on September 19, 1994 (59 *Federal Register* [FR] 48136). In September, 2007, U.S. Fish and Wildlife Service (USFWS) published a 5-year review recommending that the species remain listed as endangered. In addition, on May 25, 2011, USFWS initiated a new 5-year review to determine if the species should remain listed as endangered. Revised critical habitat for vernal pool crustaceans was designated on August 11, 2005 (70 FR 46923) Critical habitat for the vernal pool tadpole shrimp occurs in the Plan Area in Conservation Zone 11 at the northern edge of Suisun Marsh. This species is covered by the December 15, 2005, *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005). The vernal pool tadpole shrimp has no state regulatory status.

2A.38.2 Species Distribution and Status

2A.38.2.1 Range and Status

The vernal pool tadpole shrimp historically probably did not occur outside of the Central Valley and Central Coast regions (U.S. Fish and Wildlife Service 2005). The vernal pool tadpole shrimp is distributed across the Central Valley of California and in the San Francisco Bay area (Figure 2A.38-1). The vernal pool tadpole shrimp has a patchy distribution across the Central Valley of California from Shasta County southward to northwestern Tulare County (U.S. Fish and Wildlife Service 2007). In the Central Coast Vernal Pool Region, the vernal pool tadpole shrimp is found the San Francisco National Wildlife Refuge and on private land in Alameda County near Milpitas (U.S. Fish and Wildlife Service 2007; California Department of Fish and Game 2012). The largest concentration of vernal pool tadpole shrimp occurrences is found in the Southeastern Sacramento Vernal Pool Region, where the species occurs on a number of public and private lands in Sacramento County (U.S. Fish and Wildlife Service 2005, 2007).

2A.38.2.2 Distribution and Status in the Plan Area

The vernal pool tadpole shrimp has been reported from several locations in the Plan Area (Figure 2A.38-2) (U.S. Fish and Wildlife Service 2005, 2007; California Department of Fish and Game 2012). In general, within the Plan Area, vernal pools that may support the species occur in Jepson Prairie in western Conservation Zone 1, in the California Department of Fish and Wildlife (CDFW) Tule Ranch Unit of the Yolo Bypass in Conservation Zone 2 Wildlife Area, in the Stone Lakes area in Conservation Zone 3, in western Conservation Zone 8 near the town of Byron, and along the eastern and northern boundary of Conservation Zone 11 (Figure 2A.38-2). Six occurrences were observed in the Stone Lakes area during 2009 surveys conducted by the California Department of Water

Resources (DWR). A comprehensive survey of vernal pools or habitat for the vernal pool tadpole shrimp has not been conducted in the Plan Area.

2A.38.3 Habitat Requirements and Special Considerations

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters that the vernal pool tadpole shrimp inhabits fill in the fall and winter during the beginning of the wet season and dry in late-spring at the beginning of the dry season and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from surface runoff and perched groundwater from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors including the hydrologic conductivity of the surface soil horizons, the continuity and extent of hardpans and claypans underlying nonclay soils, the existence of a perched aquifer overlying the pans, slope, effects of vegetation on evapotranspiration rates, compaction of surface soils by grazing animals, and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for the vernal pool tadpole shrimp are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999). Common wetland plant species that co-occur with vernal pool tadpole shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryngium* spp.), downingia (*Downingia ornatissima* and *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007). Vernal pool tadpole shrimp commonly co-occur with other fairy shrimp (U.S. Fish and Wildlife Service 2005).

2A.38.4 Life History

2A.38.4.1 Description

The vernal pool tadpole shrimp is characterized by a smooth protective concave shell or carapace that protects its head and thorax. A pair of eyes is centered at the anterior end of its shell. Its segmented abdomen is visible (posterior), and the last segment produces a caudal lamina (tail plate), which is diagnostic for the genus, and a pair of whip-like appendages called cercopods (U.S. Fish and Wildlife Service 2005). At full maturity, the vernal pool tadpole shrimp has 30 to 35 pairs of appendages called phyllopods that propel it through the water and through which it exchanges oxygen (U.S. Fish and Wildlife Service 2007). Mature vernal pool tadpole shrimp are from 15 to 86 millimeters (0.6 to 3.3 inches) long. (U.S. Fish and Wildlife Service 2005).

2A.38.4.2 Reproduction and Growth

Vernal pool tadpole shrimp are adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of vernal pool tadpole shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the cysts may hatch. The cyst bank in the soil may comprise cysts from several years of breeding (U.S. Fish and Wildlife Service 2005, 2007). Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found that vernal pool tadpole shrimp can reproduce as early as 41 days following hatching with the average being 54 days (Helm 1998). Site-specific conditions, primarily water temperature, have been shown to affect time to reach reproductive maturity (Helm 1998).

Vernal pool tadpole shrimp have relatively high reproductive rates and may be hermaphroditic. Sex ratios can vary, perhaps in response to changes in water temperature (Ahl 1991). Genetic variation among vernal pool tadpole shrimp was studied in populations at 20 different sites in the Central Valley (King 1996). The results found that 96% of the genetic variation measured was due to differences between sites. This result corresponds with the findings of other researchers that vernal pool crustaceans have low rates of gene flow between separated sites (U.S. Fish and Wildlife Service 2005). The low rate of exchange between vernal pool tadpole shrimp populations is probably a result of the spatial isolation of their habitats and their reliance on passive dispersal mechanisms (U.S. Fish and Wildlife Service 2005). However, the studies also found that gene flow between pools within the same vernal pool complex is much higher (U.S. Fish and Wildlife Service 2005). This indicates that vernal pool tadpole shrimp populations, like most vernal pool crustacean populations, are defined by vernal pool complexes and not by individual vernal pools (U.S. Fish and Wildlife Service 2005).

2A.38.4.3 Feeding

Vernal pool tadpole shrimp feed on both living organisms such as fairy shrimp and on detritus (U.S. Fish and Wildlife Service 2007).

2A.38.4.4 Predation and Dispersal

Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1998).

Predator consumption of tadpole shrimp cysts aids in distributing populations of tadpole shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through vernal pool tadpole

shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats. (Eriksen and Belk 1999.)

2A.38.5 Threats and Stressors

Threats to vernal pool habitat and species in general, including the vernal pool tadpole shrimp, were identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). In addition, the Vernal Pool Recovery Plan identified several threats specific to the vernal pool tadpole shrimp. Brief summaries of the primary threats to the vernal pool tadpole shrimp identified in the Vernal Pool Recovery Plan and addressed in the USFWS 2007 5-year review for the vernal pool tadpole shrimp are presented below.

2A.38.5.1 Random, Naturally Occurring Events

The continuing fragmentation of vernal pool tadpole shrimp habitat range-wide may result in small isolated occurrences of this species in some areas, which could make these populations vulnerable to random environmental fluctuations or variation due to annual weather patterns and availability of food and other environmental factors (U.S. Fish and Wildlife Service 2005, 2007).

2A.38.5.2 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Specific threats to vernal pool tadpole shrimp habitat identified in the 2005 Vernal Pool Recovery Plan included the following:

- The species is threatened by the encroachment of nonnative annual grasses on the San Francisco Bay National Wildlife Refuge in the Central Coast Region, and by urban development where it is known to occur on private land in Alameda County.
- In the Northeastern Sacramento Valley Region, most of the known occurrences of the vernal pool tadpole shrimp are on California Department of Transportation (Caltrans) rights-of-way, where they continue to be threatened by road improvement projects related to general urban growth.
- In the Northwester Sacramento Valley Vernal Pool Region, the vernal pool tadpole shrimp is threatened by development on the few sites on private land where it is known to occur.
- In the Southeastern Sacramento Vernal Pool Region, extant populations of the vernal pool tadpole shrimp are threatened by continued extensive urban development.
- In the San Joaquin Vernal Pool Region, the species is threatened by development on private land.
- In the Solano-Colusa Region, the species is threatened by urbanization on private lands.

- In the Southern Sierra Foothills Vernal Pool Region, the species is threatened by development of the University of California, Merced campus, which will likely contribute to significant growth in the region. Populations on the Stone Corral Ecological Reserve may be threatened by pesticide drift from adjacent farmlands.

2A.38.5.3 Invasive Species

The invasions of vernal pools by waxy mannagrass (*Glyceria declinata*), an invasive aquatic grass (Gerlach et al. 2009), greatly increases the amount of decomposing biomass in vernal pools and may result in higher respiratory oxygen consumption relative to photosynthetic oxygen generation (Rogers 1998). Also, upland biomass of invasive species such as medusahead (*Elymus caput-medusae,* formerly *Taeniatherum*) can produce dense vegetation and thatch, shortening the ponding duration of some vernal pools (Marty 2004; Pyke and Marty 2005). Italian ryegrass (*Festuca perennis,* formerly *Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone of vernal pools and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

2A.38.5.4 Altered Hydrology

Human disturbances and changes in land use practices can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005).

2A.38.5.5 Climate Change

Climate change is expected to have an effect on vernal pool hydrology through changes in the amount and timing of precipitation inputs to vernal pools and the rate of loss through evaporation and evapotranspiration. It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool invertebrate species. Cooling and drying trends could adversely affect the vernal pool tadpole shrimp through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions could increase inundation periods, which would not necessarily be a negative effect because increased inundation periods would increase available habitat for the vernal pool tadpole shrimp. However, increased inundation periods associated with a warming trend could also negatively affect the species by not providing cool enough temperatures for the vernal pool tadpole shrimp to hatch or reproduce (U.S. Fish and Wildlife Service 2007).

2A.38.5.6 Grazing

Inappropriate grazing practices include complete elimination of grazing in area where nonnative grasses dominate the uplands surrounding vernal pools, and inappropriate timing or intensity of grazing. Appropriate grazing regimes help control nonnative weed plants such as Italian ryegrass and waxy mannagrass, which if unchecked can increase thatch buildup and decrease ponding durations and decrease the aquatic habitat available to the vernal pool tadpole shrimp (U.S. Fish and Wildlife Service 2007).

2A.38.6 Relevant Conservation Efforts

The vernal pool tadpole shrimp is protected as an endangered species under the Endangered Species Act, and critical habitat has been designated as noted above. Critical habitat occurs in the Plan Area in Conservation Zone 11 near Potrero Hills.

The amount of suitable vernal pool tadpole shrimp habitat that is currently protected within core areas has not been quantified at this time; however, 18 of the 24 core areas contain some vernal pool tadpole shrimp habitat that is protected on public lands or on private preserves or conservation banks. The Jepson Prairie core area, which covers portions of Conservation Zones 1 and 11, has several properties where the vernal pool tadpole shrimp is protected (U.S. Fish and Wildlife Service 2007).

The vernal pool tadpole shrimp is covered under the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003), the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), and the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County Habitat Conservancy 2006). In addition, the species is proposed for coverage in the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010), the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011) currently under development, and the *Butte Regional Conservation Plan* (Butte County Association of Governments 2011).

2A.38.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.38.7.1 GIS Model Data Sources

The vernal pool tadpole shrimp model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]); California Department of Water Resources 2007 LiDAR elevation data; Google 2009, 2011, and 2012 aerial imagery; and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable vernal pool tadpole shrimp habitat in the Plan Area according to the species' two habitat types, vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.38.7.2 Habitat Model Description

Modeled habitat for the vernal pool tadpole shrimp includes vernal pool complex and degraded vernal pool complex. The methods for mapping these natural community types are described in

Appendix 2.B, *Vernal Pool Complex Mapping and Modifications to Natural Community Mapping*. Modeled habitat for this species also includes alkali seasonal wetlands, in Conservation Zone 8 only.

High-value habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for the vernal pool tadpole shrimp includes the following vegetation subunits that were selected from the BDCP composite data for the vernal pool complex natural community.

- Vernal pool complex–all vegetation types

Alkali seasonal wetland complex in Conservation Zone 8 also represents high-value habitat for this species. Modeled alkali seasonal wetland complex habitat includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

Degraded vernal pool complex in the Plan Area represents low-value habitat for the vernal pool tadpole shrimp. This habitat includes the following vegetation subunits that were selected from the BDCP composite data.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools

Potential habitat without concave surfaces along the eastern border of Suisun Marsh was differentiated from other habitat using a geographic information system (GIS) constraint layer. The methods used to identify areas without concave surfaces are described in Appendix 2B, *Vernal Pool Complex Mapping and Modifications to Other Natural Community Mapping*. These areas were included in the model as low-value habitat.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural community was assumed to provide habitat for the vernal pool tadpole shrimp.

- Vernal pool complex

2A.38.7.3 Assumptions

- **Assumption:** The vernal pool tadpole shrimp potentially occurs in vernal pool complexes throughout the Plan Area.

  Rationale: This species is dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems (King et al. 1996; Helm 1998; Eriksen

and Belk 1999). The vernal pool tadpole shrimp has been reported from several locations within vernal pool complexes in the Plan Area (Figure 2A.38-2).

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide high-value habitat for the vernal pool tadpole shrimp.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

- **Assumption:** Mapped degraded vernal pool complex and areas without concave surfaces as indicated by LiDAR data represent low-value habitat for the vernal pool tadpole shrimp.

  Rationale: Mapped degraded vernal pool complex in the Plan Area ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. The aquatic features in this habitat generally do not hold water as long as intact and fully functional vernal pools: in many cases the features become saturated but never pond, or only pond after the largest storm events. Additionally, the aquatic features in the degraded vernal pool complex are at much lower densities than the intact vernal pool complexes. Because these features are saturated or inundated during the wet season and may have historically been located in or near areas with natural vernal pool complex, they may support individuals or small populations of species that are found in vernal pools and swales. However, they do not possess the full complement of ecosystem and community characteristics of natural vernal pools, swales, and their associated uplands and they are generally ephemeral features that are eliminated during the course of normal agricultural practices.

  Areas with appropriate soil conditions and for which no concave surfaces are apparent on the LiDAR data may include features that occasionally inundate but are too small or shallow to show up on the LiDAR imagery. If present, these features are likely occur at low densities and may be too ephemeral to support the species. However, because these areas do have the potential to support the species at low densities, they were classified as low-value habitat.

2A.38.8 Recovery Goals

In general, the recovery goals for vernal pool crustaceans in the Vernal Pool Recovery Plan are to achieve and protect, *in perpetuity*, self-sustaining populations throughout the full ecological, geographical, and genetic range of the species by ameliorating or eliminating the threats that caused the species to be listed (U.S. Fish and Wildlife Service 2005). Specifically, the goal of the Vernal Pool Recovery Plan is to delist the vernal pool tadpole shrimp.

Interim goals of the Vernal Pool Recovery Plan are to stabilize and protect populations so further decline in species status and range are prevented, conduct research to refine reclassification and recovery criteria, and downlist the species from endangered to threatened (U.S. Fish and Wildlife Service 2005).

General recovery criteria for vernal pool species identified in the Vernal Pool Recovery Plan include habitat protection, adaptive habitat management and monitoring, status surveys, research, and participation and outreach, the specifics of which are summarized in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005).

The Vernal Pool Recovery Plan also includes specific recovery criteria for the vernal pool tadpole shrimp. These criteria to downlist the species are to protect 80% of this species' existing occurrences and 85 to 95% of this species' suitable habitat within 24 core areas, which for the Jepson Prairie core area would be 95% of suitable habitat. The criteria to delist the species are to protect 100% of newly discovered and reintroduced populations and reintroduce the species into vernal pool regions and soil types from which surveys indicate that it has been extirpated. (U.S. Fish and Wildlife Service 2005.)

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2A.38.9.1 Literature Cited

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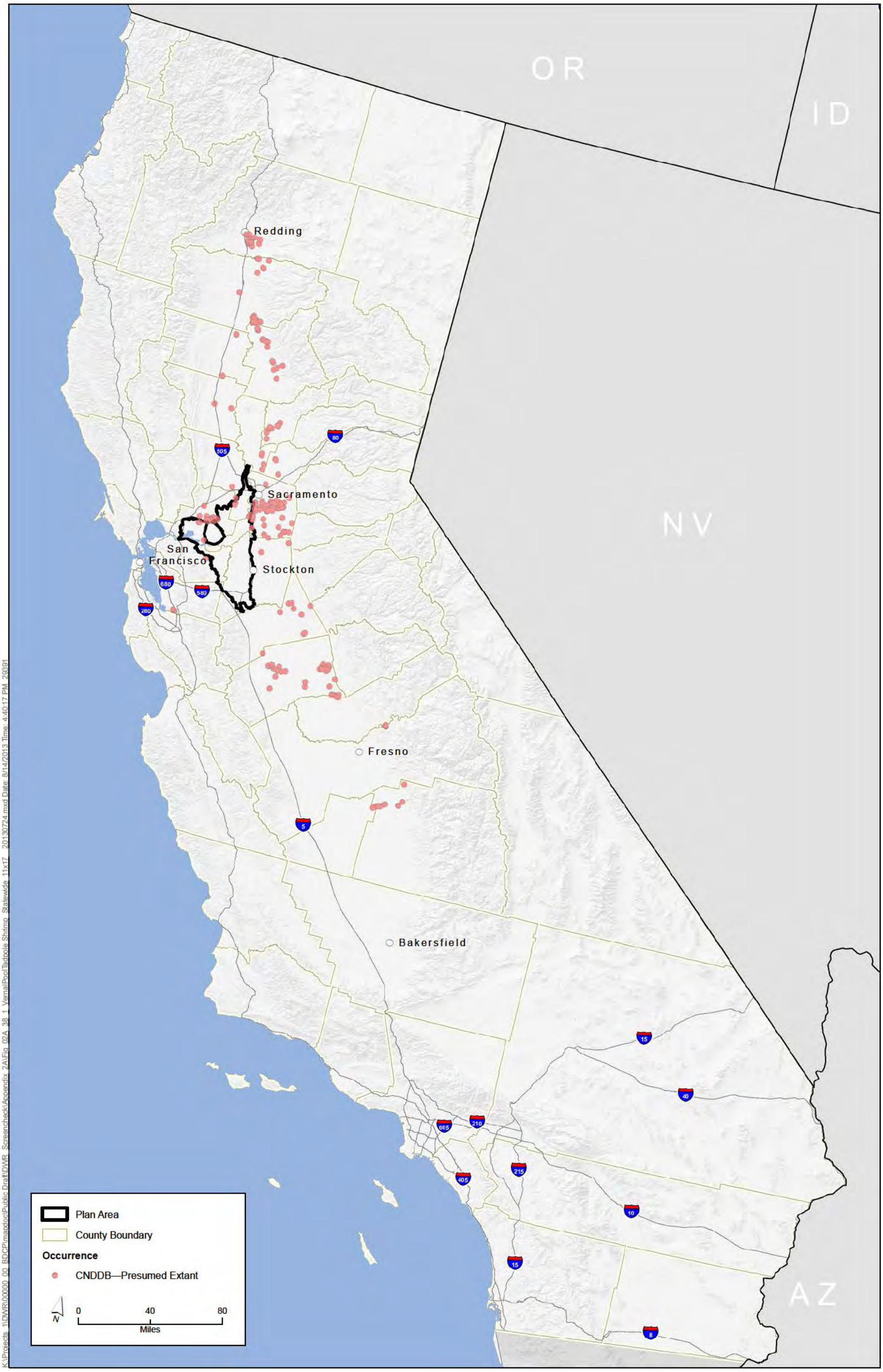

GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.38-1
Vernal Pool Tadpole Shrimp Statewide Range and Recorded Occurrences

Plan Area
Conservation Zone (CZ)
Existing Conservation Lands (Types 1, 2, 3 and 4)
Vernal Pool Core Recovery Area
Vernal Pool Complex Modeled Habitat
Degraded Vernal Pool Complex Modeled Habitat

Occurrences

CNDDB—Presumed Extant
CNDDB—Possibly Extirpated
CNDDB—Extirpated

N
0 5 10
Miles

Note: Only exis ing conservation lands >250 acres shown. Different methods were used to arrive at the existing conservation lands shown outside the Plan Area.

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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.38-2
Vernal Pool Tadpole Shrimp Habitat Model and Recorded Occurrences

Appendix 2A.39
Carquinez Goldenbush (*Isocoma arguta*)

2A.39.1 Legal Status

Carquinez goldenbush (*Isocoma arguta*) is not listed under either federal or California endangered species acts. Its Heritage Element Ranking in the California Natural Diversity Database (CNDDB) is G1/S1, which means that globally (G) and within the state (S) it is considered critically imperiled, and at very high risk of extinction due to extreme rarity (often five or fewer occurrences), steep declines, or other factors (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.1 for Carquinez goldenbush indicates that it is rare, threatened, or endangered in California or elsewhere. Its state threat level (.1) indicates that it is seriously endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with a rank of 1B meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.39.2 Species Distribution and Status

2A.39.2.1 Range and Status

Carquinez goldenbush is endemic to California, and is known only from a very limited geographic range in Solano County (Nesom 1991; California Department of Fish and Game 2012b) (Figure 2A.39-1). All of the 14 occurrences reported in the CNDDB consist of small populations restricted to ephemeral drainages, within a very narrow elevation band between uplands and Suisun Marsh, or adjacent to a large alkaline playa (California Department of Water Resources 2007; California Department of Fish and Game 2012b). Based on the geology and soils of the area within which all of the occurrences are located (Graymer et al. 2002; Natural Resources Conservation Service 2009), the species appears to be restricted to alluvial soils derived from the Tehama and Montezuma geological formations north and west of the Montezuma Hills(Graymer et al. 2002; Natural Resources Conservation Service 2009).

2A.39.2.2 Distribution and Status in the Plan Area

The 14 reported occurrences are presumed extant and are scattered in small populations within or adjacent to the Plan Area. Ten occurrences of Carquinez goldenbush are in the Plan Area, and are located near Bird's Landing, Denverton, the Montezuma Hills, the Hay Road Landfill, Jepson Prairie, and in the Vanden area (Figure 2A.39-2). The occurrences with reported abundance generally consist of a few plants (from 1 to 80 individuals); however, a large population reported inside the Plan Area west of Bird's Landing consisted of 200 plants in 1991 and 760 plants in 1992. Two populations in the Jepson Prairie area had 35 and 85 plants in the 1990s. The most recent report was of 10 plants observed just outside the Plan Area in 2008 (California Department of Fish and

Game 2012b). No additional occurrences were found during any of the most recent surveys (Delta Habitat Conservation and Conveyance Program 2011).

2A.39.3 Habitat Requirements and Special Considerations

Very little is known about the habitat requirements of Carquinez goldenbush. It grows in alluvuial soils along seasonal drainages, adjacent to the margins of alkaline playas, and in association with vegetation that is transitional between the brackish marsh and the grasslands within the 3.4 to 4.3 meter North American Vertical Datum of 1988 (NAVD88) elevation band along the eastern border of Suisun Marsh (California Department of Water Resources 2007; California Department of Fish and Game 2012b; California Native Plant Society 2012).

2A.39.4 Life History

Carquinez goldenbush is a very small shrub in the sunflower family (Asteraceae) with flowering heads that bloom from August to December and contain 10 to 13 yellow flowers (Chambers 2012; California Native Plant Society 2012). Its maximum reported height is 30 centimeters (less than 1 foot) and the woody stems that branch from the base of the plants can be either erect or lie mostly flat on the ground with the branch tips curving upward (Nesom 1991). The leaves are hairless, light gray-green in color, dotted with glands, and less than 2 centimeters (0.8 inch) long. Unlike the highly variable and closely related species that occur immediately to the south, Carquinez goldenbush has consistent morphological characteristics across its distribution (Nesom 1991).

2A.39.5 Threats and Stressors

Carquinez goldenbush is threatened by development and agriculture (California Native Plant Society 2012).

2A.39.6 Relevant Conservation Efforts

Some of the reported occurrences are generally in protected areas such as the Greater Jepson Prairie Ecosystem Regional Management Plan area (Witham 2006) or the Suisun Marsh Management Area.

2A.39.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods.*

Carquinez goldenbush occurrences in the Plan Area are all close to hydrological features such as alluvium in stream corridors on the Montezuma Block and along the upper margin of Suisun Marsh. The U.S. Geological Survey (USGS) geological data (Graymer et al. 2002) was used to select the

following alluvium units that were related to the Montezuma Block and along Suisun Marsh: Qa, Qhb, Qhbm, Qhc, Qhbm, Qhc, Qhdm, Qhf, Qmz Qoa, and Qpf. Specific regions were selected from these alluvium units that were considered directly related to the Montezuma block based on visual review of this region. These regions were exported to a geographic information system (GIS) layer. Stream corridors (intermittent and perennial) that intersected these geologic units were selected and truncated at the point at which they encountered the upper elevation of intertidal marsh (Siegel 2007). The corridors were buffered 50 feet (15 meters) on either side in an effort to capture the estimated maximum extend of alluvium deposits in close proximity to the actual rivers/streams. Field reconnaissance on the Montezuma Block area in May 2009 indicates that this buffering width is liberal and tends to over-predict potential habitat. Additionally, playa features within the region of the Jepson Prairie Preserve were extracted from the geology GIS dataset (Graymer et al. 2002) and incorporated as habitat in the model.

Physical factors such as the tidal waters and high groundwater elevations in Suisun Marsh may cause a backwater effect on the down gradient moving groundwater of the uplands resulting in localized shallow upland groundwater and resulting changes in vegetation (Rains et al. 2004), or the change in slope combined with finer textured soils at the transition from upland to marsh may cause temporary shallow water tables in the same area (Loheide II et al. 2009). Alternatively, the association of this species with stream corridors and the narrow elevation band along Suisun Marsh may be an artifact of the area's extensive dry-farmed grain cropping where regular soil discing and seeding commonly occur in smaller drainages and right up to the wetland boundaries in larger drainages and Suisun Marsh.The upper margins of the marsh (11 to 15 feet LiDAR elevation resampled to 10 meters, NAVD88) were used to identify areas that may provide suitable combinations of soil properties and moisture.

The identified potential habitat was then overlaid on National Agricultural Imagery Program aerial imagery (U.S. Department of Agriculture 2005) to visually assess whether estimated habitat agreed with current land use practices (i.e., to ensure that habitat was not currently affected by urban or agricultural uses). Predicted habitat that was affected by urban or intensive agricultural uses was removed from the model. This was accomplished by developing a GIS layer of habitat polygons designated as unsuitable.

Areas mapped comprise the following natural community types.

- Agriculture
    - Cultivated annual graminoid
    - Pasture
- Grassland
    - Pasture
    - Upland annual grasslands and forbs formation
- Alkali seasonal wetland complex
- Nontidal perennial aquatic
- Vernal pool complex

2A.39.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

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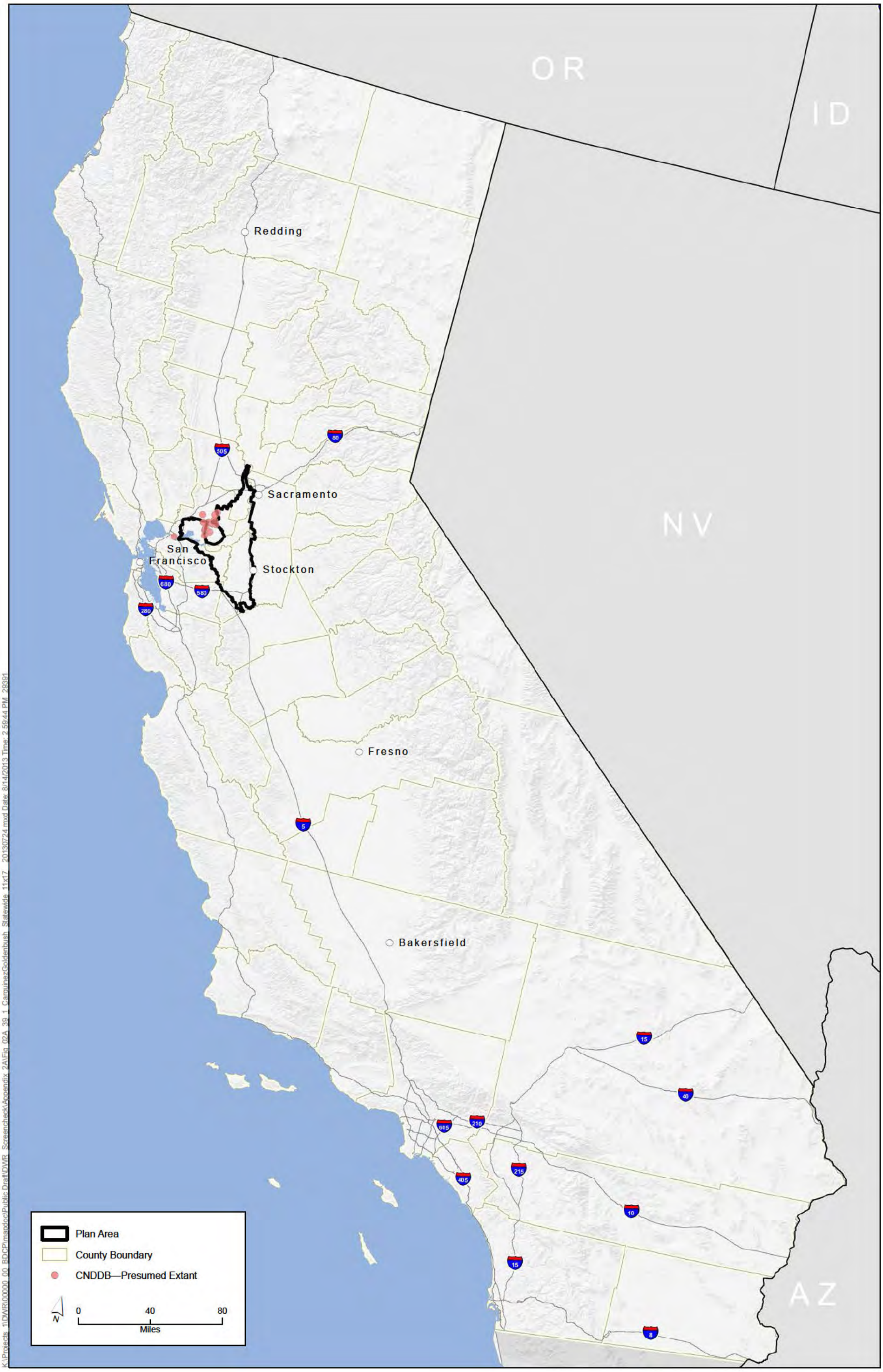
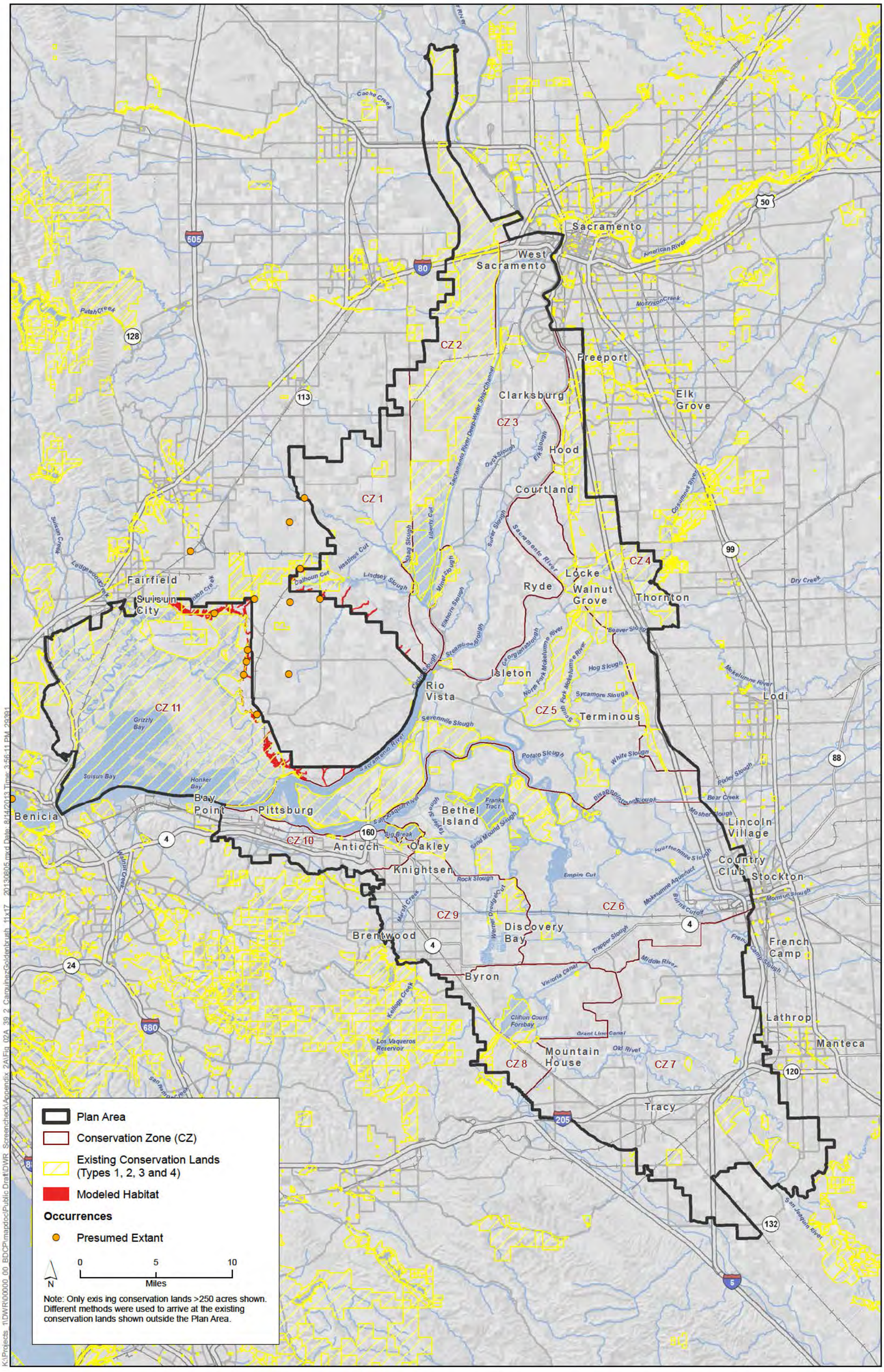


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.39-1
Carquinez Goldenbush Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.39-2
Carquinez Goldenbush Habitat Model and Recorded Occurrences

Appendix 2A.40
Delta Button Celery (*Eryngium racemosum*)

2A.40.1 Legal Status

Delta button celery (*Eryngium racemosum*) is listed as endangered under the California Endangered Species Act (August 1981). It is not listed under the federal Endangered Species Act. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G1Q/S1, which indicates that both globally (G) and within the state (S) this species is critically imperiled and is at high risk for extinction as a result of extreme rarity and steep declines The Q portion of the rank indicates that unresolved taxonomic questions remain for this rare species (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.1 for delta button celery indicates that it is rare, threatened, or endangered in California and elsewhere. Its state threat level (.1) indicates that it is seriously endangered in California (California Department of Fish and Game 2012a). Plants with a rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.40.2 Species Distribution and Status

2A.40.2.1 Range and Status

Delta button celery is endemic to the northern portion of the San Joaquin Valley, south of Brentwood, California (Figure 2A.40-1) (California Department of Fish and Game 2012b). There are 26 reported occurrences, of which only 19 are presumed extant in Calaveras, Contra Costa, and Stanislaus Counties, with the greatest number in Merced County; occurrences in San Joaquin and Contra Costa Counties are considered possibly extirpated (California Department of Fish and Game 2012b). All reported localities are between 15 and 100 feet (3 and 30 meters) in elevation, except for the two occurrences in the Sierra Nevada foothills, one at 240 feet (73 meters) in Stanislaus County and one at 1,100 feet (335 meters) in Calaveras County. However, these two occurrences may have been erroneously identified (Preston pers. comm.). The majority of occurrences (18) have not been seen recently (California Department of Fish and Game 2012b).

Extant occurrences are on private land and on land managed by the California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), and other public agencies. Occurrences on state and federally owned land are in designated wildlife areas and wildlife refuges.

2A.40.2.2 Distribution and Status in the Plan Area

Delta button celery was known to occur at two locations in the Plan Area, one immediately west of Discovery Bay, and one along the San Joaquin River northeast of Tracy (Figure 2A.40-2), but both are now considered possibly extirpated (California Department of Fish and Game 2012b). The occurrence near Discovery Bay was last observed in 1998 in a small area with about

1,500 individuals in alkali sink habitat with iodine bush (*Allenrolfea occidentalis*), alkali heath (*Frankenia salina*), and saltgrass (*Distichlis spicata*), but the area was disked in 2008 leaving no vegetation (California Department of Fish and Game 2012b). The other occurrence in the Plan Area, located about 3 miles south of Lathrop, was last observed in 1913 and is believed to have been extirpated when the area was converted to a walnut orchard.

Two additional occurrences have been recorded just outside the Plan Area: one was about 2.5 miles (4 kilometers) northeast of Vernalis, and the other was at the northeast end of Caswell Memorial State Park. Both sites were last visited in 1985, when the habitat was deemed unsuitable, and both occurrences are now considered possibly extirpated (California Department of Fish and Game 2012a).

Surveys conducted from 2009 through 2011 for the Delta Habitat Conservation and Conveyance Program found no additional occurrences of delta button celery in the conveyance planning area (Delta Habitat Conservation and Conveyance Program 2011).

2A.40.3 Habitat Requirements and Special Considerations

Based on its current and historical distributions, delta button celery occurs in seasonally scoured and inundated swales, depressions, and clay flats in the floodplain of the San Joaquin River (Woolington pers. comm.). The specific location of occurrences may shift depending on the disturbance and flooding regime. As a disturbance follower, there is no strong fidelity to a particular soil or vegetation type, but occurrences are primarily reported on alkaline clays deposited within bands of coarser textured soils and willow scrub vegetation. The associated species are characteristic of frequently disturbed riparian bottom lands and include turkey tangle fogfruit (*Phyla nodiflora*), spikerush (*Eleocharis* spp.), American bird's foot trefoil (*Acmispon americanus* var. *americanus,* formerly *Lotus purshianus*), Goodding's black willow (*Salix gooddingii*), and common sunflower (*Helianthus annuus*) (California Department of Fish and Game 2012b).

2A.40.4 Life History

Delta button celery is a prostrate biennial or short-lived perennial herb in the carrot family (Apiaceae) (Preston et al. 2012). The sprawling, branched stems are generally 4 to 20 inches (10 to 50 centimeters) in length (Preston et al. 2012). It is unique in being California's only native *Eryngium* species that produces roots and juvenile leaves at the stem nodes, and its spiny flower heads are arranged in an elongated raceme instead of a compact cyme (Preston et al. 2012). It flowers from June to October (California Native Plant Society 2012). Seeds germinate after flood water recedes.

California's *Eryngium* species can be difficult to differentiate based on morphological characteristics because species are variable and intergrade, so that individuals with characteristics that are intermediate between different species are common (Preston et al. 2012).

2A.40.5 Threats and Stressors

Threats to the species include agricultural habitat conversion, flood control activities such as channelization and channel maintenance activities, overgrazing, dredging, and invasion of habitat by nonnative plant species (California Department of Fish and Game 2008; California Native Plant Society 2012). Some occurrences have been eliminated by flood control activities and conversion to agriculture, including all of the occurrences in San Joaquin County and most in Stanislaus County (California Department of Fish and Game 2008). Many occurrences along the San Joaquin River in Merced County are threatened by reduced flooding because of controlled releases from Friant Dam and the construction of an extensive levee system (California Department of Fish and Game 2008).

2A.40.5.1 Agriculture

A substantial portion of the suitable habitat for the delta button celery is nowprime agricultural land. Much of the suitable habitat for this species has been converted to various forms of agriculture. The known occurrences that have been extirpated have been converted to agriculture (California Department of Fish and Game 2012b).

2A.40.5.2 Channel Maintenance Activities

Past channelization and channel maintenance, including dredging, has resulted in changes to the nature of the habitat and severe disturbance of adjacent areas. More importantly, channel maintenance lessens the degree and frequency of flooding, reducing suitable habitat for this species (California Department of Fish and Game 2008).

2A.40.5.3 Invasion by Nonnative Plant Species

Nonnative invasive plant species compete with the delta button celery for habitat. Because the San Joaquin River floodplain habitat is subject to periodic natural disturbance (scouring), the habitat is ideal for many native and nonnative ruderal species as well. Some of these species include common sunflower and cocklebur (*Xanthium* spp.), which may shade out delta button celery as has been noted at two protected sites in San Luis National Wildlife Refuge and Merced National Wildlife Refuge (NatureServe 2008).

2A.40.6 Relevant Conservation Efforts

The delta button celery occurs or has been extirpated at several publicly owned properties, including Caswell State Park, Merced National Wildlife Refuge, San Luis National Wildlife Refuge Complex, and the North Grasslands Wildlife Area. It is also a covered species in the *San Joaquin County Multi-species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000).

2A.40.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

Delta button celery habitat was identified as all areas between the levees from the Mossdale Bridge to Vernalis and as alkali seasonal wetland complex, vernal pool complex, valley/foothill riparian, and grassland on Brentwood (Bc), Grangerville (166), Marcuse (Mb), Solano (Sh, Sk), and Vernalis (269) soil map units in the San Joaquin Basin (i.e., south of the mainstem San Joaquin River). A constraint geographic information system (GIS) layer was developed to capture the area between the levees from the Mossdale Bridge to Vernalis, which represents delta button celery habitat. Vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP geographic information systems (GIS) vegetation data layer. For this species, a misclassification of land cover in the source data occurred north of the Discovery Bay area where intensive agriculture was classified as annual grassland, and those parcels were manually deleted from the area of predicted habitat. Additionally, other areas of potential habitat that have since been developed were also removed using a GIS layer that excluded these specific instances.

2A.40.7.1 Assumptions

- **Assumption:** Delta button celery habitat in the Plan Area is geographically constrained to areas described in Section 2A.12.7.2, *Habitat Model Description*.

  Rationale: Historical and current records of this species indicate that its distribution is limited to the San Joaquin River Basin where it occurs in a specific habitat type (Figure 2A.40-2): seasonally scoured and inundated swales, depressions, and clay flats in the floodplain of the San Joaquin River (Woolington pers. comm.). All delta button celery habitat was geographically constrained to areas in the Plan Area south of the San Joaquin River using a GIS layer that was developed to represent this constraint. The specific locations of the occurrences may shift depending on the disturbance and flooding regime. As a disturbance follower, there is no strong fidelity to a particular soil or vegetation type, but occurrences are primarily reported on alkaline clays deposited within bands of coarser textured soils and willow scrub vegetation.

2A.40.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

2A.40.9 References Cited

2A.40.9.1 Literature Cited

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2A.40.9.2 Personal Communications

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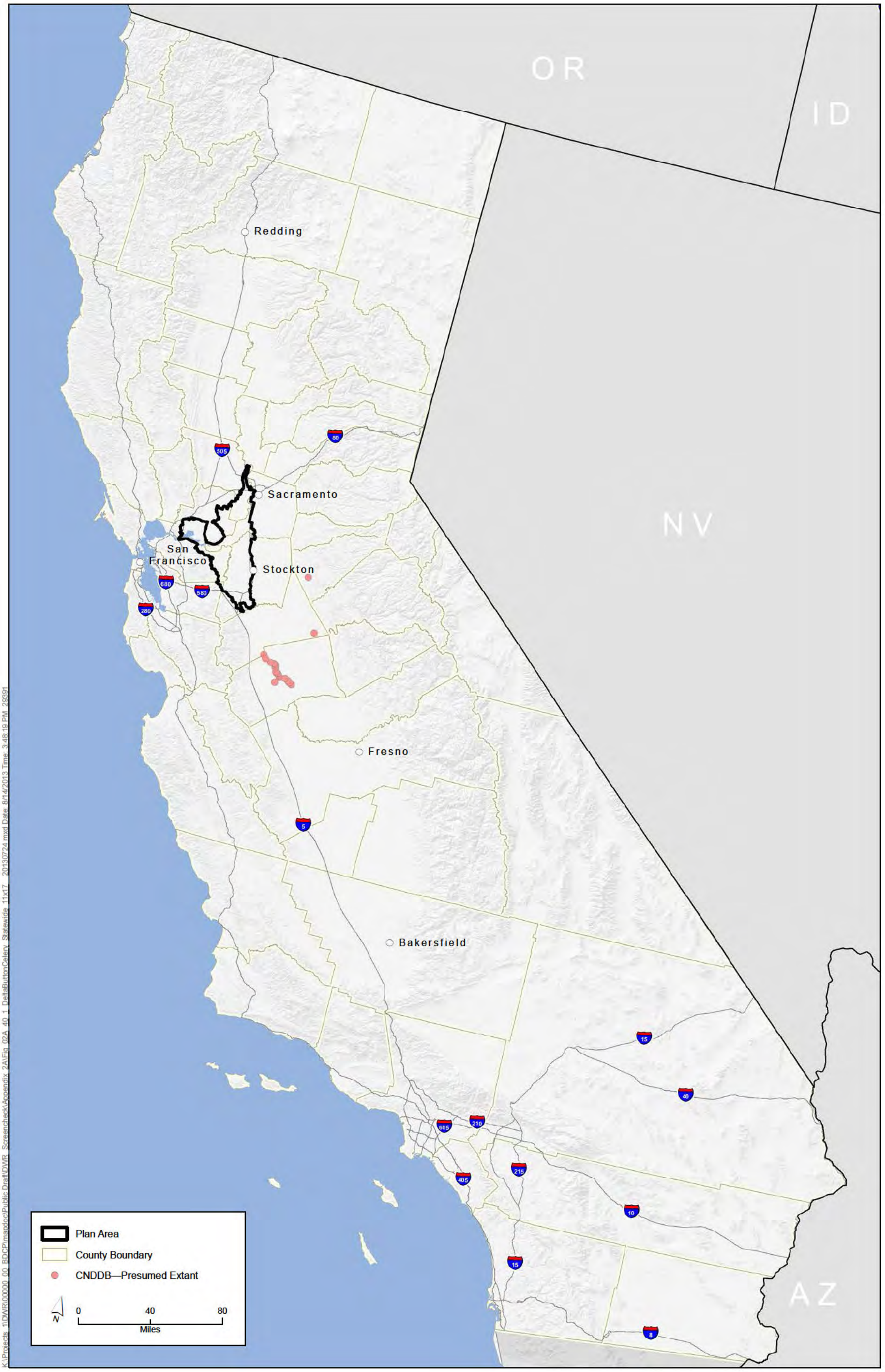
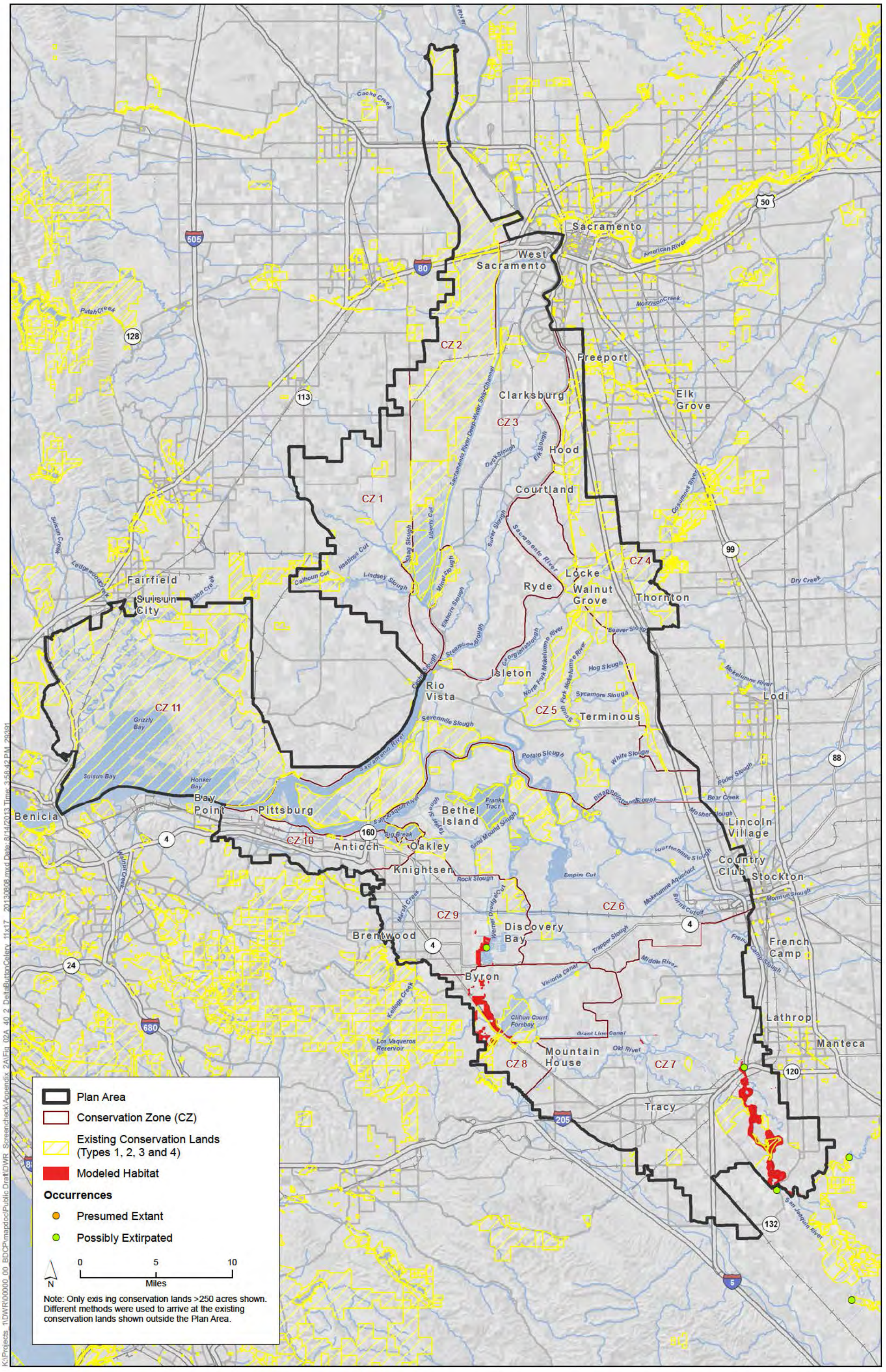


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.40-1
Delta Button Celery Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.40-2
Delta Button Celery Habitat Model and Recorded Occurrences

Appendix 2A.41
Mason's Lilaeopsis (*Lilaeopsis masonii*)

2A.41.1 Legal Status

Mason's lilaeopsis (*Lilaeopsis masonii*) is state-listed as rare under the California Native Plant Protection Act (November 1979). It is not listed under the federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2, which means that globally (G) and within the state (S), the species is considered imperiled (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.1 for Mason's lilaeopsis indicates that it is rare, threatened, or endangered in California and elsewhere, and is seriously endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with a rank of 1B meet the definitions of rare, threatened, and endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.41.2 Species Distribution and Status

2A.41.2.1 Range and Status

Mason's lilaeopsis is endemic to California and is known from 199 occurrences, all but one of which are presumed extant (Figure 2A.41-1) (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). The range of Mason's lilaeopsis extends from Napa and Solano Counties in the north, to Contra Costa and Alameda Counties in the south, to Marin County in the west, and to Sacramento and San Joaquin Counties in the east (California Department of Fish and Game 2012b).

Although population trends of Mason's lilaeopsis have not been well documented, this species is considered stable to declining (California Department of Fish and Game 2012b). Surveys in Solano County found that Mason's lilaeopsis had declined as the small islands in the sloughs decreased in size, limiting habitat along the margins of the islands (Meisler 2002).

A taxonomic review of Mason's lilaeopsis concluded that Mason's lilaeopsis is genetically indistinguishable from the more common and widespread *Lilaeopsis occidentalis* and that the morphological differences observed between the coastal and inland forms are due to environmental plasticity (Fiedler et al. 2011). The report recommends not recognizing *L. masonii* as a separate species and recommends removing it from the state's list of rare plants. However, the paper acknowledges that *L. masonii* has been useful as an umbrella species for conservation planning efforts.

2A.41.2.2 Distribution and Status in the Plan Area

Mason's lilaeopsis is found throughout the Sacramento–San Joaquin River Delta (Delta) along rivers and sloughs; the majority of known occurrences, 183, are within the Plan Area (Figure 2A.41-2) (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). Most occurrences are from the central and west Delta and it is locally common in Suisun Bay (California Native Plant Society 2012). In the south Delta, occurrences are predominately along Old River and Middle River. In the north Delta, it occurs in the Cache Slough complex and near Delta Meadows.

Over 300 stands of Mason's lilaeopsis were found during 2009 surveys (Delta Habitat Conservation and Conveyance Program 2011), including sites north of Prospect and Liberty Islands: an almost 12-mile-long line along the banks of the Deep Water Ship Channel and scattered locations along the Yolo Bypass toe drain and. Nineteen stands of Mason's lilaeopsis were found during 2010 surveys (Delta Habitat Conservation and Conveyance Program 2011). Mason's lilaeopsis was found in tidal freshwater emergent wetlands on the waterways between Webb Tract and Woodward Island, the south shore of Bacon Island, and the southeast corner of Fabian Tract on Old River. Twenty-six additional stands of Mason's lilaeopsis were found during 2011 surveys on in-channel islands, levees, and old wooden pilings along the South Mokelumne River north of Bouldin Island, San Joaquin River near Prisoner's Point on Mandeville Island, and Old River near Fay Island (Delta Habitat Conservation and Conveyance Program 2011).

2A.41.3 Habitat Requirements and Special Considerations

Mason's lilaeopsis is found in relatively unvegetated areas in brackish or fresh water habitats that are inundated by waves or tides such as estuarine wetlands and immediately below the banks of tidal sloughs, rivers, and creeks (Golden and Fiedler 1991; Fiedler and Zebell 1993; California Department of Fish and Game 2000; California Native Plant Society 2012). It is a colonizing species that establishes on newly deposited or exposed sediments (California Native Plant Society 2012). Although some reports suggest that Mason's lilaeopsis is not substrate-specific, because it is found in organic mucks, silty clays, and even pure sand throughout its range (Golden and Fiedler 1991), other reports find that it has a preference for low tidal flats on clay or silty soils (Witham and Kareofelas 1994). It is occasionally found distributed in soil pockets along riprap-lined levees (Golden and Fiedler 1991) and along the edges of tule marshes (Witham and Kareofelas 1994; May & Associates 2005). It has been found in areas with high soil salinity, but those sites might not be optimum habitat (Fiedler and Zebell 1993). Within the Delta, Mason's lilaeopsis is not found upstream from where tides affect water levels (Grewell pers. comm. in Suisun Ecological Workgroup 1997).

Plant species commonly associated with Mason's lilaeopsis in the Delta include California bulrush (*Schoenoplectus californicus*), whorled marshpennywort (*Hydrocotyle verticillata*), and low bulrush (*Isolepis cernua*) (Golden and Fiedler 1991). In the sloughs west of Liberty Island at the south end of the Sacramento River Deep Water Ship Channel, it grows in a narrow band between the mudflats and mesic terrestrial vegetation (Meisler 2002). In Suisun Marsh and other places, Mason's lilaeopsis is predominantly associated with California tule, low bulrush , and three-ribbed arrowgrass (*Triglochin striata*) (Grewell pers. comm. in Suisun Ecological Workgroup 1997; May &

Associates 2005; California Department of Fish and Game 2012a). During the Delta Habitat Conservation and Conveyance Program 2009 to 2011 surveys, some of the species associated with Mason's lilaeopsis included hardstem bulrush (*Schoenoplectus acutus*), water iris (*Iris pseudacorus*), marshpepper (*Persicaria hydropiper*), giant reed (*Arundo donax*), whorled marshpennywort, nutsedge (*Cyperus* sp.), iris-leaved rush (*Juncus xiphioides*), common buttonbush (*Cephalanthus occidentalis*), red willow (*Salix laevigata*), smooth beggartick (*Bidens laevis*), alkali weed (*Cressa truxillensis*), water pygmyweed (*Crassula aquatica*), Himalayan blackberry (*Rubus armeniacus*), common reed (*Phragmites australis*), sneezeweed (*Helenium puberulum*), Pacific aster (*Symphyotrichum chilense*), Santa Barbara sedge (*Carex barbarae*), common rush (*Juncus effusus*), seep monkeyflower (*Mimulus guttatus*), dallis grass (*Paspalum dilatatum*), and hedge false bindweed (*Calystegia sepium*) (Delta Habitat Conservation and Conveyance Program 2011).

2A.41.4 Life History

Mason's lilaeopsis, a member of the carrot family (Apiaceae), is a small 0.6- to 3-inch- (1.5- to 7.5-centimeter-) tall perennial, rhizomatous herb with tufted linear or thread-like jointed leaves. (California Department of Fish and Game 2000; Constance and Wetherwax 2012). The inflorescences consist of few to several flowered umbels of tiny white or maroon flowers (California Native Plant Society 2012; Constance and Wetherwax 2012), which bloom from April to November (California Native Plant Society 2012). Mason's lilaeopsis primarily reproduces vegetatively by creeping rhizomes or by being dislodged and floating to new sites. Because it is a rhizomatous plant, the number of individuals in a population is difficult to determine. Thus, population size is often expressed as "several colonies" or as "in square feet." Reported colony sizes range from 16 to 3,000 square feet (5 to 700 square meters) (California Department of Fish and Game 2012b).

2A.41.5 Threats and Stressors

In addition to human activity associated with fishing and hunting access posing a threat from trampling (Witham and Kareofelas 1994), habitat loss, invasions of nonnative species, and exposure to toxics are considered to be the major threats to this species.

2A.41.5.1 Reduced Habitat

The primary threat to Mason's lilaeopsis is the loss of marsh and shoreline habitat. Some of the processes and activities that threaten this habitat include erosion, flood-control improvements (e.g., channel stabilization, levee maintenance and construction, dredging), dumping spoils, agriculture, recreation, and water quality changes (California Native Plant Society 2012; California Department of Fish and Game 2012b). A long-term threat is the stabilization of banks and mudflats due to highly regulated water flow regimes, which can cause floodplain habitat to be less dynamic (Fiedler and Zebell 1993).

2A.41.5.2 Nonnative Species

Successional changes in marsh vegetation, brought on by invasions of nonnative species, to denser vegetation types or to types that can grow in the intertidal area pose an additional threat (California Native Plant Society 2012). One example of this type of threat is the invasion of some areas by

nonnative water hyacinth (*Eichhornia crassipes*) (Zebell and Fiedler 1996; California Department of Fish and Game 2012b; California Native Plant Society 2012). Additionally, diked salt marshes generally lack rare tidal marsh species. It is believed that the conditions brought about by dikes favor robust generalist species that can better tolerate the extremes of inundation and dryness in diked wetlands (Goals Project 2000), potentially displacing rare species, including the lilaeopsis.

2A.41.5.3 Exposure to Toxics

Petroleum product spills could have a significant impact on tidal flat biota, and nonbiodegradable litter such as plastics could collect near the tidal drift line, inhibiting plant establishment and growth (Witham and Kareofelas 1994).

2A.41.6 Relevant Conservation Efforts

Mason's lilaeopsis is found in a range of protected and unprotected sites (Fiedler and Zebell 1993; Witham and Kareofelas 1994; Zebell and Fiedler 1996; California Department of Fish and Game 2012b).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates Mason's lilaeopsis as a Recovery species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program has established a goal to recover the species. Successful recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

Mason's lilaeopsis is a covered species under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000). It is also proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009) and the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011).

2A.41.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

Mason's lilaeopsis habitat is identified as areas within 10 feet (3 meters) of either side of the landward boundary of tidal perennial aquatic land cover type. Vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP geographic information systems (GIS) vegetation data layer. Tidal perennial aquatic vegetation type from the Suisun Marsh and Yolo Natural Heritage Program (Boul and Keeler-Wolf 2008; TAIC 2008) classifications was converted to a line shapefile and then buffered 10 feet on either side of each line. For this species, the golf course, artificial lake, and boat docks of Discovery Bay represented a misclassification of land cover in the source data and they were deleted from the GIS vegetation data layer.

2A.41.7.1 Assumptions

- **Assumption:** Mason's lilaeopsis habitat is geographically constrained to a 10-foot-wide (3-meter-wide) buffer on each side of the landward edge of the tidal perennial aquatic land cover type (20-foot [6-meter] combined width).

  Rationale: Historical and current records of this species indicate that its distribution extends throughout almost the entire Plan Area. The species has been observed in tidally influenced waters from the Deep Water Ship Channel near West Sacramento southward and from the area of the Clifton Court Forebay northwards (Figure 2A.41-2) (Golden and Fiedler 1991; Fiedler and Zebell 1993; Witham and Kareofelas 1994; Zebell and Fiedler 1996; Suisun Ecological Workgroup 1997; Goals Project 2000; Meisler 2002; May & Associates 2005; California Department of Fish and Game 2012b). Although there are no occurrences in the Plan Area significantly south of the Old River channel near the Clifton Court Forebay, patches of suitable habitat extend beyond this area. For purposes of this model, a 10-foot-wide (3-meter-wide) buffer on each side of the landward edge of the tidal perennial aquatic land cover type (20-foot [6-meter] combined width) is included as the potential extent of tidal mudflat habitat that supports the Mason's lilaeopsis. Within the Plan Area, this species' primary habitat is tidally inundated bare areas of clay or clay loam substrate that are located on the outer margin of wave-cut beaches, or eroding earthen levees, or on the flats immediately below wave-cut beaches and eroding levees (Witham and Kareofelas 1994; Zebell and Fiedler 1996). This substrate-defined habitat has not been mapped separately, but it generally occurs in close association with the tidal perennial aquatic land cover type. Therefore, the habitat model uses the buffered landward boundary of tidal perennial aquatic land cover type as a surrogate for identifying tidal mudflats that support this species' habitat.

2A.41.8 Recovery Goals

A U.S. Fish and Wildlife recovery plan has not been prepared for this species and no recovery goals have been established; however, the CALFED Bay-Delta Plan's *Multi-Species Conservation Strategy* designates Mason's lilaeopsis as a Recovery species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program has established a goal to recover the species.

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2A.41.9.2 Personal Communication

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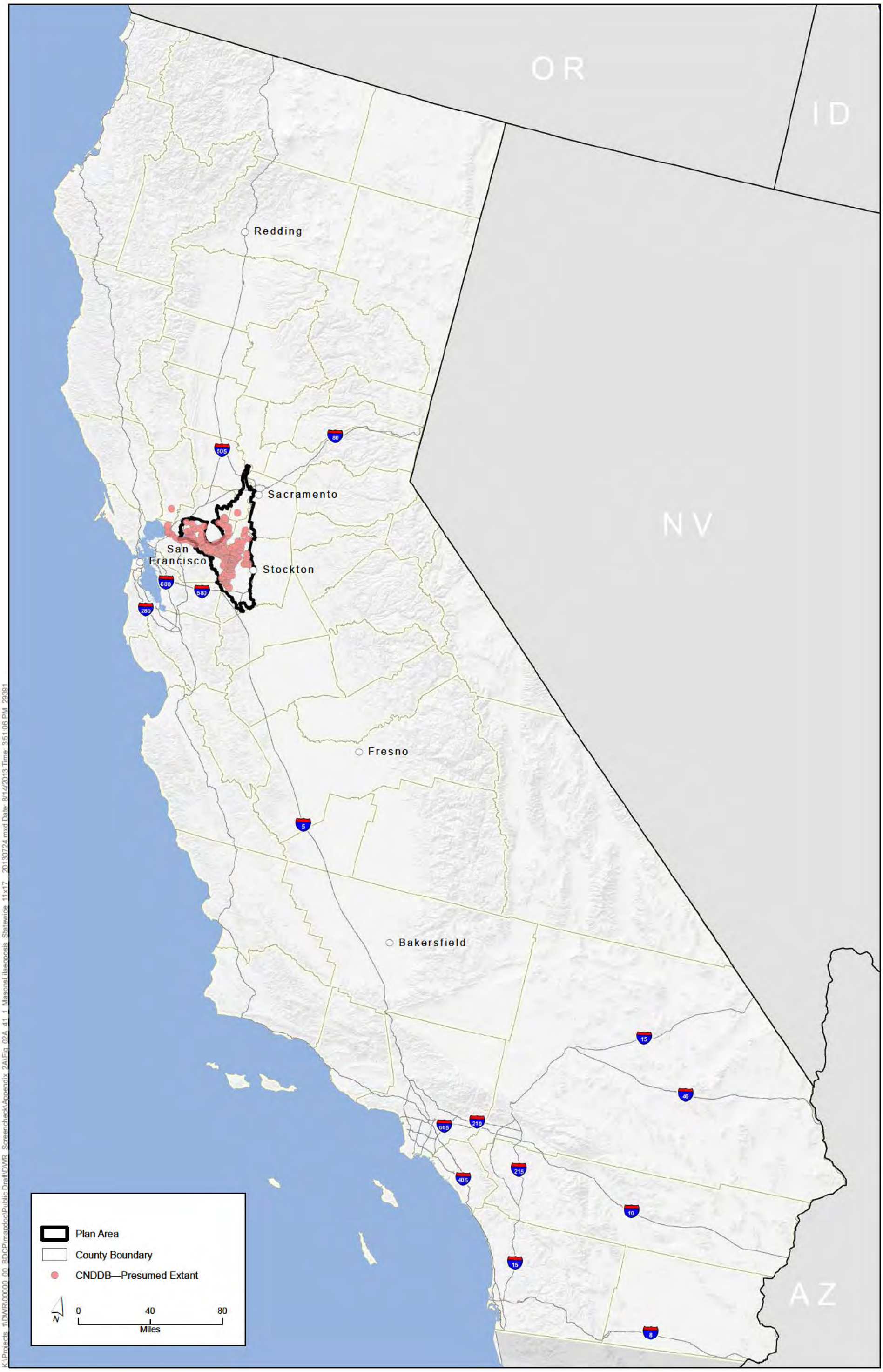
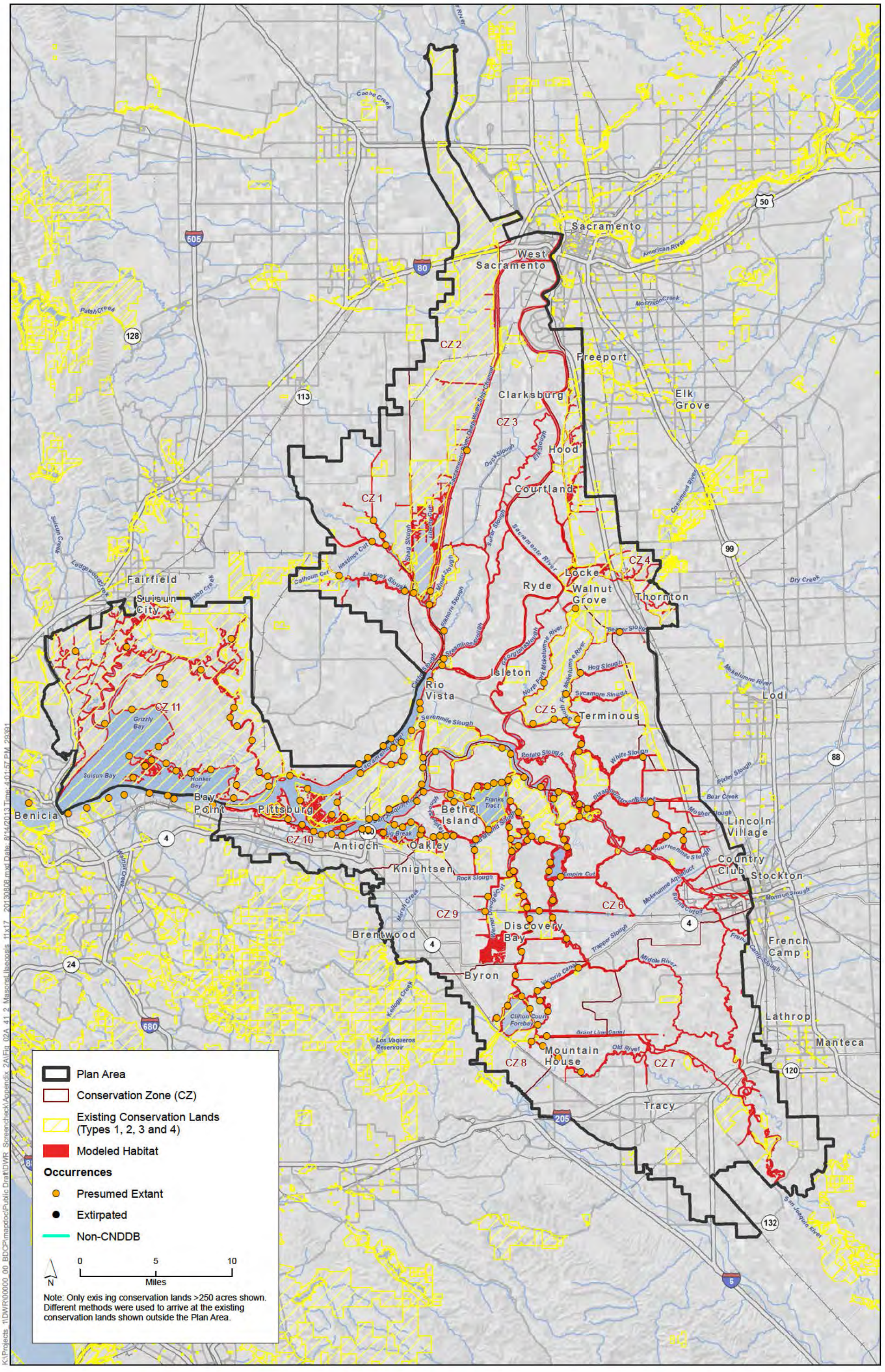


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.41-1
Mason's Lilaeoposis Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.41-2
Mason's Lilaeopsis Habitat Model and Recorded Occurrences

Appendix 2A.42
Delta Mudwort (*Limosella subulata*)

2A.42.1 Legal Status

Delta mudwort (*Limosella australis* [formerly treated as *L. subulata*]) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G4?Q/S2.1, which means that globally (G) the species as a whole is apparently secure across its overall distribution, but some factors of concern, such as narrow habitat or continuing threats, do exist. The "?" indicates that there is uncertainty about the rank. The "Q" indicates that unresolved taxonomic questions remain for this rare species. The state rank (S) indicates that it is considered imperiled, meaning at high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it vulnerable to extirpation (California Department of Fish and Game 2012a). Its state threat level (.1) identifies it as very threatened (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 2.1 for delta mudwort indicates that it is rare, threatened, or endangered in California, but more common elsewhere, with a threat level (.1) of seriously endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Without the wider distribution outside of California, plants on List 2 would be placed on List 1B. Plants with a rank of 1B and 2 are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.42.2 Species Distribution and Status

2A.42.2.1 Range and Status

In California, delta mudwort is found only in the Sacramento–San Joaquin River Delta (Delta) region (Figure 2A.42-1). Its range extends from Solano County in the north, San Joaquin County in the south, Contra Costa County in the west, and Sacramento County in the east. Outside of California, it can be found in British Columbia, on the east coast of North America, and in Europe (Wetherwax 2012). On the east coast of the United States, it is threatened by habitat destruction (California Native Plant Society 2012).

2A.42.2.2 Distribution and Status in the Plan Area

In the Plan Area, delta mudwort occurs in the tidal zones of marshes, rivers, and creeks, predominantly in the central area of the legal Delta (Figure 2A.42-2). All 58 known occurrences of the delta mudwort in California are located in the Plan Area and all are presumed extant (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). It has been observed in the tidal zone along Calhoun Cut and Barker Slough (Witham and Kareofelas 1994), in the Miner Slough Wildlife Area, along Montezuma Slough, near Three Mile

Slough, at Brown's Island, and near Collinsville among other locations throughout the Delta (California Department of Fish and Game 2012b).

Thirty-four stands of delta mudwort were recorded during the 2009 surveys conducted as part of the Delta Habitat Conservation and Conveyance Program (2011). Delta mudwort was found growing on exposed mudflats and mudbanks in tidal marshes in the central Delta from Walnut Grove to Clifton Court Forebay (Delta Habitat Conservation and Conveyance Program 2011). An additional four stands of delta mudwort were recorded during the 2011 surveys, mainly on in-channel islands as well as riprapped levees on the South Mokelumne River north of Bouldin Island and the San Joaquin River near Prisoners Point on Mandeville Island (Delta Habitat Conservation and Conveyance Program 2011).

2A.42.3 Habitat Requirements and Special Considerations

Delta mudwort grows on intertidal flats and muddy banks of watercourses in estuarine areas, surrounded by brackish or freshwater marsh and riparian scrub vegetation. It is found in brackish and freshwater tidal marsh and riparian scrub plant communities along with Mason's lilaeopsis (*Lilaeopsis masonii*) immediately below the tidal elevation where Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*) and Suisun Marsh aster (*Symphyotrichum lentum*) are commonly found (Witham and Kareofelas 1994; May & Associates 2005). Occasionally, it can be found along the edges of tule marshes (Witham and Kareofelas 1994). It blooms from May to August (Wetherwax 2012; California Native Plant Society 2012).

In addition to Mason's lilaeopsis, delta mudwort was often found intermixed with associates such as whorled marshpennywort (*Hydrocotyle verticillata*), water pygmyweed (*Crassula aquatica*), and low bulrush (*Isolepis cernua*) during the 2009 surveys (Delta Habitat Conservation and Conveyance Program 2011). Other less common associates included Delta tule pea, common reed (*Phragmites australis*), needle spikerush (*Eleocharis acicularis*), smartweeds (*Persicaria* spp.), cattail species (*Typha* spp.), American dogwood (*Cornus sericea*), Himalayan blackberry (*Rubus armeniacus*), and nutsedge (*Cyperus* spp.).

Although the data are somewhat inconclusive, delta mudwort appears to be more sensitive to salinity concentrations near or greater than 7 parts per thousand (ppt) than is Mason's lilaeopsis, with substantially reduced flowering and seed germination rates (Golden and Fiedler 1991; Fiedler and Zebell 1993; Zebell and Fiedler 1996).

2A.42.4 Life History

Delta mudwort is a stoloniferous, aquatic, perennial herb in the snapdragon family (Scrophulariaceae). The leaves are 1 to 3 centimeters (0.4 to 1.2 inches) long and cylindrical, giving the plant a grass-like appearance. The stems bear solitary white to lavender-blue flowers approximately 3 millimeters (0.1 inch) in length (Wetherwax 2012). Delta mudwort strongly resembles Mason's lilaeopsis when vegetative (before flowering and fruiting). The bell-shaped flowers of delta mudwort make it easy to distinguish when in bloom. When not blooming, Mason's lilaeopsis can be distinguished by partitions in its cylindrical leaves; delta mudwort lacks this

feature (Witham and Kareofelas 1994). The California Department of Fish and Game considers delta mudwort to be native to California (Bittman pers. comm.), whereas *The Jepson Manual, second edition* (Wetherwax 2012) identifies the species native to the east coast of North America and introduced to California by seed possibly brought in with ship ballast. The California Native Plant Society (2012) indicates that it might not be native to California and needs further study.

2A.42.5 Threats and Stressors

Delta mudwort is threatened by habitat destruction, including alteration of hydrology and recreational activities, such as boating, which creates wakes that erode banks and shorelines. Fishing and hunting access also pose a threat to this species (Witham and Kareofelas 1994). Petroleum product spills could have a significant impact on tidal flat biota, and nonbiodegradable litter such as plastics could collect near the tidal drift line, inhibiting plant establishment and growth (Witham and Kareofelas 1994).

2A.42.6 Relevant Conservation Efforts

Populations are protected on the California Department of Fish and Game Calhoun Cut Ecological Preserve and in the Miner Slough Wildlife Area (California Department of Fish and Game 2012b).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the delta mudwort as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

Delta mudwort is a covered species under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000).

2A.42.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

Vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP geographic information systems (GIS) vegetation data layer. Tidal perennial aquatic vegetation type from the BDCP GIS vegetation dataset, Suisun Marsh, and Yolo Natural Heritage Program (Boul and Keeler-Wolf 2008; TAIC 2008) classifications was converted to a line shapefile and then buffered 10 feet (3 meters) on either side of each line. For this species, the golf course, artificial lake, and boat docks of Discovery Bay represented a misclassification of land cover in the source data and were deleted from the GIS vegetation data layer. Delta mudwort habitat is identified as all areas within 10 feet on either side of the landward boundary of tidal perennial aquatic vegetation type.

2A.42.7.1 Assumptions

- **Assumption:** Delta mudwort habitat is geographically constrained to a 10-foot-wide (3-meter-wide) buffer on each side of the landward edge of the tidal perennial aquatic land cover type (20-foot [6-meter] combined width).

  Rationale: Historical and current records of this species indicate that its distribution extends almost throughout the Plan Area, having been observed in tidally influenced waters from Liberty Island southward and from the area of the Clifton Court Forebay northwards (Figure 2A.42-2) (Fiedler and Zebell 1993; Witham and Kareofelas 1994; Zebell and Fiedler 1996; California Department of Fish and Game 2012b). While there are no occurrences in the Plan Area north of Liberty Island or significantly south of the Old River channel near the Clifton Court Forebay, patches of suitable habitat extend beyond those areas. For purposes of this model, a 10-foot-wide buffer on each side of the landward edge of the tidal perennial aquatic land cover type (20-foot combined width) is included as the potential extent of tidal mudflat habitat that supports this species. In the Plan Area, this species' primary habitat is tidally inundated bare areas of clay or clay loam substrate on the outer margin of wave-cut beaches, or eroding earthen levees, or on the flats immediately below wave-cut beaches and eroding levees (Witham and Kareofelas 1994; Zebell and Fiedler 1996). This substrate-defined habitat has not been separately mapped, but it generally occurs in close association with the tidal perennial aquatic land cover type. Therefore, the habitat model uses the buffered landward boundary of tidal perennial aquatic land cover type as a surrogate for identifying tidal mudflats that support habitat for delta mudwort.

2A.42.8 Recovery Goals

A U.S. Fish and Wildlife recovery plan has not been prepared for this species and no recovery goals have been established; however, the CALFED Bay-Delta Ecosystem Restoration Program's *Multi-Species Conservation Strategy* designates delta mudwort as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

2A.42.9 References Cited

2A.42.9.1 Literature Cited

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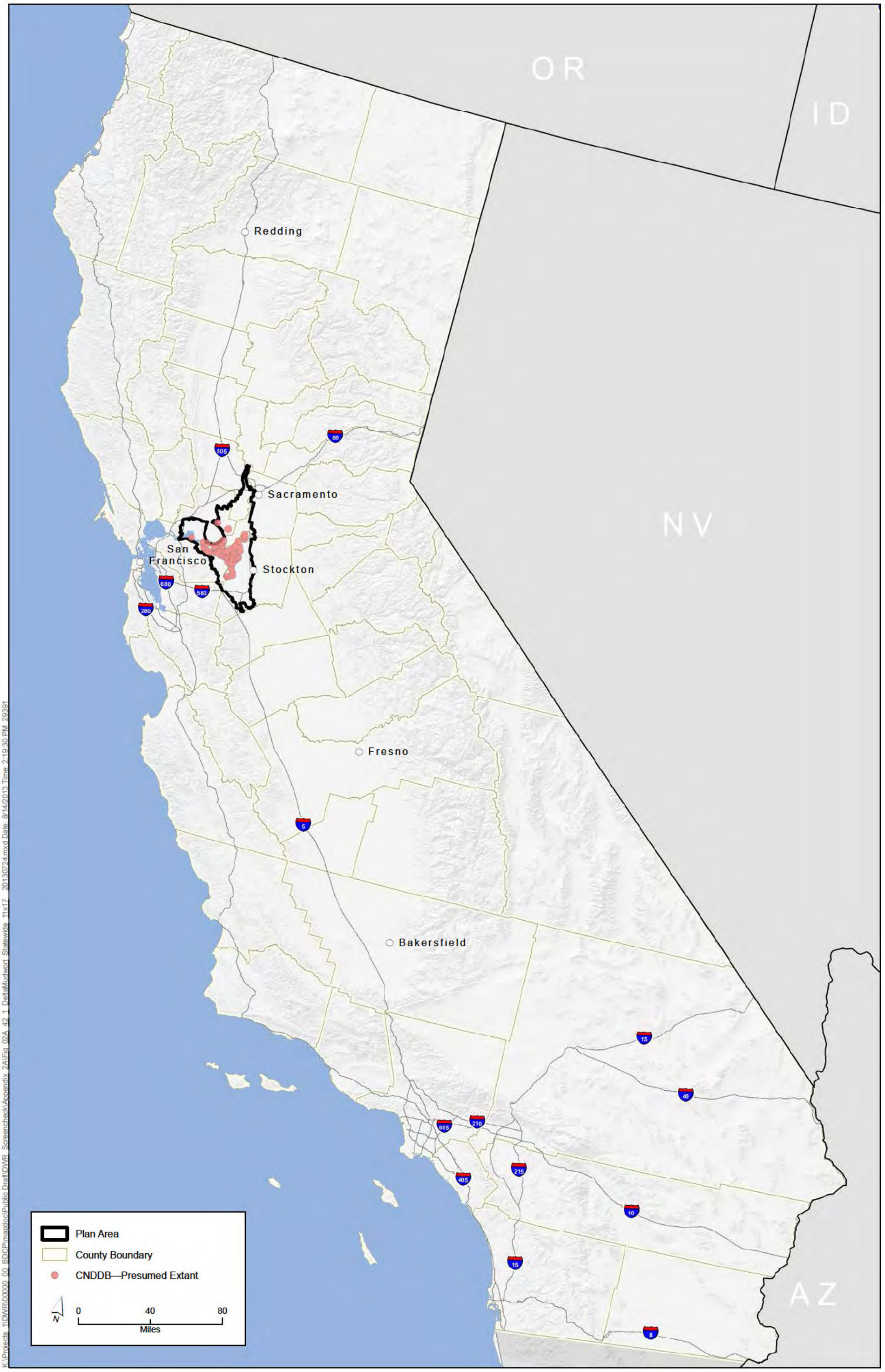
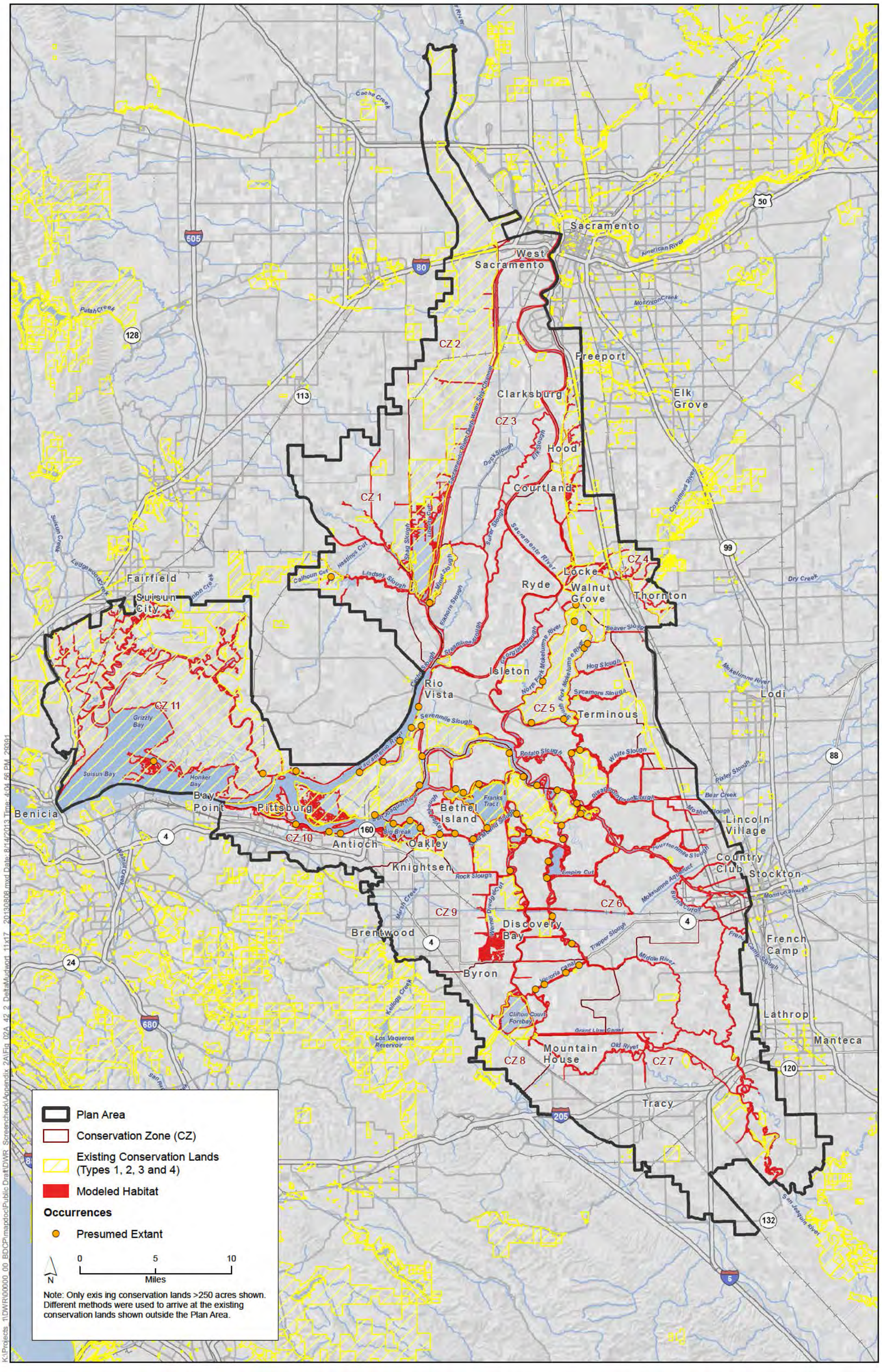
2A.42.9.2 Personal Communications

Bittman, Roxanne. Senior Biologist, California Department of Fish and Game, Sacramento, CA. September 15, 2008—Email to John Gerlach regarding the native status of Delta mudwort (*Limosella subulata*).



GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.42-1
Delta Mudwort Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDG June 2013, and DHCCP 2009-2011.

Figure 2A.42-2
Delta Mudwort Habitat Model and Recorded Occurrences

Appendix 2A.43
Delta Tule Pea (*Lathyrus jepsonii* var. *jepsonii*)

2A.43.1 Legal Status

Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G5T2/S2.2, which means that the species has a global (G) population that is secure. However, the status of this particular variety (T2) indicates that it is imperiled because of very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation (California Department of Fish and Game 2012a). The state rank (S2) indicates that it is considered imperiled (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for Delta tule pea indicates that it is rare, threatened, or endangered in California and elsewhere, with a threat level (.2) (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with a rank of 1B meet the definitions of rare, threatened, or endangered, as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code.

2A.43.2 Species Distribution and Status

2A.43.2.1 Range and Status

The range of Delta tule pea extends from Sacramento and Solano Counties in the north, Napa and Sonoma Counties in the west, and Contra Costa and San Joaquin Counties in the south (Figure 2A.43-1). Delta tule pea is endemic to California, and its distribution is based on 133 occurrences (2 of which are listed as possibly extirpated) (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). It was reported as common in Suisun Marsh in 1894 and 1911, but today it is reported as occasional to rare in Suisun Marsh. It occurs throughout the legal Sacramento–San Joaquin River Delta (Delta) (California Department of Fish and Game 2012b) and along the Napa River (Dutchman Slough) (Goals Project 2000).

2A.43.2.2 Distribution and Status in the Plan Area

In the Plan Area, there are 106 occurrences of Delta tule pea, one of which is possibly extirpated (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). It grows at and immediately above the tidal zone in marshes and along rivers and streams (Figure 2A.43-2). It is found throughout all the major tidal slough channels in Suisun Marsh and has been observed near Hass Slough, Snodgrass Slough, Lost Slough, on Ryer Island, Staten Island, Andrus Island, Bouldin Island, Rough and Ready Island, Browns Island, Winter Island, on the banks of the Middle River by the Upper and Lower Jones Tracts, and near Collinsville and Pittsburgh among other locations throughout the Delta (California Department of Fish and Game 2012b). It also

occurs within the tidal zone along Calhoun Cut and Barker Slough in the Cache Slough area (Witham and Kareofelas 1994).

Twenty-six stands of Delta tule pea were located during Delta Habitat Conservation and Conveyance Program 2009 surveys (2011). The stands ranged from Elk Slough near Courtland to Middle River near Victoria Island. The number of individuals recorded at each stand ranged from 1 to 50 plants, although the habit of this perennial vine (climbing through and over other plants) sometimes made it difficult to count. One individual Delta tule pea plant was found in tidal marsh on the southwest portion of Webb Tract during the 2010 surveys, and four stands of Delta tule pea were found during the 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011). These stands were found on in-channel islands and riprapped levees on the South Mokelumne River north of Bouldin Island, Old River near Fay Island, and the San Joaquin River near Prisoner's Point on Mandeville Island. Each stand contained between one and five individual plants.

Population trends of Delta tule pea have not been documented. According to the California Native Plant Society (2012), most known occurrences are small.

2A.43.3 Habitat Requirements and Special Considerations

Delta tule pea occurs on the borders of fresh and brackish marshes from 0 to 13 feet in elevation (Grewell et al. 2007; California Native Plant Society 2012). It has been observed to co-occur with or near other covered plant species, such as soft bird's-beak (*Chloropyron molle* ssp. *molle*), Mason's lilaeopsis (*Lilaeopsis masonii*), Suisun Marsh aster (*Symphyotrichum lentum*), and delta mudwort (*Limosella australis*) (California Department of Fish and Game 2012b).

Delta tule pea was found in riparian forest, riparian scrub, tidal marsh, and exposed mudbanks on in-channel islands during the 2009 surveys (Delta Habitat Conservation and Conveyance Program 2011). In 2009, Delta tule pea was commonly found growing with bulrush (*Schoenoplectus* spp.) and other associates, including arroyo willow (*Salix lasiolepis*), common reed (*Phragmites australis*), American dogwood (*Cornus sericea*), hedge false bindweed (*Calystegia sepium*), marshpennywort (*Hydrocotyle* spp.), Himalayan blackberry (*Rubus armeniacus*), California rose (*Rosa californica*), California grape (*Vitis californica*), narrow-leaved willow (*Salix exigua*), and narrow-leaved cattail (*Typha angustifolia*). Associated species recorded during the 2010 surveys included cattail species (*Typha* spp.), seep monkeyflower (*Mimulus guttatus*), bog rush (*Juncus effusus*), dallis grass (*Paspalum dilatatum*), Santa Barbara sedge (*Carex barbarae*), and hedge false bindweed (Delta Habitat Conservation and Conveyance Program 2011).

2A.43.4 Life History

Delta tule pea is a glabrous (without hairs) climbing perennial herb with winged stems and is a member of the pea family (Fabaceae) (Steele and Isely 2012). It is identified by the number of leaflets, its glabrous winged stem, blue-grey leaf color, and pink to pink-purple flowers. Because of its climbing habit, Delta tule pea tends to grow over other vegetation and can have stems up to 8.2 feet (2.5 meters) tall. The leaves have small, narrow stipules, 10 to 16 leaflets, and coiled branched tendrils (Steele and Isely 2012). It bears six to 15 pink-purple flowers, 0.6 to 0.8 inch

(1.5 to 2 centimeters) in length, in an unbranched inflorescence (raceme) at the end of the stems. The fruits (legumes) are glabrous (Steele and Isely 2012). Delta tule pea blooms from May to September (California Native Plant Society 2012).

2A.43.5 Threats and Stressors

The primary threat to Delta tule pea is the loss of marsh and floodplain habitat. Agriculture, water diversions, and erosion can potentially eliminate or degrade these habitats (California Native Plant Society 2012). Fishing and hunting access also pose a threat to Delta tule pea through trampling impacts (Witham and Kareofelas 1994).

2A.43.6 Relevant Conservation Efforts

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates Delta tule pea as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

Delta tule pea is a covered species under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003). Delta tule pea is proposed for coverage under and the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency. 2011).

2A.43.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.43.7.1 Habitat Model Description

Habitat was modeled separately based on the salinity of the water. For freshwater areas, essentially the area within the legal Delta, Delta tule pea habitat was identified as the area within 10 feet (3 meters) of the landward side of the landward boundary of tidal freshwater emergent wetland land cover type, exclusively where this land cover type is adjacent to grassland, vernal pool complex, valley/foothill riparian, or agricultural habitats cover types. For brackish water areas in and near Suisun Marsh, the model used all tidal brackish emergent wetland polygons (San Francisco Estuary Institute 2005; Boul and Keeler-Wolf 2008) Using the California Department of Water Resources (2007) LiDAR data set as resampled at 10 meters, the polygons were then intersected with an elevation range of 7 to 10 feet (2 to 3 meters) to capture elevations 1 foot (30 centimeters) below intertidal to 2 feet (60 centimeters) above intertidal. In other words, the upper limit of the intertidal range was estimated at 8 feet (2.5 meters) North American Vertical Datum (NAVD) 88. Siegel

estimated the intertidal range in Suisun Marsh to occur from 1 to 8 feet (30 centimeters to 2.4 meters) NAVD88 (Siegel 2007).

Areas mapped within 3 meters of tidal freshwater emergent wetland consist of the following natural community types.

- Alkali seasonal wetland complex
- Grassland
  - Pasture
  - Upland annual grasslands & forbs formation
- Managed wetland
  - *Crypsis* spp.–wetland grasses–wetland forbs not formally defined (NFD) super alliance
  - Vernal pools
- Other seasonal wetlands
- Tidal freshwater emergent wetland
- Valley/foothill riparian
  - Blackberry NFD super alliance
  - Fremont cottonwood–valley oak–willow (ash-sycamore) riparian forest NFD association
  - Intermittently flooded to saturated deciduous shrubland
  - Mixed Fremont cottonwood–willow spp. NFD alliance
  - Mixed willow super alliance
  - Valley oak (*Quercus lobata*)
  - Valley oak alliance–riparian
- Vernal pool complex

Areas mapped within 3 meters of landward edge consist of the following natural community types.

- Tidal freshwater emergent wetland
- Tidal freshwater emergent wetland

2A.43.7.2 Assumptions

- **Assumption:** Delta tule pea habitat is geographically constrained to a 10-foot-wide (3-meter-wide) buffer on the landward side of the landward boundaries of the tidal freshwater emergent wetland land and tidal brackish emergent wetland contained within the 7- to 10-foot (2- to 3-meter) elevation in Suisun Marsh.

  Rationale: Historical and current records of this species indicate that its distribution extends throughout most of the Plan Area; it has been observed in tidally influenced waters from Calhoun Cut and in the Sacramento River near Walnut Grove southward and from Tom Pain Slough near the southern boundary of the Plan Area northward (Figure 2A.43-2) (Witham and Kareofelas 1994; California Department of Fish and Game 2012b). While there are no

occurrences in the Plan Area north of Calhoun Cut and Walnut Grove, patches of suitable habitat extend into those areas. For purposes of this model, a 10-foot-wide (3-meter-wide) buffer on the landward side of the landward boundaries of the tidal freshwater emergent wetland land and tidal brackish emergent wetland contained within the 7- to 10-foot (2- to 3-meter) elevation in Suisun Marsh have been included as the potential extent of habitat that supports Delta tule pea.

2A.43.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species; however, this species is included in the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California*, which specifies the preservation of individuals and habitat, the control of invasive species, and the restoration of tidal flows as recovery criteria goals (U.S. Fish and Wildlife Service 2010). Additionally, the CALFED Bay-Delta Ecosystem Restoration Program *Multi-Species Conservation Strategy* designates Delta tule pea as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

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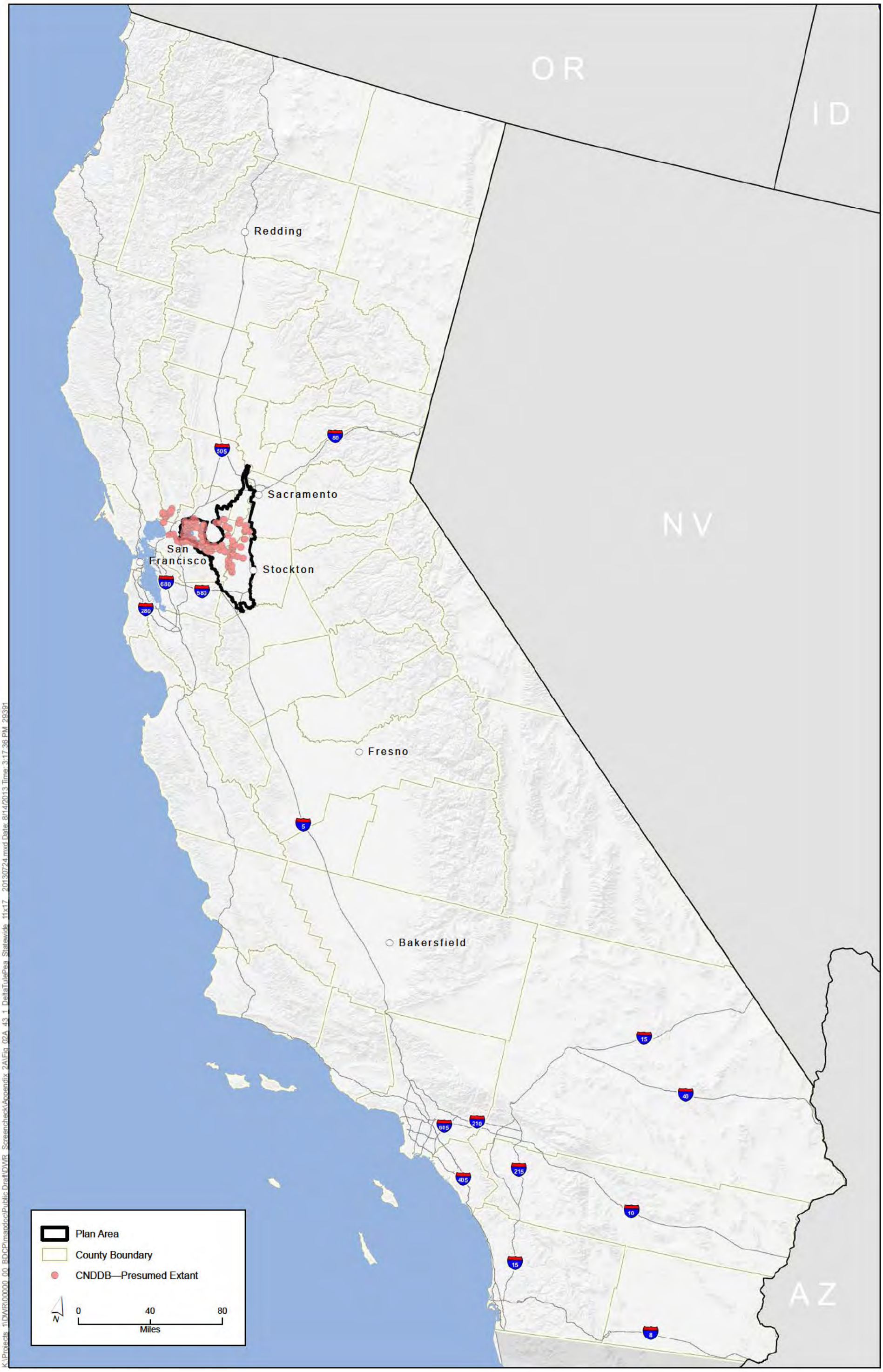
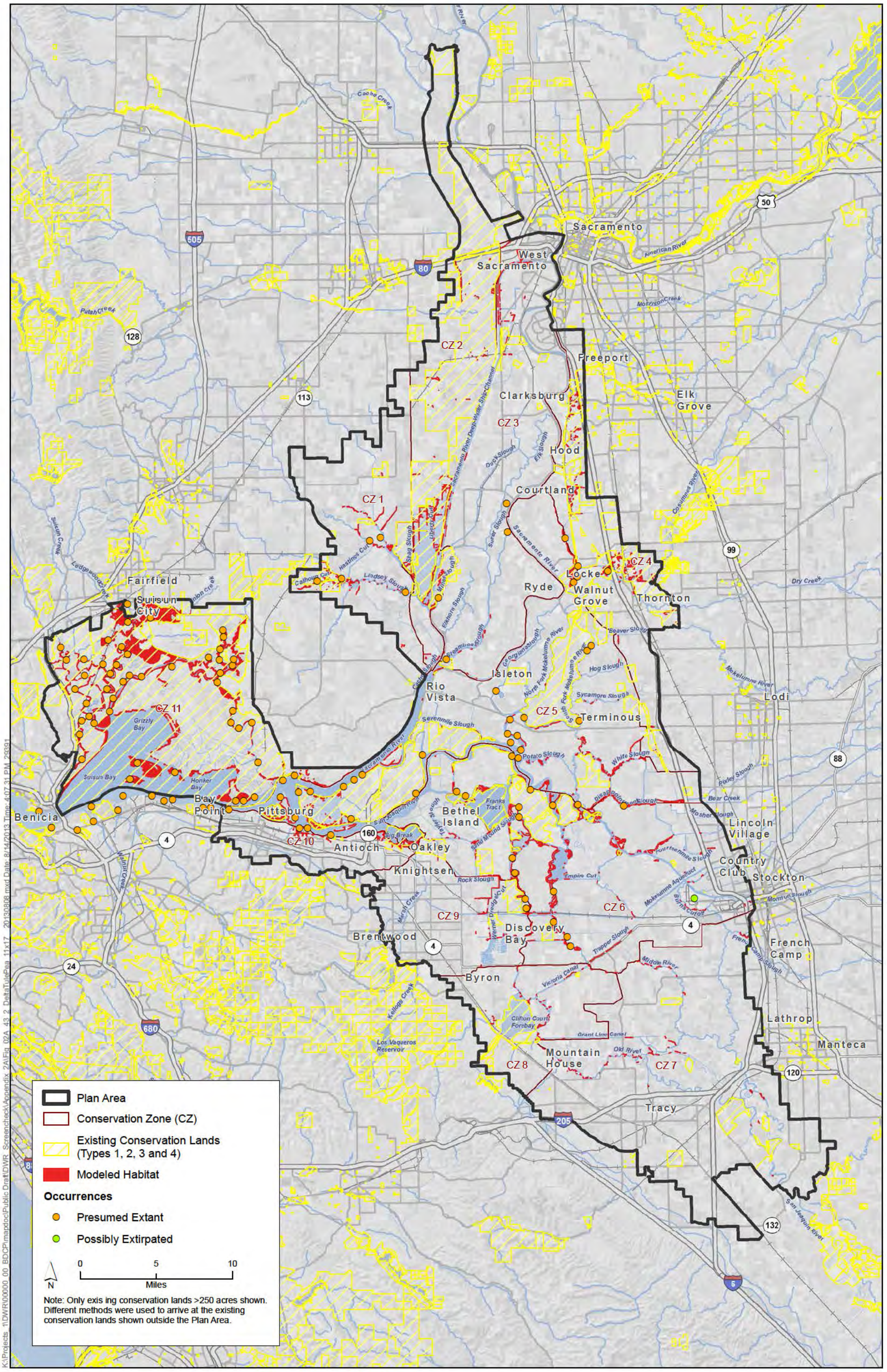


GIS Data Sources: Occurrences, CNDDB June2013; Plan Area, ICF 2012.

Figure 2A.43-1
Delta Tule Pea Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.43-2
Delta Tule Pea Habitat Model and Recorded Occurrences

Appendix 2A.44
Suisun Marsh Aster (*Symphyotrichum lentum*, Formerly *Aster lentus*)

2A.44.1 Legal Status

Suisun Marsh aster (*Symphyotrichum lentum*, formerly *Aster lentus*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2, which means that within its global range (G) and within the state range (S) the species is considered imperiled (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for Suisun Marsh aster indicates that it is rare, threatened, or endangered in California and elsewhere. Its state threat level (.2) indicates that it is fairly endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with a rank of 1B are considered to meet the definitions of rare, threatened or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.44.2 Species Distribution and Status

2A.44.2.1 Range and Status

The range of Suisun Marsh aster extends from Napa and Solano Counties in the north, to San Joaquin County in the south, to Contra Costa County in the west, and Sacramento County in the east (Figure 2A.44-1). It is endemic to Suisun Marsh and the Sacramento–San Joaquin River Delta (Delta) and is known from 175 occurrences, all presumed extant, the majority of which are within the Plan Area (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b; California Native Plant Society 2012). Historically, it ranged from marshes in the East Bay portion of San Francisco Bay (California State Coastal Conservancy 2003) to the Sonoma and Napa Rivers (Goals Project 2000).

2A.44.2.2 Distribution and Status in the Plan Area

In the Plan Area, there are 165 occurrences of Suisun Marsh aster in tidal areas throughout the west and central Delta and Suisun Marsh with scattered occurrences in the north and south Delta (Figure 2A.44-2) (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). Suisun Marsh aster occurs at the upper margin and immediately above the tidal zones of fresh and brackish marshes and along rivers and creeks. It has been observed on Andrus Island, Terminous Tract, Rindge Tract, Bethel Island, Franks Tract, and near Collinsville and Antioch, among other locations in the Plan Area (California Department of Fish and Game 2012b). A large, single occurrence was once reported along Baker Slough and Lindsey Slough on the Calhoun Cut Ecological Reserve, but this area has recently been remapped as several smaller polygons

(Witham and Kareofelas 1994) and many new occurrences were mapped in that same area in 1994 (Witham and Kareofelas 1994).

Suisun Marsh asters were recorded at 156 locations in the conveyance planning area during Delta Habitat Conservation and Conveyance surveys in 2009, ranging from channels near Prospect Island to near Stockton (Delta Habitat Conservation and Conveyance Program 2011). Stands ranged from 1 to 500 individuals and were found in habitats such as levee riprap, mud banks, and decaying pilings. Suisun Marsh aster was found at 25 more locations during 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011). These stands were found on riprapped levees, in-channel islands, and old wooden pilings on the Sacramento River near Walnut Grove, South Mokelumne River north of Bouldin Island, Potato Slough and San Joaquin River near Venice Island and into Frank's Tract, and Old River near Fay Island. Stands at these locations ranged from 1 to 14 individuals.

2A.44.3 Habitat Requirements and Special Considerations

Suisun Marsh aster grows on the upper margins of brackish and freshwater marshes in the ecotone with terrestrial habitats (Goals Project 2000). A 1994 report from the Calhoun Cut Ecological Reserve noted that many occurrences of Suisun Marsh aster were in relatively shaded areas either along north-facing banks or under overhanging trees (Witham and Kareofelas 1994). It is found above erosional cuts and along the banks of sloughs and watercourses, often occurring with common reed (*Phragmites australis*), cattails (*Typha* spp.), bulrushes (*Schoenoplectus* spp.), nutsedge (*Cyperus* sp.), purpletop vervain (*Verbena bonariensis*), dallisgrass (*Paspalum dilatatum*), willows (Salix spp.), poison hemlock (*Conium maculatum*), giant reed (Arundo donax), white alder (Alnus rhombifolia), mugwort (*Artemisia douglasiana*), iris-leaved rush (*Juncus xiphioides*), rough bugleweed (*Lycopus asper*), smooth beggartick (*Bidens laevis*), and blackberry (*Rubus* spp.) (Witham and Kareofelas 1994; May & Associates 2005; Delta Habitat Conservation and Conveyance Program 2011). It has been observed in proximity to other rare plant species, including Mason's lilaeopsis (*Lilaeopsis masonii*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Delta mudwort (*Limosella australis*), soft bird's-beak (*Chloropyron molle* subsp. *molle*), and woolly rose-mallow (*Hibiscus lasiocarpus*) (Goals Project 2000; California Native Plant Society 2012; California Department of Fish and Game 2012b; Delta Habitat Conservation and Conveyance Program 2011).

2A.44.4 Life History

Suisun Marsh aster is a perennial, rhizomatous herb in the sunflower family (Asteraceae) (Allen 2012). Some occurrences may be single plants with one to several main stems (Witham and Kareofelas 1994). It blooms from May through November, depending on environmental conditions. Suisun Marsh aster stems are 16 to 59 inches (41 to 150 centimeters) tall and have open inflorescences of several flower heads with purple outer petals (ray flowers) and yellow centers (disc flowers). Suisun Marsh aster hybridizes with the Pacific aster (*Symphyotrichum chilense*), but it can be recognized by its larger size and flower heads without hairs on the involucre (leaflike bracts beneath the flower head). Also, it has slightly succulent leaves that are thicker than those of Pacific aster (Allen 2012). Vegetatively, it closely resembles western goldentop (*Euthamia occidentalis*), but

the species are easily differentiated when flowering because western goldentop flower heads are all yellow (Baye 2007). Both the Suisun Marsh aster and the common California aster are local host plants for the field crescent butterfly (*Phyciodes campestris*) (Witham and Kareofelas 1994).

2A.44.5 Threats and Stressors

Historically, the marsh habitat suitable for Suisun Marsh aster has been lost mostly through development, dredge disposal, agricultural conversion, and diking. Diked marshes generally lack rare tidal marsh species. It is believed that the conditions brought about by dikes favor robust generalist species that can better tolerate the extremes of inundation and dryness in diked wetlands (Goals Project 2000). Such habitat losses as a result of human activities still occur, but many of the large marshes are now parts of preserves or are otherwise in highly restrictive development zones. Current threats to Suisun Marsh aster include invasive plants, erosion, creek channelization, levee maintenance and construction, and possibly herbicide applications (California Department of Fish and Game 2012b; California Native Plant Society 2012).

2A.44.6 Relevant Conservation Efforts

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the Suisun Marsh aster as a Recovery species (CALFED Bay-Delta Program 2000). This means that the program has established a goal to recover the species. Successful recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

Suisun Marsh aster is a covered species under the approved *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000).

2A.44.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.44.7.1 Habitat Model Description

Habitat was modeled separately based upon the salinity of the water. For freshwater areas, essentially the area within the legal Delta, Suisun Marsh aster habitat was identified as the area within 10 feet (3 meters) of the landward side of the landward boundary of tidal freshwater emergent wetland BDCP land cover type exclusively where this land cover type is adjacent to grassland, vernal pool complex, valley/foothill riparian, or agricultural habitats land cover types. For brackish water areas in and near Suisun Marsh, the model used all tidal brackish emergent wetland polygons (San Francisco Estuary Institute 2005; Boul and Keeler-Wolf 2008), which, using the California Department of Water Resources (2007) LiDAR data set as resampled at 10 meters, were then intersected with an elevation range of 7 to 10 feet (2 to 3 meters) to capture elevations 1 foot (30 centimeters) below intertidal to 2 feet (60 centimeters) above intertidal (i.e., the upper limit of the intertidal range was estimated at 8 feet, North American Vertical Datum of 1988 [NAVD88]). The

intertidal range in Suisun Marshto is estimated to occur between 1 to 8 feet (30 centimeters to 2.4 meters) NAVD88 (Siegel 2007).

Areas mapped within 3 meters of tidal freshwater emergent wetland and tidal brackish emergent wetland consist of the following natural community types.

- Alkali seasonal wetland complex
- Grassland
    - Pasture
    - Upland annual grasslands and forbs formation
- Managed wetland
    - *Crypsis* spp.-wetland grasses-wetland forbs not formally defined (NFD) super alliance
- Other natural seasonal wetland

Areas mapped within 3 meters of tidal freshwater emergent wetland consist of the following natural community types.

- Vernal pools

Areas mapped within 3 meters of landward edge comprise the following natural community types.

- Tidal brackish emergent wetland
- Tidal freshwater emergent wetland

2A.44.7.2 Assumptions

- **Assumption:** Suisun Marsh aster habitat is geographically constrained to a 10-foot-wide (3-meter) buffer on the landward side of the tidal freshwater emergent wetland land and tidal brackish emergent wetland contained within the 7- to 10-foot elevation in Suisun Marsh.

  Rationale: Historical and current records of this species indicate that its distribution extends throughout most of the Plan Area, having been observed in tidally influenced waters from Calhoun Cut and in the Sacramento River near Walnut Grove southward and from Tom Pain Slough near the southern boundary of the Plan Area northward (Figure 2A.44-2) (Witham and Kareofelas 1994; California Department of Fish and Game 2012b). While there are no occurrences in the Plan Area north of Calhoun Cut and Walnut Grove, patches of suitable habitat extend into those areas. For purposes of this model, a 10-foot-wide (3-meter) buffer on the landward side of the tidal freshwater emergent wetland land and tidal brackish emergent wetland contained within the 7- to 10-foot elevation in Suisun Marsh has been included as the potential extent of habitat that supports Suisun Marsh aster.

2A.44.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established; however, the CALFED Bay-Delta Ecosystem Restoration Program *Multi-Species Conservation Strategy* designates the Suisun Marsh aster as a Recovery species (CALFED Bay-Delta Program 2000). This means that the program has established a goal to recover the species.

Successful recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

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2A.44.9.1 Literature Cited

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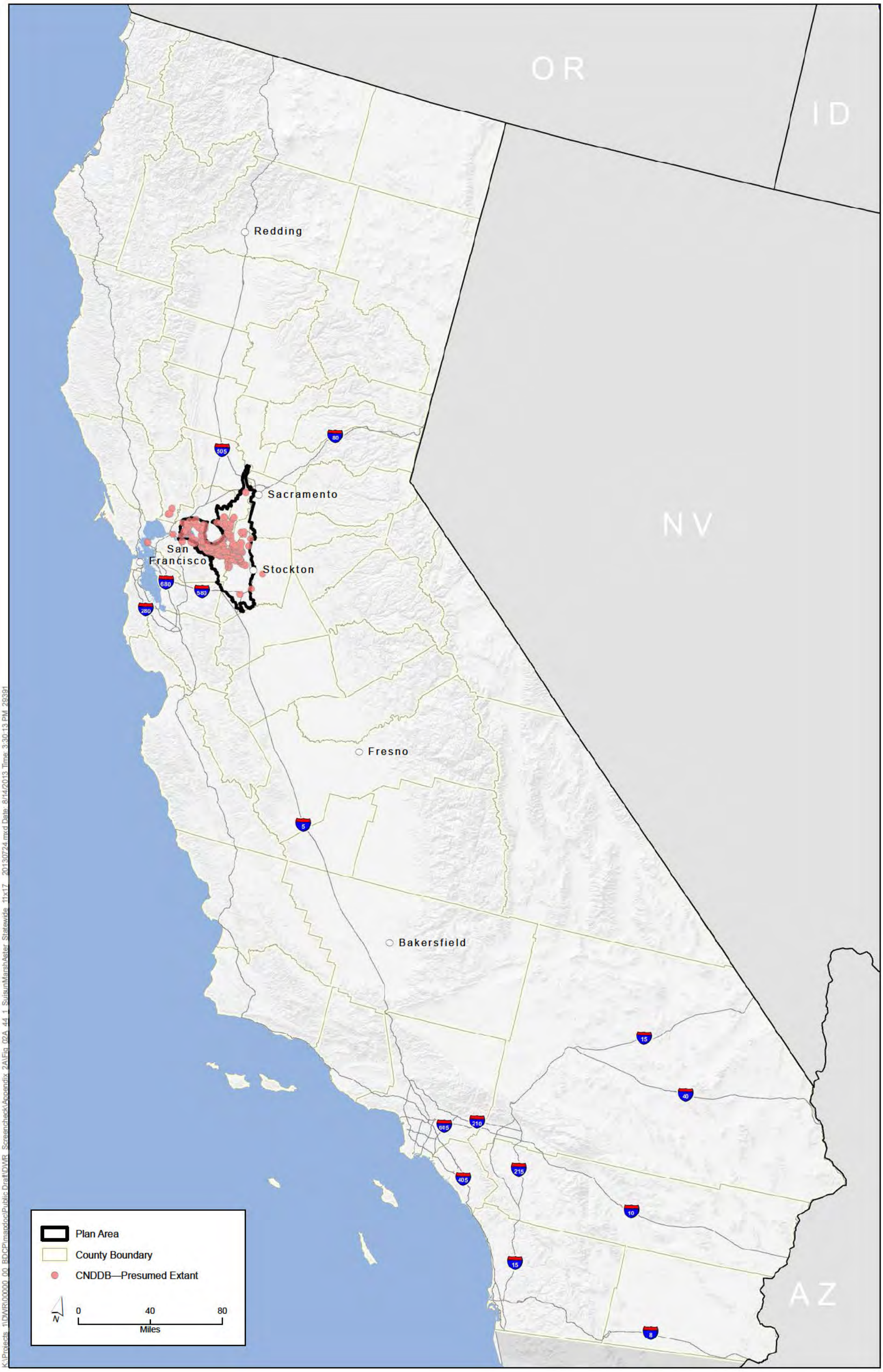
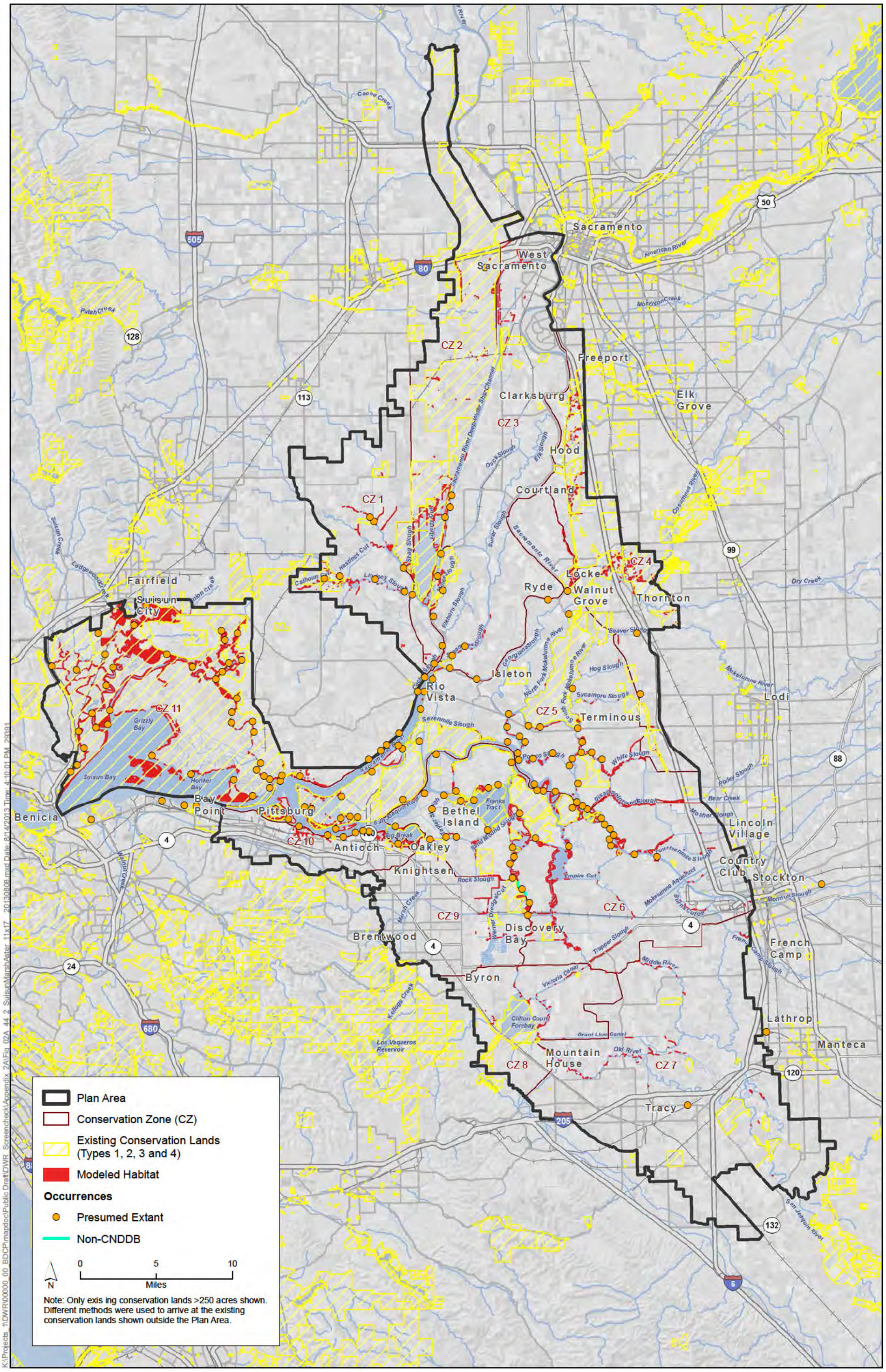


GIS Data Sources: Occurrences, CNDDB June2013.

Figure 2A.44-1
Suisun Marsh Aster Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.44-2
Suisun Marsh Aster Habitat Model and Recorded Occurrences

Appendix 2A.45
Brittlescale (*Atriplex depressa*)

2A.45.1 Legal Status

Brittlescale (*Atriplex depressa*) is not listed under either federal or California endangered species acts. This species' Heritage Element Ranking in the California Natural Diversity Database (CNDDB) is G2Q/S2.2, which means that globally (G) and within the state (S) brittlescale is considered imperiled. This status is a result of its very restricted range, very few populations (often 20 or fewer), steep population declines, or other factors that make it very vulnerable to extirpation. The state threat level (.2) indicates that the species is threatened. The Q portion of the rank indicates that unresolved taxonomic questions remain for this rare species (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for brittlescale indicates that it is rare, threatened, or endangered in California or elsewhere. Its state threat level (.2) indicates that it is fairly endangered in California (California Department of Fish and Game 2012a; California Native Plant Society 2012). Plants with a rank of 1B meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.45.2 Species Distribution and Status

2A.45.2.1 Range and Status

Brittlescale is endemic to California. Its range extends from Glenn and Colusa Counties in the north, to Merced County in the south. Yolo, Solano, Contra Costa, and Alameda Counties are within its range (California Department of Fish and Game 2012b; California Native Plant Society 2012). The CNDDB reports 59 observations for this species, all presumed extant (California Department of Fish and Game 2012b) and an additional three occurrences were found during surveys in 2011 (Delta Habitat Conservation and Conveyance Program 2011) for a range wide total of 62 occurrences (Figure 2A.45-1). There has been confusion in identifying this species correctly. Some of the occurrences reported from south of Merced County may be misidentified populations of lesser saltscale (*Atriplex minuscula*) (Preston pers. comm. 2003). There is also disagreement regarding the morphological characteristics that separate these two species (Preston pers. comm. 2009).

2A.45.2.2 Distribution and Status in the Plan Area

There are eight occurrences of brittlescale, all presumed extant, in the Plan Area (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b) (Figure 2A.45-2). Within the Plan Area, brittlescale has been reported from five localities in Solano County: at Olcott Lake on Jepson Prairie, at a second location in Jepson Prairie southwest of Olcott Lake, between Bird's Landing and Montezuma Slough, in the mitigation area for the access to Potrero Hills Landfill, and from Contra Costa County near Byron Hot Springs (AMEC and Foothills

Associates 2001; California Department of Fish and Game 2012b) (Figure 2A.45-2). The Bird's Landing population had approximately 300 plants in 1991 and the Potrero Hills population had 213 plants in 1996 (California Department of Fish and Game 2012b). Brittlescale is also found in numerous occurrences adjacent to the Plan Area in and along drainages and alkaline seeps in Solano County and eastern Contra Costa County (California Department of Fish and Game 2012b).

Brittlescale was found in the Plan Area at 14 locations during 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011). One stand was found near the Byron Hot Springs occurrence, and the other 13 stands were found southwest of Clifton Court Forebay. The stands located southwest of Clifton Court Forebay represent a new occurrence not yet recorded in the CNDDB. Brittlescale plants were found in scalds in grazed alkali seasonal wetlands. At each location, populations contained from 15 to over 1,000 individuals. No brittlescale was found in the conveyance planning area during surveys conducted in 2009 and 2010 (Delta Habitat Conservation and Conveyance Program 2011).

2A.45.3 Habitat Requirements and Special Considerations

Brittlescale is found in meadows, seeps, and vernal pools, with alkaline clay soils (California Native Plant Society 2012). Species associated with brittlescale include common spikeweed (*Centromadia pungens*), saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), low barley (*Hordeum depressum*), Mediterranean barley (*Hordeum marinum* subsp. *gussoneanum*), western niterwort (*Nitrophila occidentalis*), Parish's pickleweed (*Arthrocnemum subterminale*, formerly *Salicornia subterminalis*), bush seepweed (*Suaeda nigra,* formerly *S. moquinii*), heartscale (*Atriplex cordulata* var. *cordulata*), and San Joaquin spearscale (*Atriplex joaquinana*) (California Department of Fish and Game 2012b; California Native Plant Society 2012). The reported CNDDB occurrences in Solano and east Contra Costa Counties are in proximity to hydrologic features such as stream corridors and playa pools. It is not known whether this association with hydrologic features is a strict habitat requirement or a legacy of land management practices such as extensive dry-farmed grain and other intensive agriculture that avoid planting and cultivation of hydrologic features, continuing to the present (Gerlach pers. comm.).

2A.45.4 Life History

Brittlescale is a small (less than 8 inches [20 centimeters]) annual herb of the goosefoot family (Chenopodiaceae) that blooms from June to October (Zacharias 2012; California Native Plant Society 2012). Its stems, which grow flat along the ground and turn upward near their tips, are white, scaly, and brittle (Zacharias 2012). Leaf blades are small (0.2 to 0.3 inch [4 to 8 millimeters]) and egg-shaped to heart-shaped, with entire margins. The leaves, which are generally densely covered with small, white scales, are opposite, unlike many other *Atriplex* species (Zacharias 2012). Its reddish seeds are 0.04 to 0.06 inch (1 to 1.5 millimeter) long (Zacharias 2012). Brittlescale is found at elevations of 3 to 1,050 feet (1 to 320 meters) (California Native Plant Society 2012). It is closely related to *Atriplex minuscula* (lesser saltscale) and *Atriplex parishii* (Parish's brittlescale); it has sometimes been treated as a variety of *Atriplex parishii* (Parish's brittlescale) (California Native Plant Society 2012; Welsh 2003).

2A.45.5 Threats and Stressors

The primary threat to brittlescale is the loss of suitable habitat within its range (California Department of Fish and Game 2012b). Other threats include livestock grazing and trampling (California Department of Fish and Game 2012b), invasive species, and the periodic inundation of managed marshes to create habitat for waterfowl (Showers 1996).

2A.45.6 Relevant Conservation Efforts

Brittlescale is a covered species in the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (East Contra Costa County Habitat Conservancy 2006); it is proposed for coverage under the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011). In the Plan Area, occurrences are generally protected under the *Greater Jepson Prairie Ecosystem Management Plan* (Witham 2006) while many of the other occurrences are located on public wildlife refuges (California Department of Fish and Game 2012b).

2A.45.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

Brittlescale occurrences in and near the Plan Area are all close to hydrologic features such as stream corridors and playa pools. These features are located on either alluvium associated with the Montezuma Block along the western boundary of the Plan Area (Band 1998; Graymer et al. 2002) or on alluvium associated with tertiary formations located along the southwest boundary of the Plan Area (Schruben et al. 1998). Specific regions selected from these alluvium units were considered directly related to the Montezuma block or the tertiary formation along the southwest boundary of the Plan Area via visual review of this region. These regions were exported to a geographic information system (GIS) layer.

Stream corridors (intermittent and perennial) that intersected these geologic units were selected and truncated at the point at which they encountered the upper elevation of intertidal marsh (Siegel 2007). The corridors were buffered 50 feet (15.2 meters) on either side of their centerlines to capture the estimated maximum extent of alluvium deposits in proximity to the streams. Field reconnaissance on the Montezuma Block area on May 30, 2009, found that this buffering width is liberal and tends to over-predict potential habitat (Gerlach pers. comm.).

The identified potential habitat was then overlaid on National Agricultural Imagery Program aerial imagery (U.S. Department of Agriculture 2005) to visually assess whether estimated habitat agreed with current land use practices (i.e., to ensure that habitat was not currently affected by urban or agricultural uses). Predicted habitat that was affected by urban or intensive agricultural uses was removed from the model. This was accomplished by developing a GIS layer of habitat polygons that were designated as unsuitable.

2A.45.8 Recovery Goals

A U.S. Fish and Wildlife recovery plan has not been prepared for this species and no recovery goals have been established.

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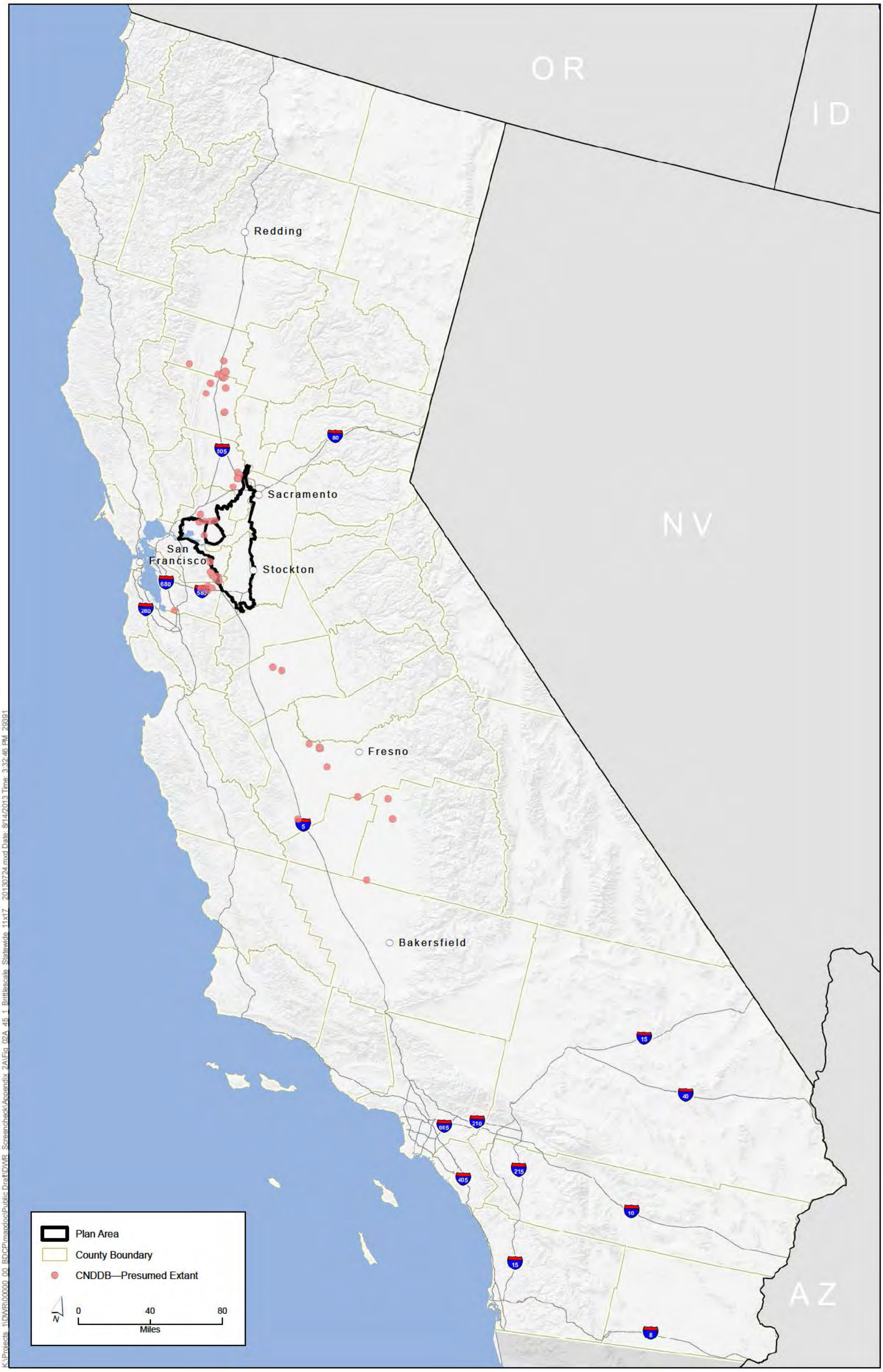
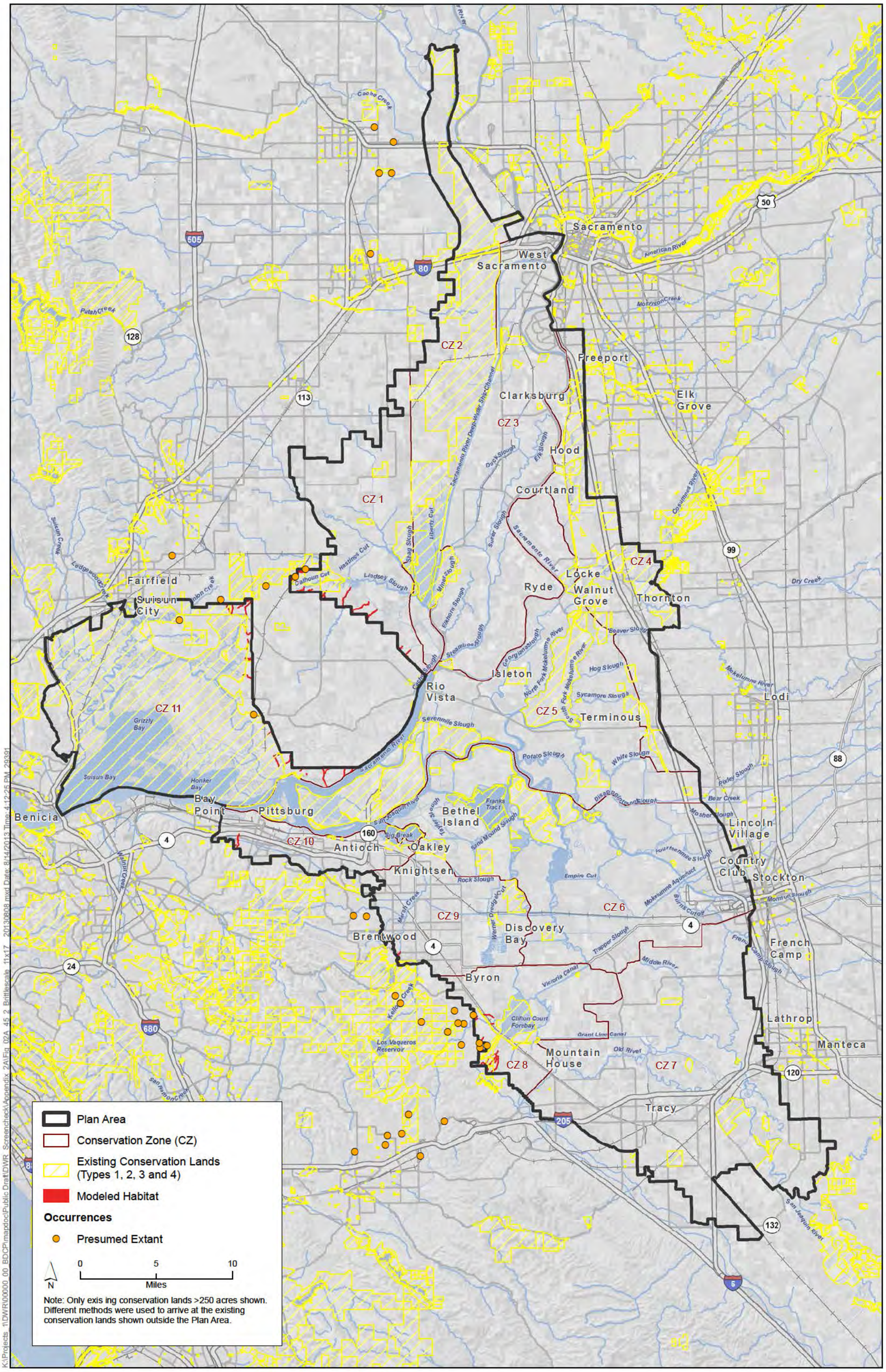


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.45-1
Brittlescale Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.45-2
Brittlescale Habitat Model and Recorded Occurrences

Appendix 2A.46
Heartscale (*Atriplex cordulata* var. *cordulata*)

2A.46.1 Legal Status

Heartscale (*Atriplex cordulata* var. *cordulata*) is not listed under either federal or California endangered species acts. Its Heritage Element Ranking in the California Natural Diversity Database (CNDDB) is G3T2/S2.2?, which means that globally (G) the species is vulnerable and at moderate risk of extinction due to restricted range and relatively few populations (often 80 or fewer), recent and widespread declines, or other factors, but the variety (T) is considered imperiled. Within the state (S) the species is imperiled. This status is a result of its very restricted range, very few populations (often 20 or fewer), steep population declines, or other factors making it very vulnerable to extirpation. The state threat level is threatened (.2) with some measure of uncertainty (?) (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for heartscale indicates that it is rare, threatened, or endangered in California and elsewhere. Its state threat level (.2) indicates that it is fairly endangered in California (California Department of Fish and Game 2012a; California Native Plant Society 2012). Plants with rank of 1B meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.46.2 Species Distribution and Status

2A.46.2.1 Range and Status

Heartscale is endemic to California. Its range extends through the Central Valley from Glenn County in the north to Fresno County in the south (Figure 2A.46-1) (California Native Plant Society 2012). There are 56 extant occurrences (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). An additional 9 occurrences are extirpated and 1 is possibly extirpated (California Department of Fish and Game 2012b). Fourteen of these records appear to be based on false identifications (i.e., other *Atriplex* species falsely identified as heartscale) (Preston pers. comm.).

2A.46.2.2 Distribution and Status in the Plan Area

In the Plan Area, there are eight confirmed occurrences of heartscale, all presumed to be extant (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). The populations in the Plan Area are generally small and often subjected to prolonged grazing by sheep (California Department of Fish and Game 2012b), which may have both positive and negative impacts on this species. One occurrence consists of 100 to 200 plants observed in 1994 in an alkali meadow near the margin of Calhoun Cut, and a second record (made in 2006) was based on a listing of heartscale as an associate of alkali milk vetch in mesic alkaline grassland at the edge of

a vernal pool. A third occurrence in the Plan Area southwest of Clifton Court Forebay, reported in the 2009 Delta Habitat Conservation and Conveyance Program surveys, consisted of two stands of 15 and 150 individuals, both in alkaline seasonal wetlands that were surrounded by grazed pasture (Delta Habitat Conservation and Conveyance Program 2011). However, this third occurrence was likely to have been falsely identified; heartscale has not been confirmed to occur in Contra Costa or Alameda Counties, and all reported occurrences of heartscale from those counties have been identified as crownscale (*Atriplex coronata*) or are likely to be crownscale (Preston pers. comm.), which has been collected multiple times in the vicinity of Byron and Clifton Court Forebay (Consortium of California Herbaria 2012).

No heartscale was found during the Delta Habitat Conservation and Conveyance Program 2010 surveys. Eight stands were reported during the 2011 surveys, located in scalds in alkaline seasonal wetlands southeast of Byron Hot Springs. Most of these sites were grazed by cattle. Each stand contained between 10 and 30 individuals (Delta Habitat Conservation and Conveyance Program 2011). As noted above, these plants are probably crownscale.

2A.46.3 Habitat Requirements and Special Considerations

Heartscale is found in meadows, seeps, riparian wetlands, chenopod scrub, and valley and foothill grasslands in various soils that are either saline or alkaline (California Department of Fish and Game 2012b; California Native Plant Society 2012) (Figure 2A.46-2). Species associated with heartscale include common spikeweed (*Centromadia pungens*), saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), low barley (*Hordeum depressum*), bush seepweed (*Suaeda nigra,* formerly *S. moquinii*), and alkali weed (*Cressa truxillensis*) (California Department of Fish and Game 2012b; California Native Plant Society 2012). It often co-occurs with other annual *Atriplex* species.). The reported CNDDB occurrences in Solano and East Contra Costa Counties are in proximity to hydrologic features such as stream corridors and playa pools. It is not known whether this association with hydrologic features is a strict habitat requirement or a legacy of land management practices that continue to the present. These include dry-farmed grain and other intensive agriculture practices that avoid planting and cultivation of hydrologic features (Gerlach pers. comm.).

2A.46.4 Life History

Heartscale is a small- to medium-sized 4- to 20-inch- (10- to 50-centimeter) tall annual herb of the goosefoot family (Chenopodiaceae) that blooms from April to October (Zacharias 2012; California Native Plant Society 2012). It produces one or more erect stems with branches ascending to scaly gray tips with woolly fibers. The leaves are grayish-green, scaly, egg-shaped, and from 0.25 to 0.5 inch (0.6 to 1.5 centimeter) in length. Lower leaf bases are heart-shaped while upper leaf bases are rounded. The inflorescences consist of small dense clusters of flowers, and seeds are reddish brown and about 0.1 inch (2 millimeters) wide (Zacharias 2012). Heartscale can be found at elevations up to 1,840 feet (560 meters) (California Native Plant Society 2012).

2A.46.5 Threats and Stressors

Reported threats to heartscale include agriculture intensification, development, nonnative plants, overgrazing, and trampling (California Department of Fish and Game 2012b; California Native Plant Society 2012).

2A.46.6 Relevant Conservation Efforts

Heartscale is a covered species under the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000). In the Plan Area, occurrences are generally protected on the *Greater Jepson Prairie Ecosystem Management Plan* (Witham 2006) while many of the other occurrences are located on public wildlife refuges (California Department of Fish and Game 2012b).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates heartscale as a Maintain species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects on the species created by program restoration actions. To the extent practicable, the program will improve species habitat conditions.

2A.46.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

Heartscale is typically found in alkali grassland, alkali meadow, or iodine bush scrub with alkaline soils, usually near or on the margins of scalds, slick spots, and vernal pools. At these locations, heartscale generally occurs on soils that have an accumulation of clay in the subhorizon (alfisols) and that also have horizons with high levels of sodium, usually indicated in soil surveys as strongly to very strongly alkaline. It most often occurs on soil series classified as loams (Solano, Fresno, El Peco, Riz, Waukena, Traver, Merced, Rossi, Pedcat) and less commonly on clay soils (Pescadero, Willows). Only three of these soil types occur in the Plan Area (Solano, Pescadero, Willows).

The habitat model proposed for heartscale is based on the species range in the Plan Area (Solano and Yolo Counties), soils types, and the plant community. The model excludes area that have been developed or cultivated; i.e., where the topography, soils, and hydrology have been substantially altered. The three model parameters are as follows:

- Yolo and Solano Counties
- Solano, Pescadero, and Willows soils
- Grassland, alkali seasonal wetland, and vernal pool complex natural communities

Potential habitat was determined by intersecting the geographic information systems (GIS) coverage for the three parameters. The identified potential habitat was then overlaid on National Agricultural Imagery Program aerial imagery (U.S. Department of Agriculture 2005) to visually assess whether estimated habitat agreed with current land use practices (to ensure that habitat was

not currently affected by urban or agricultural uses). Predicted habitat that was occupied by urban or intensive agricultural uses was manually removed from the model.

2A.46.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

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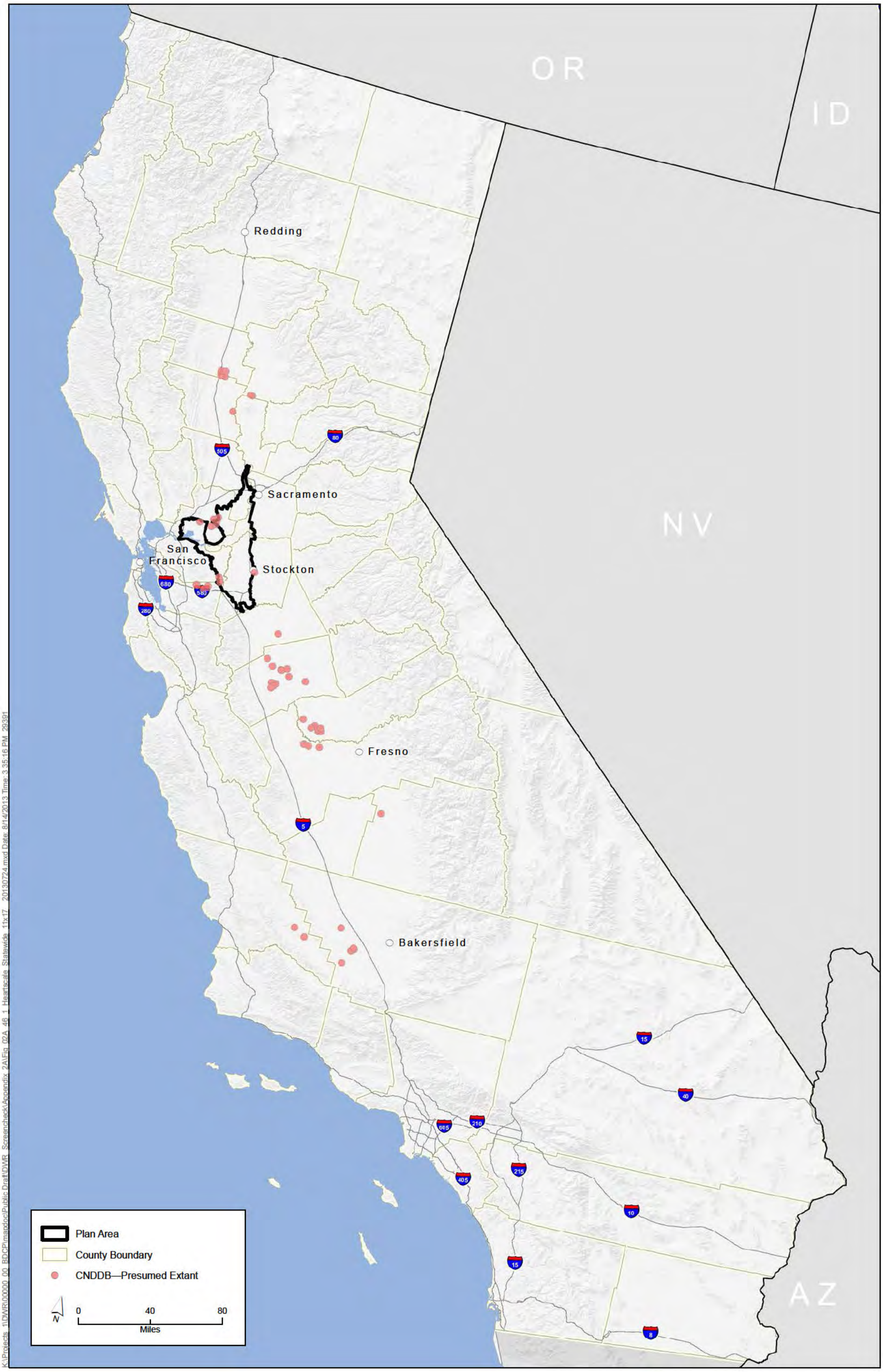
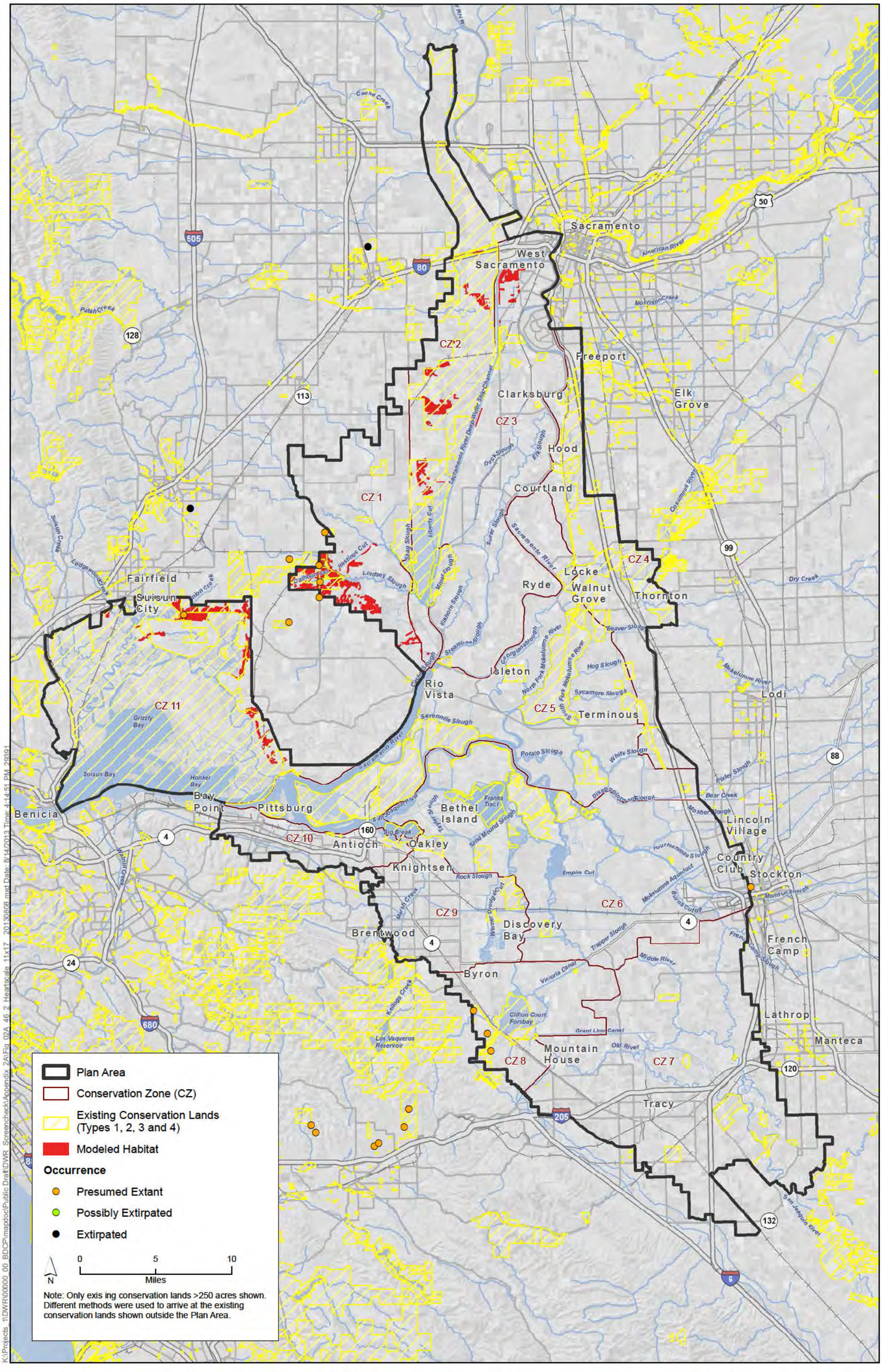


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.46-1
Heartscale Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.46-2
Heartscale Habitat Model and Recorded Occurrences

Appendix 2A.47
Side-Flowering Skullcap (*Scutellaria lateriflora*)

2A.47.1 Legal Status

Side-flowering skullcap (*Scutellaria lateriflora*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G5/S1, which means that globally (G) the species population is secure or ineradicable because it is common outside of California, but within the state (S) the species is considered critically imperiled (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 2.2 for side-flowering skullcap indicates that it is rare, threatened, or endangered in California but more common elsewhere. Its state threat level (.2) indicates that it is fairly endangered in California (California Department of Fish and Game 2012a). Plants with a rank of 2 are considered to meet the definitions of rare, threatened and endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.47.2 Species Distribution and Status

2A.47.2.1 Range and Status

Side-flowering skullcap is a widespread but scattered species of swamps, marshes, and bogs in the central and eastern United States, but in California it is limited to a small area of the Sacramento–San Joaquin River Delta (Delta) in the Plan Area (Figure 2A.47-1). There are 12 extant occurrences reported in the CNDDB, the majority within 3 miles of Walnut Grove in southeast Sacramento County (California Department of Fish and Game 2012b). Prior to 2009, side-flowering skullcap was known from only two occurrences. It was collected from Bouldin Island in 1892 but that occurrence has not been relocated since, and it was discovered in 1993 in the vicinity of Delta Meadows State Park (California Department of Fish and Game 2012b). The 2009 surveys identified it in Sycamore Slough and also found additional occurrences in the Delta Meadows State Park area (California Department of Fish and Game 2012b; Delta Habitat Conservation and Conveyance Program 2011). It has also been recorded from a crop field on an herb farm in Gilroy in Santa Clara County (Hrusa 1999; Consortium of California Herbaria 2012), but this occurrence is not recorded in the CNDDB.

2A.47.2.2 Distribution and Status in the Plan Area

As noted above, side-flowering skullcap is known to occur in the Plan Area only on Bouldin Island in San Joaquin County and in the Delta Meadows State Park area in Sacramento County (Figure 2A.47-2) (California Department of Fish and Game 2012b). During botanical surveys of the Plan Area in 2009, it was found at the Delta Meadows State Park, and at additional locations in and along the channels of Snodgrass Slough, Lost Slough, and the Mokelumne River (Delta Habitat Conservation and Conveyance Program 2011). No additional occurrences of this species were discovered during 2009 surveys conducted along channels in the north, west, south, and central

Delta, and none were found during the 2010 and 2011 surveys. The Bouldin Island occurrence recorded in 1892 has not been found since, and the exact location is unknown, but it is presumed to be still extant. Numbers of plants observed at the other 11 occurrences are low, ranging from 1 to 68, and 7 occurrences have 10 or fewer plants (California Department of Fish and Game 2012b). Population conditions have been rated as fair to good, although population trends are unknown for all occurrences (California Department of Fish and Game 2012b). Of the 12 occurrences, two are in existing conservation lands in the vicinity of Delta Meadows State Park in the greater Cosumnes-Mokelumne River area.

2A.47.3 Habitat Requirements and Special Considerations

Side-flowering skullcap occurs in wet meadows, seeps, marshes and swamps (California Department of Fish and Game 2012b; California Native Plant Society 2012). In the Plan Area it occurs in freshwater tidal areas along channels and sloughs, almost always growing on partially submerged logs along tidal channels (California Department of Fish and Game 2012b). This ensures that the plant is well watered but not growing in anaerobic soils. Typical associated species include common nightshade (*Solanum americanum*), bugleweed (*Lycopus americanus*), soft rush (*Juncus effusus*), spike bentgrass (*Agrostis exarata*), white alder (*Alnus rhombifolia*), purpletop vervain (*Verbena bonariensis*), willowherb (*Epilobium* spp.), and buttonwillow (*Cephalanthus occidentalis*) (California Department of Fish and Game 2012b).

In the Delta Meadows State Park area it co-occurs with the rare marsh skullcap (*Scutellaria galericulata*), often on the same stumps.

2A.47.4 Life History

Side-flowering skullcap is a perennial rhizomatous herb in the mint family (Lamiaceae). It stands 7 to 24 inches (20 to 60 centimeters) tall (Olmstead 2012). The 0.5- to 1-inch- (1.3- to 2.5-centimeter-) long leaves are opposite. The flowers, which are blue and arise from the leaf axils, are grouped in pairs oriented along one side of the stems. The stem is erect and typically branched and may be smooth or sparsely covered with very short hairs less than 0.02 inch (less than 0.5 millimeter) long. It blooms from July to September (California Native Plant Society 2012). It can produce small, more or less spherical brown fruit (Olmstead 2012). Little is known about reproduction in this species, but based on similar species, it is probably insect-pollinated and reproduces by seed, but it may also spread vegetatively by rhizomes.

2A.47.5 Threats and Stressors

While side-flowering skullcap is deemed secure globally (California Department of Fish and Game 2012b), general threats to wetland habitats include development, intensive agriculture, and invasive plant species. In the Delta, side-flowering skullcap grows on logs, stumps, and other large woody material along shoreline that supports primarily riparian and marsh vegetation, and lack of shoreline coarse woody material may be a limiting factor in parts of the Delta.

2A.47.6 Relevant Conservation Efforts

Most side-flowering skullcap plants found in the Plan Area are located within or directly adjacent to Delta Meadows River Park, a California State Park property that was established to preserve and protect one of the last remaining areas of the northern Sacramento-San Joaquin River Delta with large stands of fairly mature riparian vegetation. This park is now closed (California State Parks 2012).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the side-flowering skullcap as a Maintain species (CALFED Bay-Delta Program 2000). This designation indicates that the program will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects on the species created by program restoration actions. It also means that the species' population and habitat are unlikely to be affected by program actions.

2A.47.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.47.7.1 GIS Model Data Sources

The side-flowering skullcap model uses vegetation types and associations from the following data set: Hickson and Keeler-Wolf 2007. Using this vegetation map, the model maps the distribution of suitable habitat for side-flowering skullcap in the Plan Area according to the species' habitat association with woody riparian habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.47.7.2 Habitat Model Description

The following California Department of Fish and Wildlife (CDFW) vegetation subunits were selected from the BDCP valley riparian natural community as mapped by Hickson and Keeler-Wolf (2007):

- *Alnus rhombifolia*/*Cornus sericea*
- *Alnus rhombifolia*/*Salix exigua* (*Rosa californica*)
- California dogwood (*Cornus sericea*)
- *Cornus sericea*–*Salix exigua*
- *Cornus sericea*–*Salix lasiolepis*/(*Phragmites australis*)
- *Quercus lobata*–*Alnus rhombifolia* (*Salix lasiolepis*–*opulus fremontii*–*Quercus agrifolia*)
- *Salix lasiolepis*–*Cornus sericea*)/*Schoenoplectus* (formerly *Scirpus*) spp.–(*Phragmites australis*–*Typha* spp.) complex unit
- White alder (*Alnus rhombifolia*)
- White alder (*Alnus rhombifolia*)–Arroyo willow (*Salix lasiolepis*) restoration

2A.47.7.3 Soils

Side-flowering skullcap is found primarily on logs, stumps, and downed wood both in the Plan Area and in regions that are similar to Delta habitats. Therefore, the presence of stumps and downed wood seems to be more of a determining factor for the presence of side-flowering skullcap than soil type. Moist soils with plenty of organic matter would most closely resemble woody substrate.

2A.47.7.4 Assumptions

- **Assumption:** Side-flowering skullcap habitat is restricted to the vegetation types described in Section 2A.47.7.2, *Habitat Model Description*.

  Rationale: *Cornus sericea* is an appropriate species to use for a preliminary side-flowering skullcap species model because it is associated with Delta riparian vegetation types that support side-flowering skullcap and because these vegetation types can provide the habitat characteristics that side-flowering skullcap seems to require, namely, woody substrate in freshwater tidal areas. Known nontidal sites were removed with a geographic information system (GIS) constraint layer.

2A.47.8 Recovery Goals

Side-flowering skullcap is not a federally or state listed species. No recovery goals have been formulated for this species. Possible conservation measures could include avoidance, collection of clones by moving woody substrate with plants to new locations in the appropriate tidal range, and by the restoration of tree dominated vegetation along the uppermost limits of freshwater tidal areas in the Delta.

2A.47.9 References Cited

2A.47.9.1 Literature Cited

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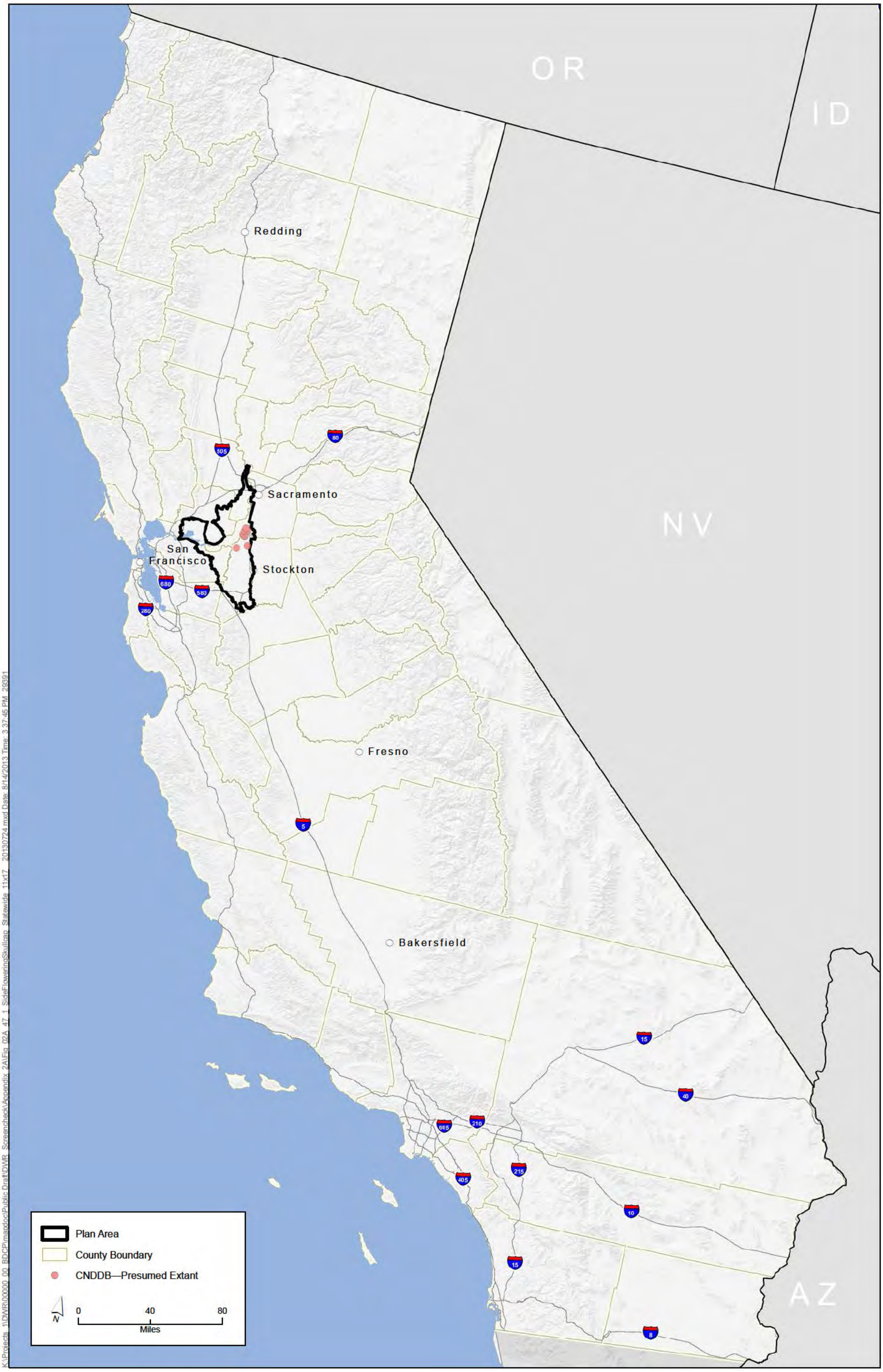
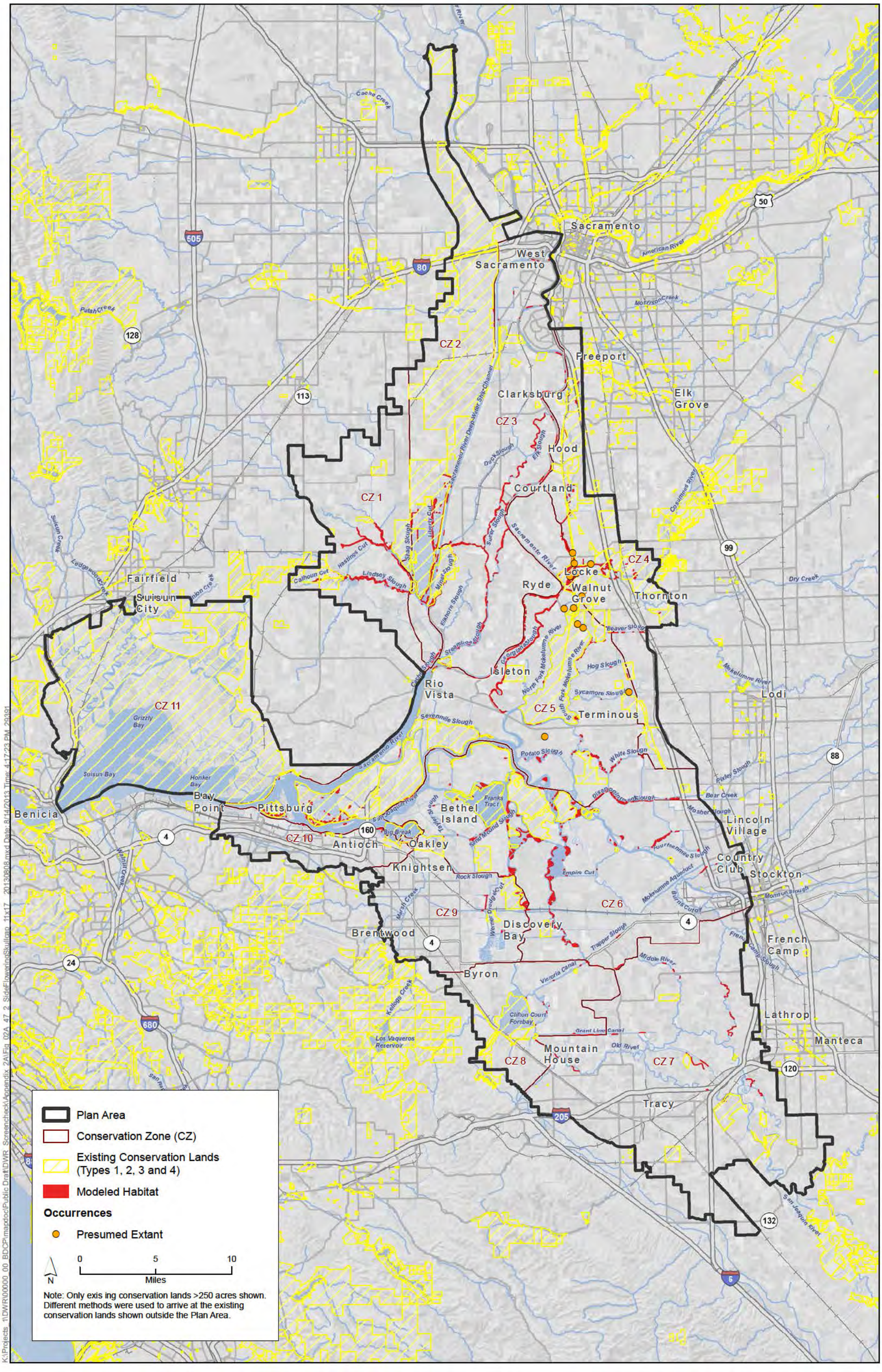


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.47-1
Side-Flowering Skullcap Statewide Range and Recorded Occurrences



K:\Projects_1\DWR\000000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix_2A\Fig_02A_47_2_SideFloweringSkullcap_11x17_20130808.mxd Date: 8/14/2013 Time: 4:17:23 PM_29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.47-2
Side-Flowering Skullcap Habitat Model and Recorded Occurrences

Appendix 2A.48
Slough Thistle (*Cirsium crassicaule*)

2A.48.1 Legal Status

Slough thistle (*Cirsium crassicaule*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2.2 which means that globally (G) and within the state (S) the species is considered imperiled; its state threat level is threatened (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.1 for slough thistle indicates that it is rare or endangered in California and elsewhere. Its state threat level (.1) indicates that it is seriously endangered in California (California Department of Fish and Game 2012a). It is endemic to California. Plants with a rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.48.2 Species Distribution and Status

2A.48.2.1 Range and Status

Slough thistle is endemic to the San Joaquin Valley and is known from 19 occurrences, two of which are possibly extirpated; it has a disjunct distribution: occurrences are known in San Joaquin County in the north, but the majority of occurrences are in Kings and Kern Counties in the south (California Department of Fish and Game 2012b; California Native Plant Society 2012) (Figure A.48-1). A cluster of occurrences has been reported from the former flood channels that historically conveyed high flows between Buena Vista Lake and Tulare Lake (California Department of Fish and Game 2012b). Long-term casual monitoring indicates that this species was extirpated at one Hacienda Spillway occurrence (Hansen pers. comm.), and another occurrence between Hacienda Spillway and the Goose Lake Canal was extirpated by the construction of storage ponds (California Department of Fish and Game 2012b). Species experts believe that its populations are declining (Griggs pers. comm.; Hansen pers. comm.).

2A.48.2.2 Distribution and Status in the Plan Area

Slough thistle has been recorded at two locations in the southern end of the Plan Area along the San Joaquin River near Lathrop (Figure A.48-2) (California Department of Fish and Game 2012b). One occurrence, located 1mile north of the San Joaquin River Club, has not been seen since 1974, and a second occurrence recorded 2 miles northeast of Lathrop Bridge near the confluence with Old River has not been seen since 1933 (California Department of Fish and Game 2012b). Both occurrences are in areas of intensive agriculture (California Department of Fish and Game 2012b). It appears likely that the plant no longer occurs at these sites, although the occurrence north of the San Joaquin River Club is still considered extant. If this occurrence is actually extant, then it would be significant

as the northernmost occurrence and highly disjunct from the remainder of the populations in California. Neither record provides information on the population size. Slough thistle was not observed during botanical survey of Sacramento–San Joaquin River Delta (Delta) waterways conducted in 2009, 2010, or 2011 (Delta Habitat Conservation and Conveyance Program 2011).

2A.48.3 Habitat Requirements and Special Considerations

Slough thistle grows in freshwater marshes and swamps and in chenopod scrub and riparian scrub habitats (California Native Plant Society 2012). It is found at elevations below 100 meters above sea level (California Native Plant Society 2012; Keil 2012). The locations reported in the southern San Joaquin Valley are all along or adjacent to high flood-flow areas (California Department of Fish and Game 2012b) such as the Hacienda Spillway, where high flows from the Kern River historically broke through the Sand Ridge and flowed into Tulare Lake (Hansen pers. comm.). Because these high flood-flow areas have been preserved, albeit in a modified condition for floodwater conveyance, some habitat has been preserved in what is now an area of intensive agricultural production. Historically, slough thistle was likely present throughout the Tulare Basin in lesser flow channels as well. It is generally found in the portions of channels that flood at high water and on the banks of floodwater conveyance canals and drains (Griggs pers. comm.; Hansen pers. comm.). Apart from the notation on one specimen that it was collected "growing in shallow water of canal", there is no information on specific habitat conditions or associated species for the records in the Plan Area.

2A.48.4 Life History

Slough thistle is a robust (3- to 10-foot-[1- to 3-meter-] tall) annual or biennial herb in the sunflower family (Asteraceae). It blooms from May to July (Keil 2012) to as late as August (California Native Plant Society 2012). Unless grazed, it generally has a stout single stem that is hollow and openly branched near the top of the plant (Keil 2012). Its spiny leaves are thinly covered with cobwebby-tomentose hairs on top and gray-tomentose hairs below; lower leaves range from 6 to 27 inches (15 to 69 centimeters) (Keil 2012). Slough thistle flowers are pale rose-purple or sometimes white in color, 0.8 to 1.2 inches (2 to 3 centimeters) long, and are grouped into spiny heads 0.5 to 1.0 inch wide, which are in turn grouped into loose to crowded flat-topped clusters (Keil 2012). The flowers are probably insect pollinated, like many other thistles. The small seeds have a pappus (Keil 2012), an adaptation for wind dispersal.

2A.48.5 Threats and Stressors

Conversion of suitable habitat to agricultural land uses and competition from nonnative plants have been reported as the primary threats to slough thistle (California Native Plant Society 2012). In the southern San Joaquin Valley, other threats include vegetation clearing on the banks of drains and canals, and weed control efforts (Griggs pers. comm.; Hansen pers. comm.).

2A.48.6 Relevant Conservation Efforts

Slough thistle is a covered species in the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000), the *PG&E San Joaquin Valley Operations & Maintenance Habitat Conservation Plan* (Pacific Gas and Electric Company 2006), the *Metro Bakersfield Habitat Conservation Plan* (City of Bakersfield and County of Kern 1994), the *Kern Valley Floor Habitat Conservation Plan* (Kern County Planning Department 2006), the *ARCO Coles Levee (ARCO Western Energy) Habitat Conservation Plan*, and the *Kern Water Bank Habitat Conservation Plan/Natural Community Conservation Plan* (Kern Water Bank Authority 1997). It is also covered under the *Kern and Pixley National Wildlife Refuges Comprehensive Conservation Plan* (U.S. Fish and Wildlife Service 2005).

2A.48.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*. A geographic information system (GIS) constraint layer was developed to limit suitable habitat to the areas between the levees from the Mossdale Bridge to Vernalis. A historical occurrence from 1933 was located just north of the Mossdale Bridge but aerial imagery and the CNDDB occurrence information for this site (California Department of Fish and Game 2012b) indicate that the occurrence has probably been extirpated by conversion to intensive agriculture.

2A.48.7.1 Assumptions

- **Assumption:** Slough thistle habitat is geographically constrained to areas along the river that have been disturbed by flood events and are being colonized by willow scrub vegetation.

  Rationale: Historical records of this species indicate that its distribution in the Plan Area is limited to the flood plain of the San Joaquin River (Figure A.48-2). Based on its distribution in the southern San Joaquin Valley, its habitat is likely to be areas along the river that have been disturbed by flood events and are being colonized by willow scrub vegetation.

2A.48.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

2A.48.9 References Cited

2A.48.9.1 Literature Cited

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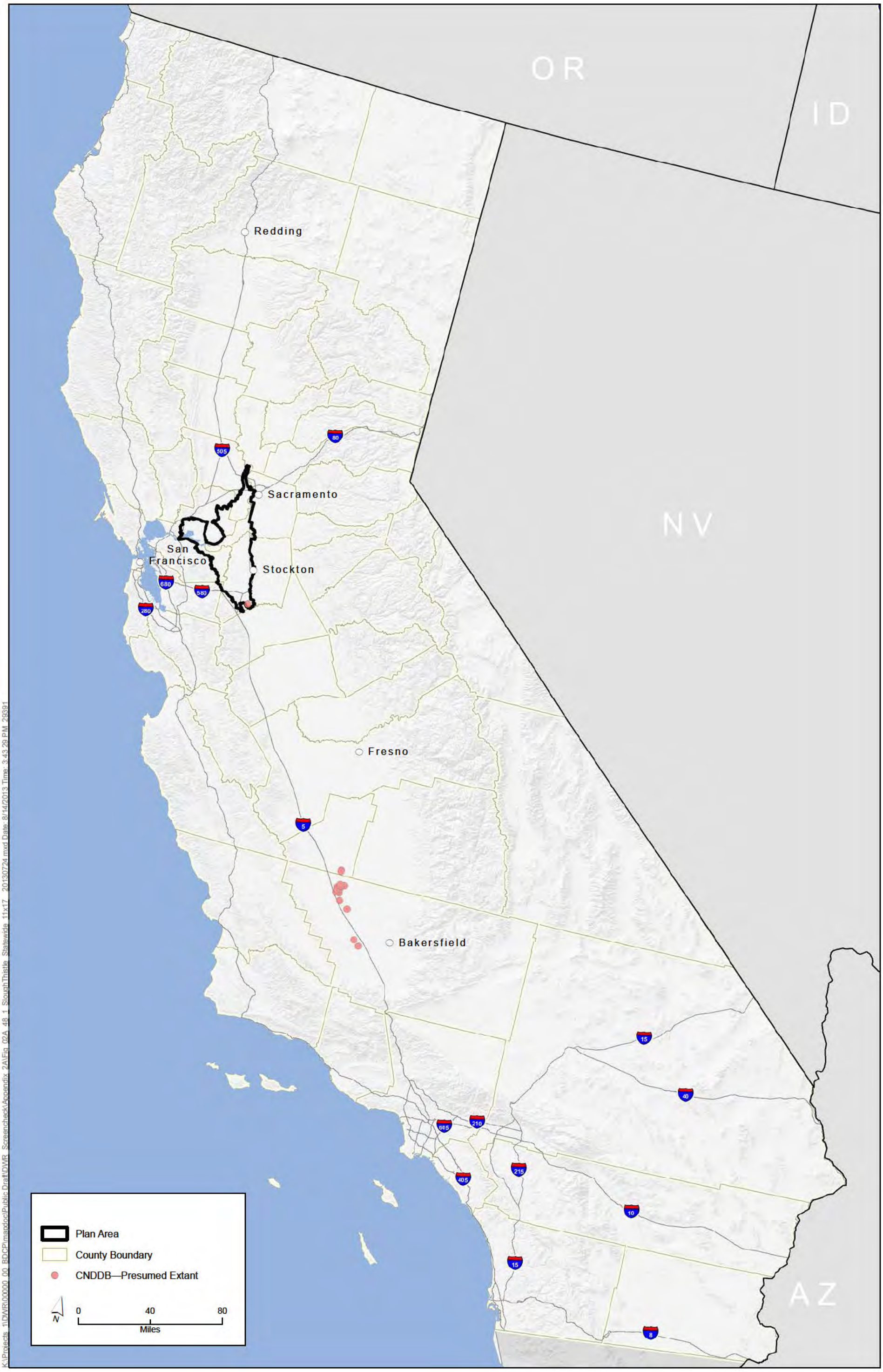
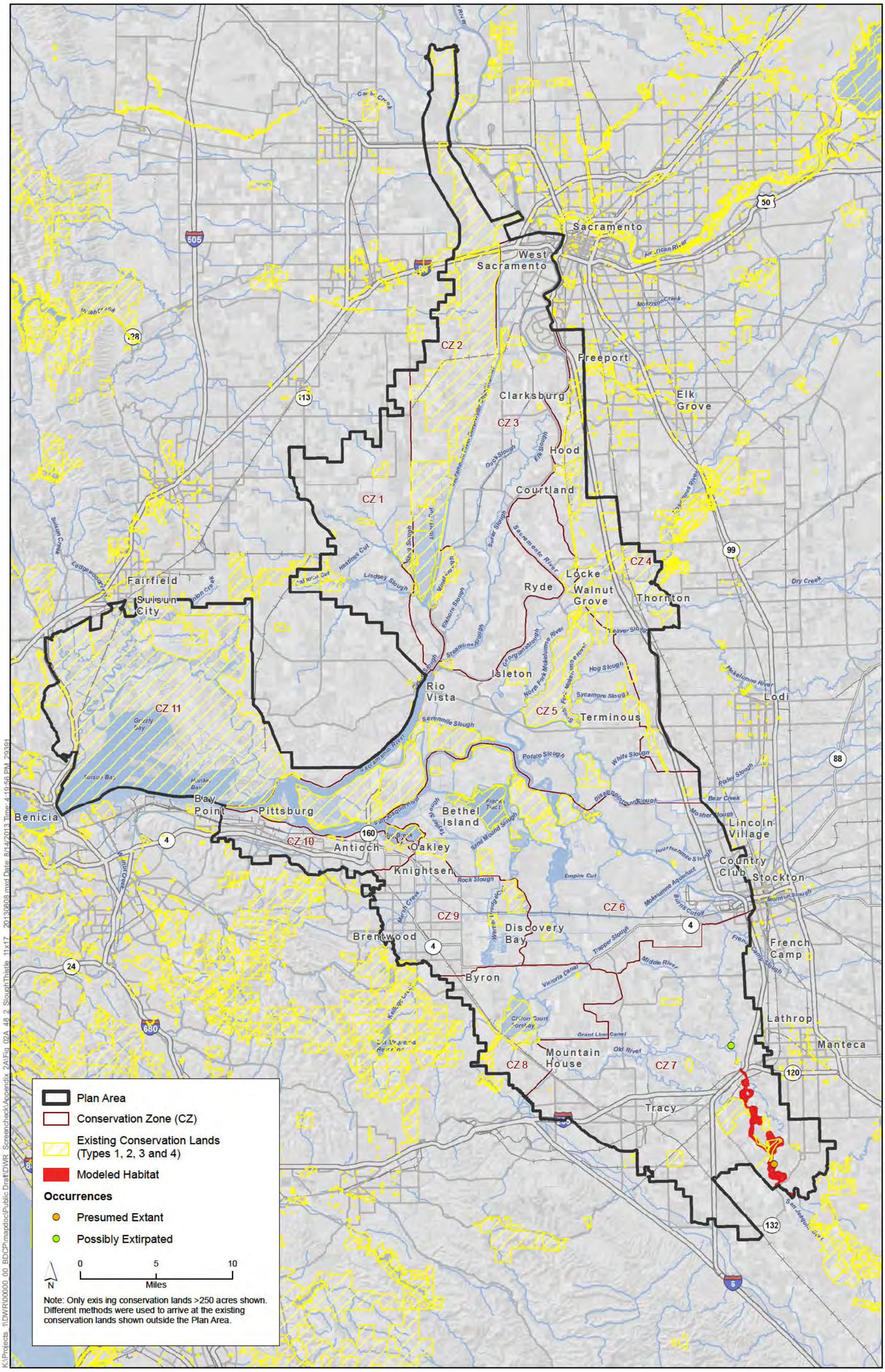


GIS Data Sources: Occurrences, CNDDB June 2013; Plan Area, ICF 2012.

Figure 2A.48-1
Slough Thistle Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.48-2
Slough Thistle Habitat Model and Recorded Occurrences

Appendix 2A.49

Soft Bird's-Beak (*Chloropyron molle* ssp. *molle*)

2A.49.1 Legal Status

Soft bird's-beak (*Chloropyron molle* ssp. *molle* formerly known as *Cordylanthus mollis* ssp. *mollis*) is listed as endangered under the federal Endangered Species Act (November 1997; 62 *Federal Register* [FR] 61916) and listed as rare under the California Native Plant Protection Act (July 1979). Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2T1/S1, which means that globally (G) this species is imperiled and the subspecies is critically imperiled and is at high risk for extinction as a result of restricted range, very few populations and steep decline the(the G rank refers to the global range of the species, while the T rank refers to the subspecies) (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for soft bird's-beak indicates that the species is rare, threatened, or endangered in California and elsewhere. The state threat level (.2) indicates that the species is fairly threatened in California (California Department of Fish and Game 2012a). Plants with a rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

U.S. Fish and Wildlife Service (USFWS) designated critical habitat for soft bird's-beak in the four areas that contain the largest and most intact populations and habitat (2007; 72 FR 18528), including two in the Plan Area: Unit 2, which includes the Hill Slough Wildlife Management Area, and Unit 4 of the Rush Ranch/Grizzly Island Wildlife Management Area.

In the most recent 5-year review, USFWS recommended the continuation of endangered status for soft bird's-beak (U.S. Fish and Wildlife Service 2009).

2A.49.2 Species Distribution and Status

2A.49.2.1 Range and Status

Soft bird's-beak is endemic to salt and brackish marshes from San Pablo Bay to Suisun Bay and is known from 26 occurrences, 18 of which are presumed extant (California Department of Fish and Game 2012b). Historically, the range of soft bird's-beak extended from tidal marshes of Napa and Solano Counties in the north, Contra Costa County in the south, Sonoma and Marin Counties in the west, and Sacramento County in the east (Figure 2A.49-1). It is now believed to be extirpated from Marin, Sacramento and Sonoma Counties but remains extant in Napa, Solano, and Contra Costa Counties (California Department of Fish and Game 2012b). The largest extant occurrences are on California Department of Fish and Wildlife (CDFW) reserves and wildlife areas, a California Department of Parks and Recreation park, a county park, and a property held for conservation purposes by a land trust.

2A.49.2.2 Distribution and Status in the Plan Area

Ten extant occurrences are known in the Plan Area, mostly around the edges of northern Suisun Marsh between the marsh plain and the uplands (Figure 2A.49-2) (California Department of Fish and Game 2012b; U.S. Fish and Wildlife Service 2009). These occurrences are on lands managed by CDFW (Grizzly Island and Hill Slough Wildlife Areas) and Solano Land Trust (Spring Branch Marsh Restoration Site in Rush Ranch Open Space Reserve), and in private ownership.

An additional occurrence near Martinez has been extirpated, and two additional occurrences are possibly extirpated, including a single, unvouchered occurrence, reported in Sacramento County along the north bank of the San Joaquin River immediately west of the Antioch Bridge, and last observed in 1972 at a site that is now riprapped shoreline (California Department of Fish and Game 2012b).

Information on numbers of plants in the Plan Area is limited. Only four occurrences have population size estimates, and at three occurrences, the estimates are in the range of several thousand; the population is declining at two of these occurrences and increasing at one (California Department of Fish and Game 2012b).

2A.49.3 Habitat Requirements and Special Considerations

Soft bird's-beak grows at the upper margin of tidal brackish high marshes in the San Francisco Estuary, often near the upper marsh–upland boundary (Grewell 2005; Grewell et al. 2007). Where the topography is relatively uniform, soft bird's-beak is distributed in bands at the upper margin of the brackish high marsh. In Suisun Marsh these bands are not correlated with elevation, but with soil pore water salinity during the dry season, which is determined by distance to channel and varies from season to season depending on freshwater flows from creeks draining into the marsh (Culberson 2001). Where the topography is more complex, such as areas with ridges or mounds and on levee banks, soft bird's-beak can be found in a variety of patch shapes (Grewell 2005; Grewell et al. 2007). Plant distribution is influenced by a number of factors, including the existence of a persistent seed bank, the dispersal and germination dynamics of its floating seed, the extent of bare soil where seedlings can establish, the presence of appropriate long-lived annual or perennial host species, and the absence of dense populations of large, perennial, nonnative plant species (Grewell et al. 2003; Grewell 2005; Grewell et al. 2007). The presence of a natural tidal inundation pattern is important and the more muted the tidal influence is, such as tidal creeks with salt water exclusion gates or marshes with extensive levee systems, the less suitable the habitat is for soft bird's-beak (Grewell et al. 2003; Grewell 2005; Grewell et al. 2007). A number of hypotheses have been suggested to explain the effects of the muted tidal influence, including increased rates of seed predation and herbivory by native insects, high densities of inappropriate host species such as nonnative annual plants, and invasion and displacement by large nonnative plant species such as perennial pepperweed (*Lepidium latifolium*) (Grewell 2005).

Frequent plant associates include pickleweed (*Salicornia pacifica,* formerly *Salicornia virginica* or *Sarcocornia*), saltgrass (*Distichlis spicata*), salt marsh dodder (*Cuscuta salina*), and spearscale (*Atriplex prostrata*) (Baye et al. 2000; Grewell 2005; Grewell et al. 2007).

Recent research in an analogous plant community has documented complex positive and negative ecological relationships between the related Point Reyes bird's-beak (*Chloropyron maritimum* subsp. *palustre*) and salt marsh dodder, and population dynamics and community structure (Grewell 2008), but these findings have not been extended to soft bird's-beak.

2A.49.4 Life History

Soft bird's-beak is a 4- to 16-inch-(10- to 40-centimeter-) tall annual herb in the broomrape family (Orobanchaceae). Previously, it had been assigned to the figwort family (Scrophulariaceae). All species of *Chloropyron* are hemiparasites: root parasites that have chlorophyll and photosynthesize but also draw nutrients from the host plant through modified roots systems (Wetherwax and Tank 2012). Species of *Chloropyron* are not host-specific, and can parasitize a range of host plants. Emerging seedlings depend for survival on finding a suitable host plant and establishing a root connection on a host that will live until the bird's-beak has produced seed (U.S. Fish and Wildlife Service 2009). Native summer perennial and annuals are suitable hosts, whereas nonnative winter annual grasses such as sickle grass (*Hainardia cylindrica*) and rabbitsfoot grass (*Polypogon monspeliensis*) are inappropriate hosts—their roots are readily parasitized by soft bird's beak seedlings, but they complete their lifecycle and die in mid- to late spring, causing premature death of the hemiparasite seedling.

Soft bird's-beak flowers from July to November (California Native Plant Society 2012; Wetherwax and Tank 2012). It is out-crossing and pollinators appear to include a range of native bee species (Grewell 2005). Its seeds can float for long periods in fresh or salt water and are dispersed by water, which is likely to aid its spread and establishment in gaps in the salt marsh vegetation community (Grewell 2005). Seed germination responds to variable environmental factors, and the complex interactions between seed germination requirements, the availability of bare soil for seedling establishment, and the presence or absence of appropriate host species contribute to large annual fluctuations in population sizes (Grewell 2005). Soft bird's-beak has a persistent seed bank that is important to long-term population persistence—it can even disappear in poor years, reappearing when conditions improve (Grewell 2005).

2A.49.5 Threats and Stressors

Threats to the subspecies include the destruction of habitat, erosion, the elimination or muting of tidal regimes, overgrazing and trampling by livestock, rooting by feral pigs, invasion of habitat by nonnative annual plants that are inappropriate hosts, recent invasion of its habitat by perennial pepperweed (*Lepidium latifolium*), alteration of salinity regimes, mosquito abatement, and oil spills (California Department of Fish and Game 2012b; California Native Plant Society 2012; Fiedler et al. 2007; Grewell et al. 2003; Grewell 2005; U.S. Fish and Wildlife Service 2009). Trampling and disturbance by cattle, feral pigs, and human foot traffic can directly damage plants and also damage the fragile root connections between soft bird's-beak and the host plants (U.S. Fish and Wildlife Service 2009). Seed predation by moth larvae is an important factor in population declines at sites in Suisun Marsh (62 FR 61916.). The moth larvae spend part of their life cycle buried in sediment, and under muted tidal regimes, survival of the moth larvae appeared to be enhanced, in turn increasing seed predation on soft bird's-beak (Grewell et al. 2003).

2A.49.6 Relevant Conservation Efforts

Soft bird's-beak occurs on a number of state and federal agency lands where it is protected from development but sometimes is affected by lawful site use and management activities: Benicia State Recreation Area (California Department of Parks and Recreation), Rush Ranch Open Space Reserve (Solano Land Trust), Fagan Marsh Ecological Reserve, Hill Slough Wildlife Area, and Grizzly Island Wildlife Area (CDFW), and Concord Naval Weapons Station (U.S. Department of Defense) (Grewell 2005; 72 FR 18517; U.S. Fish and Wildlife Service 2009; California Department of Fish and Game 2012b).

At the Rush Ranch site in Suisun Marsh, marsh restoration was coupled with the experimental reintroduction of soft bird's-beak by seeding in 2000 (Grewell et al. 2003; Grewell 2005). In the short term, the population grew exponentially for 4 years, but long-term success is unclear because the 2004 census reported a substantial drop in seed production for the 2004 cohort (Grewell 2005).

In addition to the experimental reintroduction, surveys and research were conducted at Rush Ranch Open Space and Benicia State Recreation Area to provide ecological and demographic data to inform habitat management efforts aimed at conserving and recovering soft bird's-beak (Grewell 2005).The aim of the population census was to determine current distribution and population size, standardize historical population data, and analyze population trends. The aim of the demographic monitoring was to evaluate threats to critical life stages, diagnose causes of population performance, and refine a life cycle model for conservation. This study highlighted the need for invasive plant control and restoration of historical tidal regimes and brackish marsh habitat. A control plan for perennial pepperweed is being developed by Solano Land Trust for implementation at Rush Ranch.

The Blacklock Restoration Project, which is the first tidal restoration project implemented by the Suisun Marsh Charter agencies in Suisun Marsh (a range of federal, state, and local agencies), created 70 acres of tidal marsh along Little Honker Bay. These agencies are preparing the *Suisun Marsh Habitat Management, Preservation and Restoration Plan* (75 FR 66780), a 30-year plan designed to address the various conflicts regarding use of marsh resources within about 60,000 acres of wetlands, with the focus on achieving an acceptable multiple-stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands and their functions.

In 2002, Concord Naval Weapons Station prepared an *Integrated Natural Resource Management Plan* that includes protection of soft bird's-beak and its habitat, which it is now being implemented (Tetra Tech 2002). In November 2005, the Inland Area of the base was approved for closure, but the Tidal Area remains in operation as a port under the command of the U.S. Army.

Soft bird's-beak is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), which includes a Coastal Marsh Natural Community Conservation Strategy designed to maintain water and sediment quality standards, hydrology and ecological functions, and contribute to the restoration of tidally influenced coastal marsh habitat, as well as a specific conservation measure to salvage and recover populations of soft bird's-beak affected by covered activities.

2A.49.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.49.7.1 Habitat Model Description

The modeled habitat for soft bird's-beak consisted of pickleweed- and saltgrass-dominated vegetation located west of the Antioch Bridge. To isolate habitat in and near Suisun Marsh the model used all Tidal Brackish Emergent Wetland polygons from the San Francisco Estuary Institute (2005) that were limited by specific CDFW vegetation units of Boul and Keeler-Wolf (2008) that are known to be closely associated with soft bird's-beak habitat.

The following vegetation subunits were selected from the BDCP vegetation dataset to represent soft bird's-beak habitat in the Delta.

- *Distichlis spicata*–annual grasses
- *Distichlis spicata–Salicornia virginica* (currently known as *Salicornia pacifica*)
- Pickleweed (*Salicornia virginica*)
- *Salicornia virginica–Cotula coronopifolia*
- *Salicornia virginica–Distichlis spicata*

The following vegetation subunits were selected from the BDCP vegetation dataset to represent habitat in Suisun Marsh.

- Tidal brackish emergent marsh
    - *Atriplex triangularis* (currently known as Atriplex prostrata)
    - *Atriplex triangularis* (generic)
    - *Atriplex*/annual grasses
    - *Atriplex*/*Distichlis*
    - *Distichlis* (generic)
    - *Distichlis spicata*
    - *Distichlis spicata*–annual grasses
    - *Distichlis spicata–Salicornia pacifica (*formerly known as *Sarcocornia* or *Salicornia virginica)*
    - *Distichlis–Juncus–Triglochin–Glaux*
    - *Distichlis*/annual grasses
    - *Distichlis*/*Cotula*
    - *Distichlis*/*Juncus*
    - *Distichlis*/*Lotus*
    - *Distichlis*/*S. americanus*
    - *Distichlis*/*S. maritimus*

- *Distichlis*/*Salicornia*
- *Lepidium* (generic)
- *Lepidium*/*Distichlis*
- Pickleweed (*Salicornia virginica*) *Salicornia* (generic)
- *Salicornia pacifica*
- *Salicornia pacifica*–*Cotula coronopifolia*
- *Salicornia pacifica*–*Distichlis spicata*
- *Salicornia*/annual grasses
- *Salicornia*/*Atriplex*

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the following natural communities, and vegetation alliances where the information was available, were assumed to provide soft bird's-beak habitat.

Areas mapped within 3 meters of tidal perennial aquatic habitat comprise the following natural community types.

- Alkali seasonal wetland complex
- Grassland
  - Pasture
  - Upland annual grasslands and forbs formation
- Managed wetland
  - *Crypsis* spp.–wetland grasses–wetland forbs not formally defined (NFD) super alliance
  - Vernal pools

Areas mapped within 3 meters from landward edge comprise the following natural community types.

- Tidal perennial aquatic
  - Tidal perennial aquatic–water

Areas mapped within 3 meters from tidal perennial aquatic comprise the following natural community types.

- Vernal pool complex

2A.49.7.2 Assumptions

- **Assumption:** Soft bird's beak habitat is restricted to the vegetation types described in Section 2A.49.7.1, *Habitat Model Description*.

  Rationale: Historical and current records of this species indicate that the distribution of soft bird's-beak is limited to areas west of Antioch Bridge (Figure 2A.49-2) (California Department of Fish and Game 2012b). A geographic information system (GIS) constraint layer was developed to limit suitable habitat to this area. Soft bird's-beak grows at the upper margin of tidal brackish high marshes in the San Francisco Estuary (Baye et al. 2000; Grewell 2005; Grewell et al. 2007). Where the topography is relatively uniform, soft bird's-beak is generally distributed in bands in the Transition zone into the Marsh Plain zone. Where the topography is more complex, such as along tidal creeks, areas with some relief such as ridges or mounds, and on levees, soft bird's-beak can be found in a variety of patch shapes (Grewell 2005; Grewell et al. 2007). Frequent plant associates include pickleweed, saltgrass, salt marsh dodder, and spearscale (Baye et al. 2000; Grewell 2005; Grewell et al. 2007).

- **Assumption:** Soft bird's beak habitat is geographically constrained to a 10-foot-wide (3-meter-wide) buffer on the landward side of the landward boundaries of the tidal freshwater emergent wetland land and tidal brackish emergent wetland contained within the 7- to 10-foot (2- to 3-meter) elevation in Suisun Marsh.

  Rationale: This buffer on the landward side represents marsh within the elevational band at which the species is typically found.

2A.49.8 Recovery Goals

Soft bird's-beak is federally listed as endangered, and is included in the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (U.S. Fish and Wildlife Service 2010). The plan's objectives are as follows.

- Secure self-sustaining wild populations of each covered species throughout its full ecological, geographical, and genetic range.
- Ameliorate or eliminate, to the extent possible, the threats that caused the species to be listed or of concern and any future threats.
- Restore and conserve a healthy ecosystem function supportive of tidal marsh species.

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designation for soft bird's-beak is Recovery (CALFED Bay-Delta Program 2000) meaning that the program has established a goal to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

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2A.49.9.2 Federal Record Notices Cited

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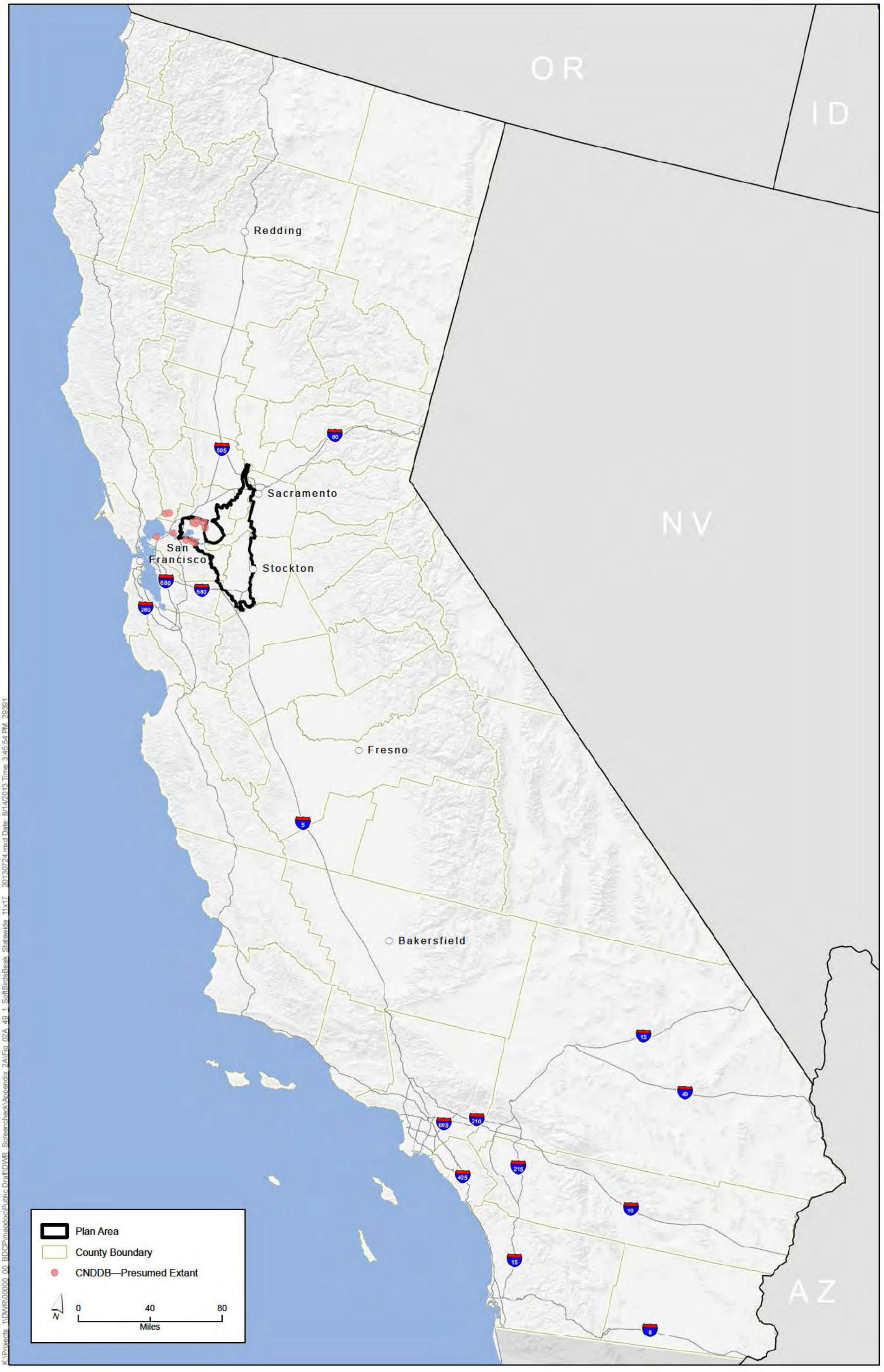
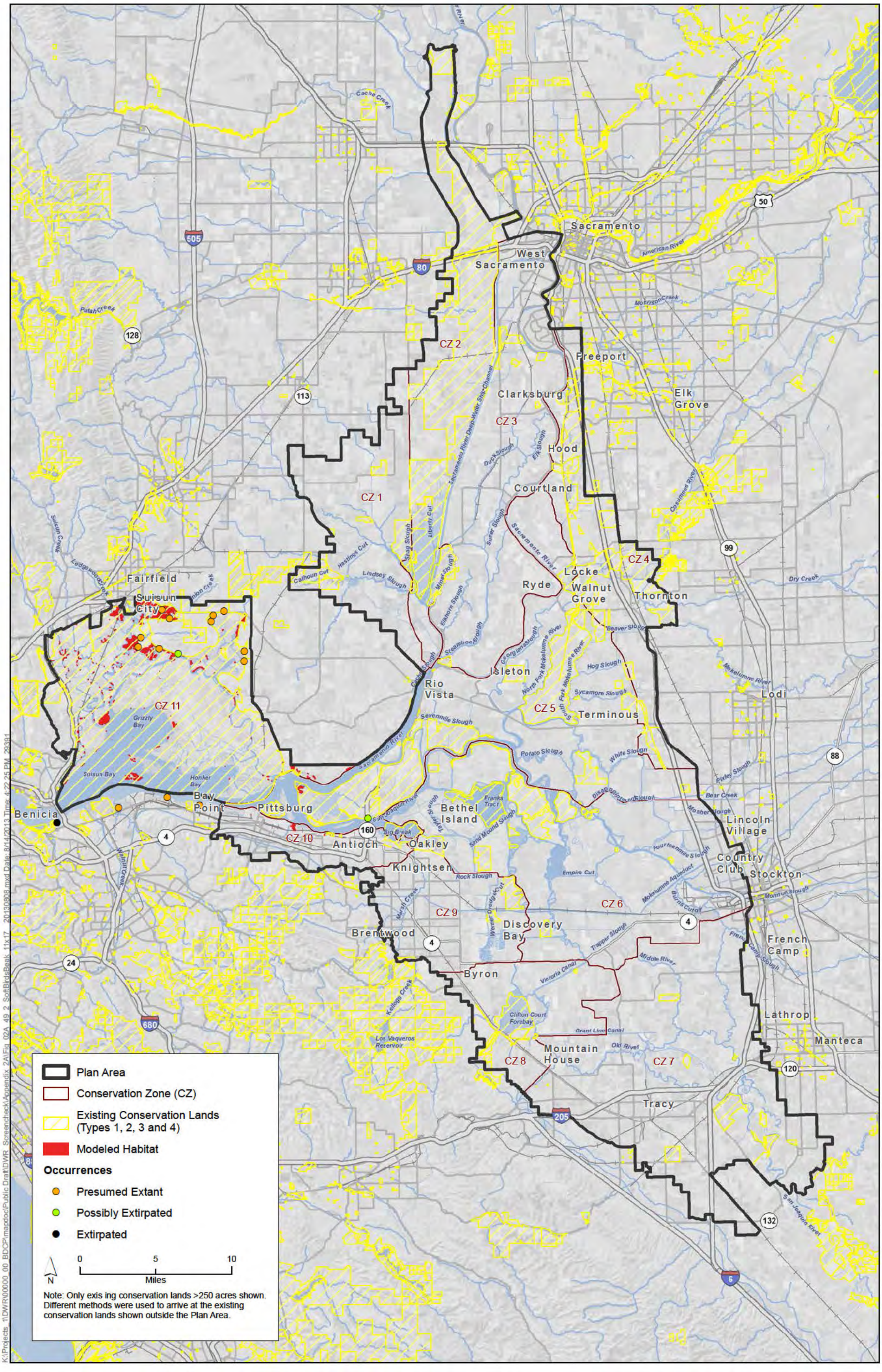


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.49-1
Soft Bird's Beak Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.49-2
Soft Bird's Beak Habitat Model and Recorded Occurrences

Appendix 2A.50

Suisun Thistle (*Cirsium hydrophilum* var. *hydrophilum*)

2A.50.1 Legal Status

Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) is listed as endangered under the federal Endangered Species Act (November 1997; 62 *Federal Register* [FR] 61916). It is not listed under the California Endangered Species Act. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G1T1/S1, which means that globally (G) both the species and this particular variety (T) are critically imperiled and within the state (S) this variety is critically imperiled, meaning it is at high risk for extinction as a result of restricted range, very few populations and steep decline (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.1 for Suisun thistle indicates that it is rare, threatened, or endangered in California and elsewhere. Its state threat level (.1) indicates that it is seriously endangered in California (California Department of Fish and Game 2012a). Plants with a rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

The. S. Fish and Wildlife Service (USFWS) designated critical habitat for Suisun thistle in three areas of Suisun Marsh (April 2007; 72 FR 18517). Suisun thistle was not known to occur in Unit 1 (Hill Slough Marsh) when that unit was designated, although it had all the necessary habitat features. The species was subsequently discovered there in 2007 (California Department of Fish and Game 2012a). Unit 2, Peytonia Slough Ecological Reserve and Unit 3, Rush Ranch/Grizzly Island Wildlife Area, contain or did contain Suisun thistle populations at the time of the listing.

In the most recent 5-year review, USFWS recommended the continuation of endangered status for Suisun thistle (U.S. Fish and Wildlife Service 2009).

2A.50.2 Species Distribution and Status

2A.50.2.1 Range and Status

Suisun thistle is endemic to Suisun Marsh in Solano County, California (62 FR 61916; U.S. Fish and Wildlife Service 2009) (Figure A.50-1). In 1975, Suisun thistle was presumed to be extinct because it had not been observed for 15 years (62 FR 61916; U.S. Fish and Wildlife Service 2003, 2009); however, extensive surveys in 1989 rediscovered Suisun thistle on Grizzly Island (Figure A.50-2) (California Native Plant Society 2012). It currently occurs in a very small area, less than 4 miles across, in the northern portion of Suisun Bay. The four known occurrences are in existing conservation lands on lands managed by the California Department of Fish and Wildlife (CDFW) (Peytonia Slough Ecological Reserve, Hill Slough Wildlife Area, and the Joice Island Unit of the Grizzly Island Wildlife Area) and on private conservation lands (Rush Ranch Open Space) (California Department of Fish and Game 2012b).

Thousands of plants were observed at Rush Ranch in 2003 (Fiedler et al. 2007), but much smaller numbers have been observed at the other occurrences (California Department of Fish and Game 2012b). The population at the Peytonia Slough Ecological Reserve had declined to a single plant in 1996, and the population may have been extirpated by an arson fire in 2001 (U.S. Fish and Wildlife Service 2003, 2009).

2A.50.2.2 Distribution and Status in the Plan Area

All four occurrences of Suisun thistle are located in the Plan Area. No additional occurrences were found during surveys conducted in 2009, 2010, and 2011 for the BDCP (Delta Habitat Conservation and Conveyance Program 2011).

2A.50.3 Habitat Requirements and Special Considerations

Suisun thistle is restricted to the brackish tidal marshes of Suisun Marsh (62 FR 61916; U.S. Fish and Wildlife Service 2009), specifically in relict, undiked, high tidal marshes (fully tidal, emergent estuarine marshes), and is almost always found along first-order channels or mosquito control ditches that link to first-order channels (Fiedler et al. 2007; U.S. Fish and Wildlife Service 2009). This habitat restriction is likely due to its low tolerance for soil salinity and possibly a preference for soils with less organic matter content. The Rush Ranch area of Suisun Marsh has been studied to determine how biological and physical factors interact in marshes around the mean high water elevation (Culberson 2001; Culberson et al. 2004). The studies identified patterns of salinity and organic matter accumulation that help explain the position of Suisun thistle within the marsh habitat. The primary factor driving this correlation was found to be soil pore water salinity. The salinity of the water in the channel water and streamside soil pore water was generally 2 to 5 parts per thousand with a nonlinear increase with distance from the channel to approximately 15 parts per thousand in the plain 131 feet (40 meters) from the channel. The study also found that below-ground accumulation of organic carbon was the likely cause of the gradual increase in elevation (30 centimeters) from streamside to 230 feet (70 meters) out in the plain.

Associated plant species include salt grass (*Distichlis spicata*), Oregon gumweed (*Grindelia stricta*), marsh jaumea (*Jaumea carnosa*), triangle orache (*Atriplex prostrata*, formerly A*. triangularis*), Baltic rush (*Juncus balticus* subsp. *ater*), perennial pepperweed (*Lepidium latifolium*), silverweed (*Potentilla anserina* subsp. *pacifica*), curly dock (*Rumex crispus*), pickleweed (*Salicornia pacifica,* formerly *Salicornia virginica* or *Sarcocornia*), cattails (*Typha* spp.), common threesquare (*Schoenoplectus americanus*), hedge false bindweed (*Calystegia sepium*), and wild celery (*Apium graveolens*) (California Department of Fish and Game 2012b).

2A.50.4 Life History

Suisun thistle is a large (3- to 4.5-feet-[1- to 1.5-meter-]) tall biennial or short-lived perennial herb in the sunflower family (Asteraceae) (Keil 2012). Its stems are erect, slender, and branched above the middle (Keil 2012; U.S. Fish and Wildlife Service 2003). Suisun thistle leaves are spiny and deeply lobed; lower leaves have ear-like basal lobes, and upper leaves are reduced to narrow strips

with strongly spine-toothed margins (62 FR 61916; U.S. Fish and Wildlife Service 2003). It blooms from June to September (California Native Plant Society 2012). The inflorescences are pale lavender-rose in color, about 1 inch (2.5 to 3 centimeters) in length, and grow singly or in loose groups (Keil 2012). Flower head bracts have a distinct green, glutinous ridge on the back that distinguishes Suisun thistle from other *Cirsium* species in the area (62 FR 61916). It is monocarpic, meaning that the plant dies after flowering. The flowers are probably insect pollinated, like many other thistles. The small seeds have a pappus (Keil 2012), an adaptation for wind dispersal.

2A.50.5 Threats and Stressors

Historically, the marsh habitat suitable for Suisun thistle has been lost mostly through development, dredge disposal, agricultural conversion, and diking. Diked marshes generally lack rare tidal marsh species. It is believed that the conditions brought about by dikes favor robust generalist species that can better tolerate the long inundation periods in diked managed wetlands (Goals Project 2000).

Currently, the major threats to Suisun thistle are the nonnative and highly invasive perennial pepperweed and habitat destruction by feral pigs, and perhaps fire during sensitive periods of the species' lifecycle (Fiedler et al. 2007). Perennial pepperweed invades the streamside and transition zone, forming dense monoculture that displaces native vegetation, and by 2003, it had had invaded 85 percent of the Suisun thistle population (Fiedler et al. 2007). The extensive soil disturbance and plant damage caused by feral pigs is considered a serious threat (Culberson 2001; Fiedler et al. 2007; U.S. Fish and Wildlife Service 2009).

Other potential but unquantified threats include hybridization with the nonnative bull thistle (*Cirsium vulgare*) and seed predation by the thistle weevil (*Rhinocyllus conicus*) introduced to control nonnative invasive thistle species (Fiedler et al. 2007).

2A.50.6 Relevant Conservation Efforts

The CDFW provides some protection for Suisun thistle populations at Grizzly Island Wildlife Area and Peytonia Slough Ecological Reserve (California Native Plant Society 2012).

The Blacklock Restoration Project is the first tidal restoration project implemented by the Suisun Marsh Charter agencies in Suisun Marsh (a range of federal, state, and local agencies), and it created 70 acres of tidal marsh along Little Honker Bay. These agencies are preparing the *Suisun Marsh Habitat Management, Preservation and Restoration Plan*, a 30-year plan designed to address the various conflicts regarding use of marsh resources in about 60,000 acres of wetlands, with the focus on achieving an acceptable multiple stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands and their functions (Bureau of Reclamation et al. 2010).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the Suisun thistle as a Recovery species (CALFED Bay-Delta Program 2000). This means that the program has established a goal to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

Suisun thistle is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009), which includes a Coastal Marsh Natural Community Conservation Strategy designed to maintain water and sediment quality standards, hydrology and

ecological functions, and contribute to the restoration of tidally influenced coastal marsh habitat, as well as a specific conservation measure to salvage and recover populations of Suisun thistle affected by covered activities.

2A.50.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.50.7.1 Habitat Model Description

The modeled habitat for Suisun thistle in and near Suisun Marsh consists of all tidal brackish emergent wetland polygons with the appropriate vegetation (San Francisco Estuary Institute 2005; Boul and Keeler-Wolf 2008).

The following vegetation subunits were selected from the tidal brackish emergent wetland natural community:

- *Atriplex triangularis*
- *Atriplex triangularis* (generic)
- *Atriplex*/annual grasses
- *Atriplex*/*Distichlis*
- *Distichlis* (generic)
- *Distichlis spicata*
- *Distichlis spicata*–annual grasses
- *Distichlis spicata*–*Salicornia pacifica* (formerly *Salicornia virginica* or *Sarcocornia*)
- *Distichlis*–*Juncus*–*Triglochin*–*Glaux*
- *Distichlis*/annual grasses
- *Distichlis*/*Cotula*
- *Distichlis*/*Juncus*
- *Distichlis*/*Lotus*
- *Distichlis*/*S. americanus*
- *Distichlis*/*S. maritimus*
- *Distichlis*/*Salicornia*
- *Lepidium* (generic)
- *Lepidium*/*Distichlis*
- Pickleweed (*Salicornia pacifica*)
- *Salicornia* (generic)
- *Salicornia pacifica*

- *Salicornia pacifica–Cotula coronopifolia*
- *Salicornia pacifica–Distichlis spicata*
- *Salicornia*/annual grasses
- *Salicornia*/*Atriplex*

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the tidal brackish emergent wetland natural community was assumed to provide Suisun thistle habitat.

2A.50.7.2 Assumptions

- **Assumption:** Suisun thistle habitat is geographically constrained to the Suisun Marsh.

  Rationale: Suisun thistle is endemic to Suisun Marsh and is found primarily away from the main channels that are dominated by large emergent wetland species.

2A.50.8 Recovery Goals

Suisun thistle is federally listed as endangered, and is included in the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (U.S. Fish and Wildlife Service 2010). The plan's objectives are as follows:

- Secure self-sustaining wild populations of each covered species throughout their full ecological, geographical, and genetic range.
- Ameliorate or eliminate, to the extent possible, the threats that caused the species to be listed or of concern and any future threats.
- Restore and conserve a healthy ecosystem function supportive of tidal marsh species.

Additionally, the CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the Suisun thistle as a Recovery species (CALFED Bay-Delta Program 2000). This means that the program has established a goal to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

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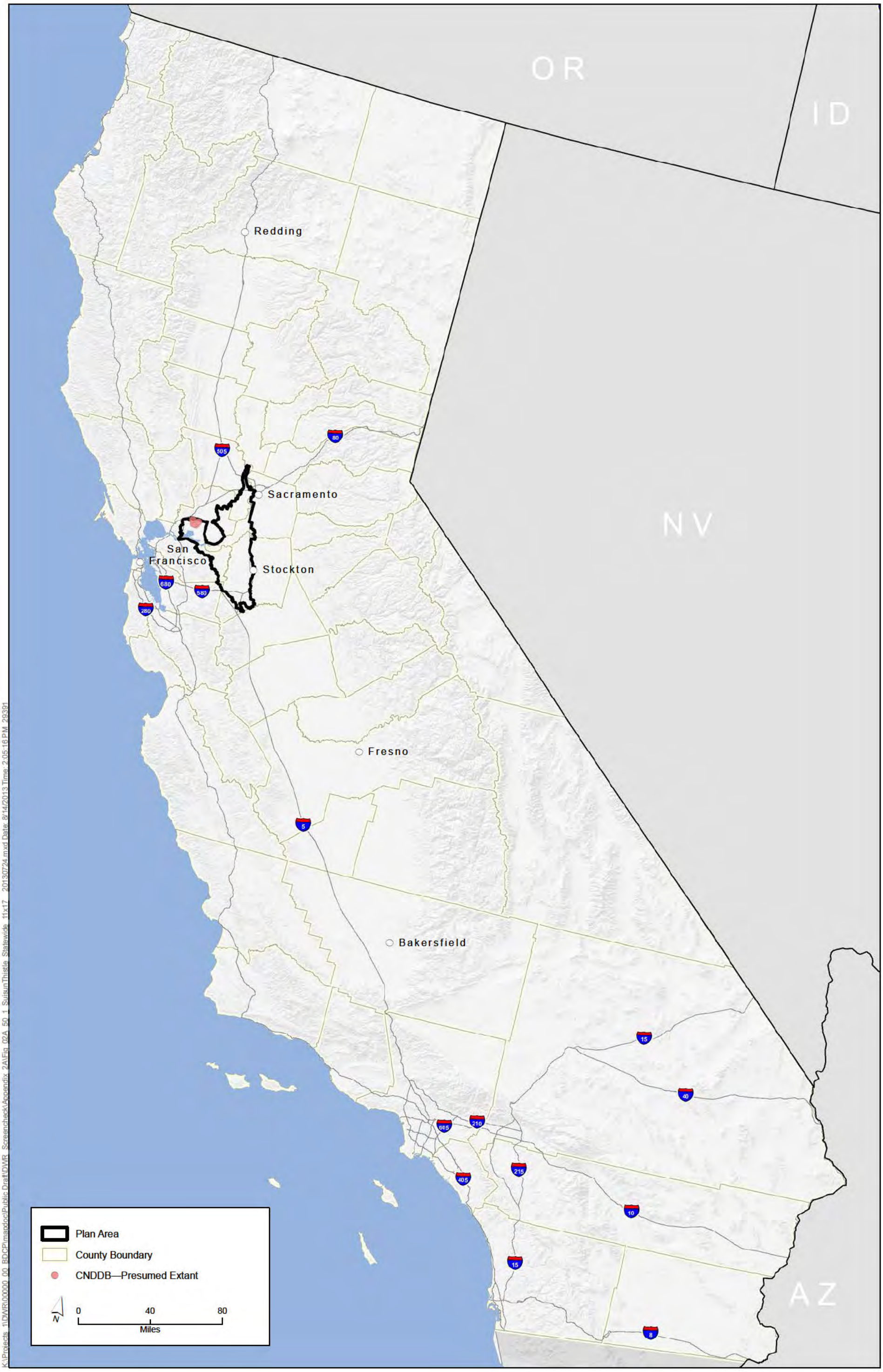
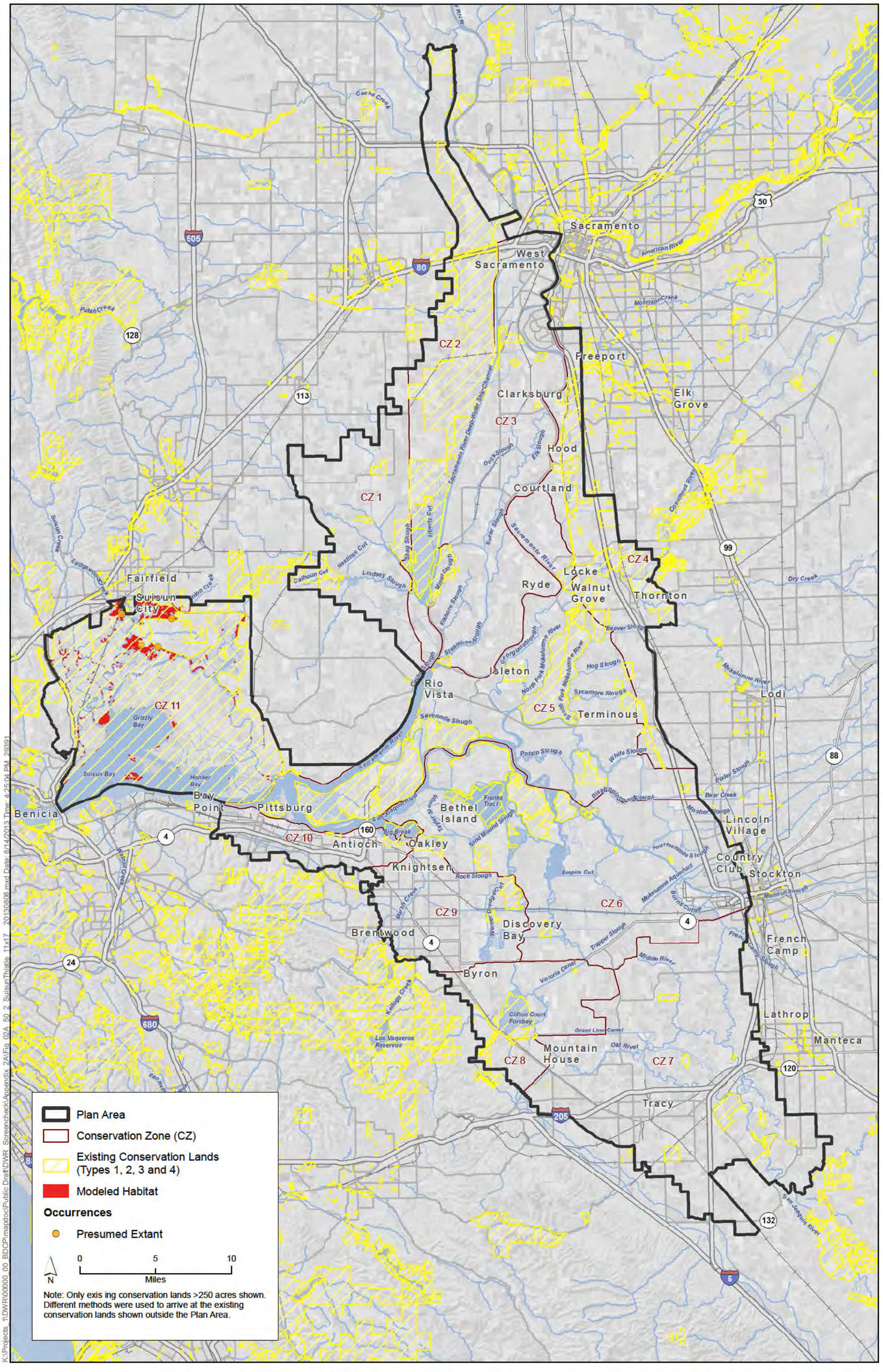


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.50-1
Suisun Thistle Statewide Range and Recorded Occurrences



K:\Projects 1\DWR\00000_00 BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix 2A\Fig 02A_50_2 SuisunThistle 11x17 20130808.mxd Date: 8/14/2013 Time: 4:25:04 PM 29391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences CNDDB June 2013.

Figure 2A.50-2
Suisun Thistle Habitat Model and Recorded Occurrences

Appendix 2A.51
Alkali Milk-Vetch (*Astragalus tener* var. *tener*)

2A.51.1 Legal Status

Alkali milk-vetch (*Astragalus tener* var. *tener*) is not listed under either federal or California Endangered Species Acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2T2/S2, which means that globally (G) and within the state (S) both the species and variety (T) are imperiled and are at high risk for extinction as a result of restricted range, very few populations and steep decline (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for alkali milk-vetch indicates that it is rare, threatened, or endangered in California and elsewhere. Its state threat level (.2) indicates that it is somewhat endangered in California. Plants with a rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.51.2 Species Distribution and Status

2A.51.2.1 Range and Status

Alkali milk-vetch is endemic to California. The current range of alkali milk-vetch comprises the Southern Sacramento Valley, northern San Joaquin Valley, and east San Francisco Bay Area, extending from Napa, Solano, and Yolo Counties in the north, to Merced County in the south, to Alameda County in the west (Figure 2A.51-1). A total of 68 occurrences are known (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). Sixteen of the known extant occurrences are in the Solano-Colusa Vernal Pool Region of Solano County (Keeler-Wolf et al. 1998), and another five are located in an area between Newman, Merced, and Los Banos in the San Joaquin Vernal Pool Region of Merced County (Silveira 1996 as cited in U.S. Fish and Wildlife Service 2005; California Department of Fish and Game 2012b).

Historically, alkali milk-vetch was widely distributed around the San Francisco Bay region and in the Sacramento and northern San Joaquin Valleys as far south as Monterey and San Benito Counties (Barneby 1964), but by 1989 only a few populations remained (Liston 1992). A 1990 survey of historical collection sites in Yolo and Solano Counties found six plants at the City of Woodland Preserve and six small populations at the Jepson Prairie Preserve (Witham 1990). A 2002 survey concluded that 25 of the 65 known occurrences should be considered to be extirpated (Witham 2002). Currently, 28 of the 68 known occurrences are considered to be extirpated or possibly extirpated, and another six occurrences have not been observed in the past 20 years (California Department of Fish and Game 2012a).

2A.51.2.2 Distribution and Status in the Plan Area

In the Plan Area there are 16 extant occurrences, mostly in the Jepson Prairie and Yolo Bypass areas (Figure 2A.51-2). Small groups of up to 20 plants were found on suitable habitat on the Tule Ranch (Witham 2003). It has been observed 0.25 mile south of Saxon Station on the western edge of the Yolo Bypass on the Yolo Bypass Wildlife Area. To the west, it was observed growing in clay soils west of Bunker Station. To the south, multiple occurrences are recorded in vernally wet grassland in the Jepson Prairie Preserve. Further south, in the Suisun Marsh area, it was observed in an alkaline vernal pool in the Montezuma Wetlands Restoration Project. On the southwest edge of the Plan Area, it has been observed in alkaline grassland vegetation northwest of the junction of Byron Hot Springs Road and Armstrong Road. A population observed in the Stockton area near Smith Canal is believed to be extirpated. (California Department of Fish and Game 2012b).

During the 2010 and 2011 field surveys for the BDCP, three new occurrences of alkali milk-vetch were found in disturbed vernal pools west of Clifton Court Forebay: in 2010, six stands were located, ranging from 1 to 40 plants. In 2011, 25 stands were located, ranging from 1 to 250 plants (Delta Habitat Conservation and Conveyance Program 2011).

2A.51.3 Habitat Requirements and Special Considerations

Little is known about the ecology of alkali milk-vetch. In the Central Valley, it appears to be restricted to alkaline soils in areas that are, or were, historically subject to flooding and overland flows (Silveira 2000; Witham 2003; Environmental Science Associates and Yolo County Planning & Public Works Department 2005). In the former Air Force communications facility site at the Yolo Grasslands Park in Yolo County, it is found growing on the ryegrass (*Festuca perennis*, formerly *Lolium multiflorum*)-dominated floodplains above the upper margins of vernal pools and swales that contain the listed Solano grass (*Tuctoria mucronata*) and Colusa grass (*Neostapfia colusana*) (Environmental Science Associates and Yolo County Planning & Public Works Department 2005). All individuals at that site were found in areas that had been subjected to a prescribed burn that subsequently flooded briefly in February (Environmental Science Associates and Yolo County Planning & Public Works Department 2005). In two subsequent years, the same area burned due to arson fires and also flooded during the winter, but only a few individuals were detected during the following spring, in contrast to the large population that became established after the prescribed burn (Gerlach pers. comm.). At the Tule Ranch site in the Yolo Bypass, alkali milk-vetch is found in vernally mesic grasslands dominated by annual ryegrass and associated with alkaline vernal pools (Witham 2003). In the occurrences near the City of Woodland and along the Willow Slough Bypass in Yolo County, it is found in areas that were once alkali sink vegetation but which were converted to rice fields and then fallowed for many years or which were converted into a levee system (Andrews 1970; Crampton 1979; Showers 1988, 1996; EIP Associates 1998; Foothill Associates 2002). In the greater Jepson Prairie area it grows in vernal pool grassland that is dominated by annual ryegrass (Witham 2006).

The populations southeast of the city of Woodland and north of the city of Davis are in an area greatly affected by human activities. This area historically was alkaline sink vegetation lying along both sides of the north channel of Putah Creek and Willow Slough and above the Yolo Basin (U.S. Bureau of Soils 1909a, 1909b; Mann et al. 1911). The hydrology, salts, and clay soils that

created and maintained the alkaline sink vegetation were deposited when floodwaters from Putah Creek flowed northward from the area near the City of Davis and emptied into Willow Slough. That flow was also supplemented when the combined floodwaters of Putah Creek, Cache Creek, and all of the drainages of the Blue Ridge filled the Cache/Putah Basin, drained eastward through a gap in the Plainfield Ridge, and flowed into the Yolo Basin through Willow Slough (Graymer et al. 2002). This area has also been heavily invaded by annual ryegrass (Dawson et al. 2007).

There are few data documenting the population trends of alkali milk-vetch. Because most of the recent observations of individuals have been at sites where it was previously considered extirpated, it appears that those individuals have established from long-lived seed banks. A large multiple-year survey of California's vernal pool vegetation found that alkali milk-vetch was the most variable rare taxon in terms of occurrence and only appeared once during the 5-year study at a very low cover value (1%) (Buck 2004; Barbour et al. 2007).

2A.51.4 Life History

Alkali milk-vetch is a 2- to 16-inch (4- to 40-centimeter)-tall herbaceous annual plant in the pea family (Fabaceae) . It is differentiated from Ferris' milk-vetch (*Astragalus tener* var. *ferrisiae*) based on the morphology of its fruits (Liston 1990, 1992). Alkali milk-vetch has short, stout, strongly curved pods (Witham 2003). The leaves of alkali milk-vetch are 1 to 3 inches (2 to 9 centimeters) long, with 7 to 17 pinnately compound, well-separated leaflets. Three to twelve pink-purple, pea-like flowers are arranged in a dense inflorescence and are produced from March to June (California Native Plant Society 2012).

Liston (1992) found alkali milk-vetch capable of self-pollination, but the presence of high levels of genetic diversity in each population indicated that insect pollinators are responsible for maintaining high levels of outcrossing within the populations (Liston 1992). Milk-vetch species are known to produce long-lived seed banks.

The environmental conditions influencing germination of alkali milk-vetch seeds are unknown (U.S. Fish and Wildlife Service 2005). However, a long-lived soil seed bank may be important for the long-term viability of alkali milk-vetch populations. Populations have been rediscovered at locations where mature plants have not been observed for many years, which suggests that viable seed may persist in the soil seed bank. Witham observed that recruitment increased in a population near the Jepson Prairie Preserve after pipeline construction (Witham 1990). Alkali milk-vetch was also observed in an artificially constructed vernal pool near Albrae at a site where no occurrences had been recorded since 1923 (U.S. Fish and Wildlife Service 2005). This importance of such a seed bank is also supported by studies that have found that this species persists across multiple seasons despite the absence of reproductive plants (Buck 2004; Barbour et al. 2007).

2A.51.5 Threats and Stressors

Development, intensive agriculture, and invasive nonnative plant species (especially ryegrass) are considered the primary threats to alkali milk-vetch (Showers 1996; Witham 2003; Environmental Science Associates and Yolo County Planning & Public Works Department 2005; Dawson et al. 2007; California Native Plant Society 2012).

2A.51.6 Relevant Conservation Efforts

Alkali milk-vetch is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005). Alkali milk-vetch is a covered species under the permitted *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009) and the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's Multi-Species Conservation Strategy designates the alkali milk-vetch as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions under its control and within its scope that are necessary to contribute to the recovery of the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

2A.51.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.51.7.1 GIS Model Data Sources

The alkali milk-vetch model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]), aerial imagery (Google 2009), and aerial photography (U.S. Department of Agriculture 2005, 2010). Using these data sets, the model maps the distribution of suitable alkali milk-vetch habitat in the Plan Area according to the species' two habitat types: vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.51.7.2 Habitat Model Description

Modeled habitat for alkali milk-vetch includes vernal pool complex habitat, degraded vernal pool complex habitat, and alkali seasonal wetland complex habitat.

Vernal pool complex habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agriculture or development. Modeled vernal pool complex habitat for alkali milk-vetch consists of the following vegetation subunit that was selected from the BDCP vernal pool complex natural community.

- Vernal pool complex–all vegetation types

Degraded vernal pool complex habitat ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. Modeled degraded vernal pool complex habitat for

alkali milk-vetch includes the following vegetation subunits that were selected from the BDCP vernal pool complex community.

- Vernal pool complex
  - Degraded vernal pool complex–California annual grasslands–herbaceous
  - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
  - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
  - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
  - Degraded vernal pool complex–vernal pools

Modeled alkali seasonal wetland complex habitat for alkali milk-vetch includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the vernal pool complex natural community was assumed to provide alkali milk-vetch habitat.

2A.51.7.3 Assumptions

- **Assumption:** Alkali milk-vetch habitat is restricted to the vegetation types described in Section 2A.51.7.2, *Habitat Model Description*.

  Rationale: Historical and current records of this species in the Plan Area indicate that the current distribution of alkali milk-vetch is limited to alkaline soil areas with vernal pool and swale microtopography along the western border of the Plan Area (Figure 2A.51-2) (Witham 2002, 2003, 2006; Environmental Science Associates and Yolo County Planning & Public Works Department 2005; Baraona et al. 2007; California Department of Fish and Game 2012b). The vegetation cover of the alkaline soils is typically a combination of vernal pool adapted species and ryegrass (Witham 2002, 2003, 2006; California Department of Fish and Game 2012b). Because alkali milk-vetch also frequently occurs in the same habitats as Heckard's peppergrass (Witham 2002, 2003, 2006; California Department of Fish and Game 2012b) and Heckard's peppergrass was discovered in the Stone Lakes area by the 2009 field survey teams (Delta Habitat Conservation and Conveyance Program 2011), alkali milk-vetch's habitat range was extended into areas with vernal pool and swale microtopography along the eastern border of the Plan Area.

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide habitat for alkali milk-vetch.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

2A.51.8 Recovery Goals

Although alkali milk-vetch is not a federally listed plant, it is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005). The recovery plan's goal is to ensure the long-term conservation of this variety and 32 other taxa by using an ecosystem level strategy that is based on current knowledge of the existing conditions of vernal pool communities, the distribution and status of the populations of each of the species, and current and anticipated process that impact vernal pool ecosystems. Because the goal of the recovery plan is primarily directed at habitat preservation, its implementation program specifically addresses factors that relate to habitat acquisition and management:

- Habitat protection
- Adaptive habitat management and monitoring
- Status surveys
- Research
- Public participation

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the alkali milk-vetch as a Contribute to Recovery species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions under its control and within its scope that are necessary to recover the species. Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

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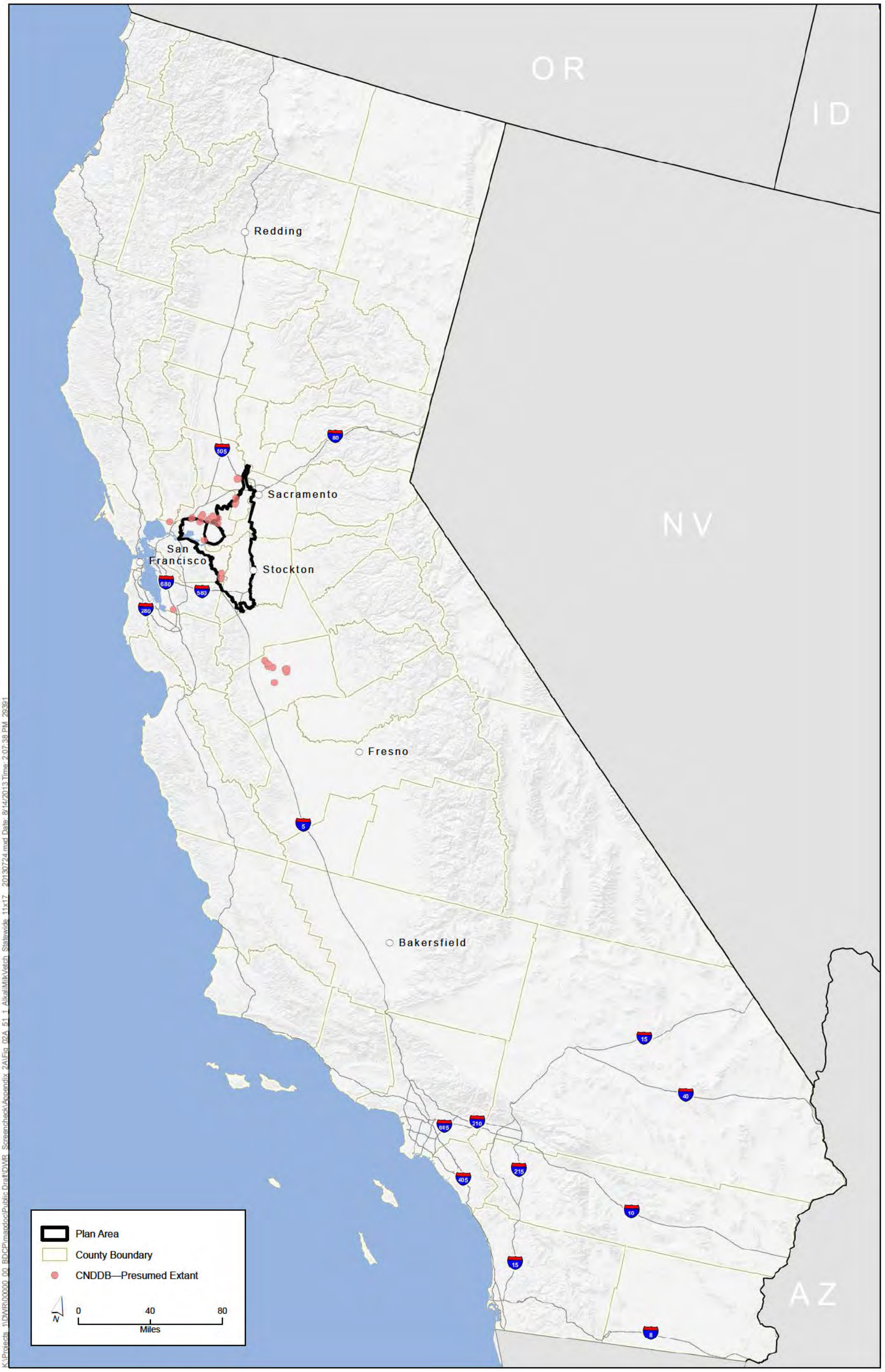
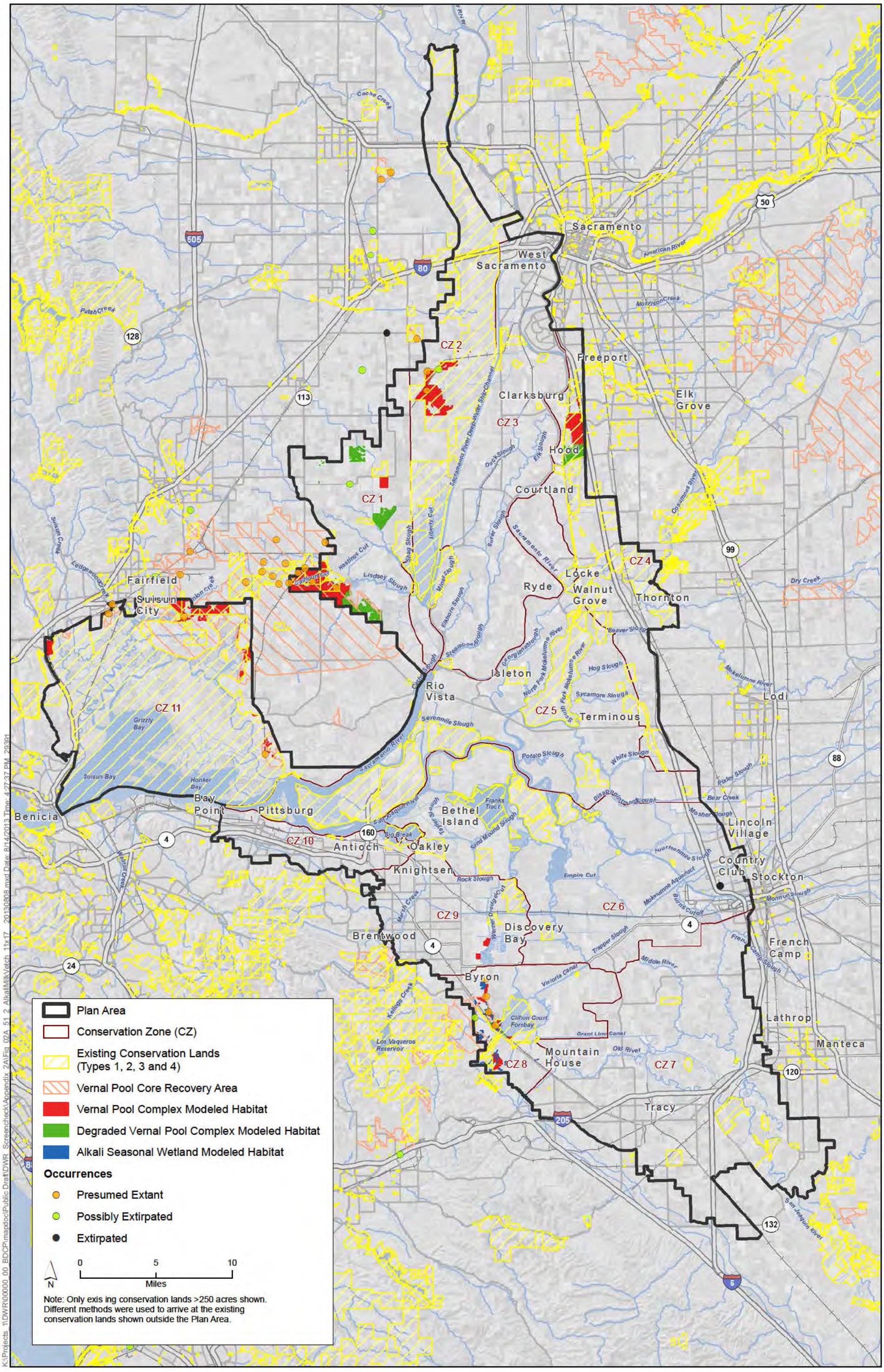


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.51-1
Alkali Milk-Vetch Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences CNDDB June 2013, DHCCP 2009-2011, and Witham 2003.

Figure 2A.51-2
Alkali Milk-Vetch Habitat Model and Recorded Occurrences

Appendix 2A.52
Boggs Lake Hedge-Hyssop (*Gratiola heterosepala*)

2A.52.1 Legal Status

Boggs Lake hedge-hyssop (*Gratiola heterosepala*) is listed as endangered under the California Endangered Species Act (November 1978). It is not listed under the federal Endangered Species Act. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2 which means that both globally (G) and within the state (S) it is considered imperiled, meaning at high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep population declines, or other factors making it vulnerable to extirpation (California Department of Fish and Game 2012a; California Native Plant Society 2012).

The California Rare Plant Rank of 1B.2 for Boggs Lake hedge-hyssop indicates that it is rare, threatened, or endangered in California and elsewhere. Its state threat level (.2) indicates that it is somewhat endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code(California Department of Fish and Game 2012a).

2A.52.2 Species Distribution and Status

2A.52.2.1 Range and Status

Boggs Lake hedge-hyssop occurs in northeastern California on the Modoc Plateau in Siskiyou, Modoc, Lassen, and Shasta Counties and then southward in the Central Valley to Fresno County. There are also records from Boggs Lake in Lake County (Figure 2A.52-1) (California Department of Fish and Game 2012b; California Native Plant Society 2012). It is widely distributed throughout the range of vernal pool habitat (Barbour et al. 2007),including one occurrence in Oregon, where it is state listed as threatened (California Native Plant Society 2012). Population sizes range from small numbers to thousands of plants (California Department of Fish and Game 2012b; California Native Plant Society 2012). There are 89 known occurrences, two of which are extirpated and one of which is possibly extirpated (California Department of Fish and Game 2012b).

2A.52.2.2 Distribution and Status in the Plan Area

Several populations have been reported to occur sporadically on and in the vicinity of Jepson Prairie Preserve and the Gridley Preserve, one of which is in the Plan Area (Witham 2006; Barbour et al. 2007; California Department of Fish and Game 2012b) (Figure 2A.52-2). There are no reported occurrences in the southwestern portion of the Plan Area, but that area is within the species' range and potentially suitable claypan vernal pool habitat occurs there. No additional occurrences were found during the 2009, 2010, or 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011).

2A.52.3 Habitat Requirements and Special Considerations

Boggs Lake hedge-hyssop has been reported from various habitats, including the edges of marshes and natural lakes, stock ponds, swales, and vernal pools (Witham 2006; Barbour et al. 2007; California Department of Fish and Game 2012b). It has been observed in several types of vernal pools, including basalt flow, hardpan, claypan, and alkaline playa pools. In the Plan Area, the species commonly associated with Boggs Lake hedge-hyssop include toothed downingia (*Downingia cuspidata*), dwarf downingia (*Downingia pusilla*), Fremont's goldfields (*Lasthenia fremontii*), and white-headed navarretia (*Navarretia leucocephala* subsp. *bakeri*) (Barbour et al. 2007; California Department of Fish and Game 2012b).

2A.52.4 Life History

Boggs Lake hedge-hyssop is a very small (less than 10-centimeter [less than 4-inch]-tall), semi-aquatic annual herb of the plantain family (Plantaginaceae) that blooms from April to August (Estes 2012; California Native Plant Society 2012). The lower portions of the brownish-red fleshy stems are glabrous, and the upper portions are glandular-sticky with puberulent hairs (Estes 2012). Leaves are small (less than 2 centimeters [less than 0.8 inch]) and rounded at the tips. The predominantly yellow corolla has five lobes: two are yellow and fused; three are white and separate (Estes 2012). A related species that is much more common—bractless hedge-hyssop (*Gratiola ebracteata*)—can be distinguished from Boggs Lake hedge-hyssop by its more elongate and pointed sepals and mostly white flowers. Boggs Lake hedge-hyssop seeds can lie dormant in the soil for years, and the number of vegetative plants in a population can vary greatly from year to year (U.S. Fish and Wildlife Service 2005).

2A.52.5 Threats and Stressors

Vernal pool loss through development, damage by intensive grazing, trampling, off-road vehicles, and invasive nonnative species are generally cited as threats (California Department of Fish and Game 2012b; California Native Plant Society 2012). Grazing generally has negative effects on this species, especially through trampling (California Department of Fish and Game 2012b).

2A.52.6 Relevant Conservation Efforts

Boggs Lake hedge-hyssop is protected on a number of public, private, and mitigation bank sites throughout California (U.S. Fish and Wildlife Service 2005). In the Plan Area, it is generally protected on Solano Land Trust properties in the Jepson Prairie area (Witham 2006). It is a covered species under the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003) and the *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000); and it is proposed for coverage under the *Solano Multi-Species Habitat Conservation Plan* (Solano County Water Agency 2009) and the *South Sacramento Habitat Conservation Plan* (Sacramento County 2010).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the Boggs Lake hedge-hyssop as a Maintain species (CALFED Bay-Delta Program 2000). This means that the program will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects to the species created by program restoration actions. To the extent practicable, the ERP will improve species habitat conditions.

2A.52.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.52.7.1 GIS Model Data Sources

The Boggs Lake hedge-hyssop model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]). Using these data sets, the model maps the distribution of suitable Boggs Lake hedge-hyssop habitat in the Plan Area according to the species' two habitat types: vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.52.7.2 Habitat Model Description

Modeled habitat for Boggs Lake hedge-hyssop includes vernal pool complex, degraded vernal pool complex, and alkali seasonal wetland complex.

Vernal pool complex habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for Boggs Lake hedge-hyssop includes the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex–all vegetation types

Areas mapped comprise the following natural community type.

- Vernal pool complex

Degraded vernal pool complex habitat ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. Modeled degraded vernal pool complex habitat for Boggs Lake hedge-hyssop includes the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs

- Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
- Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
- Degraded vernal pool complex–vernal pools

Modeled alkali seasonal wetland complex habitat for Boggs Lake hedge-hyssop includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the vernal pool complex natural community was assumed to provide Boggs Lake hedge-hyssop habitat.

2A.52.7.3 Assumptions

- **Assumption:** Boggs Lake hedge-hyssop habitat is restricted to the vegetation types described in Section 2A.52.7.2, *Habitat Model Description*.

  Rationale: Historical and current records of this species in the Plan Area indicate that its current distribution is limited to alkaline soil areas with vernal pool and swale microtopography along the northwestern border of the Plan Area (Figure 2A.52-2) (Witham 2006; California Department of Fish and Game 2012b). The vegetation cover of the alkaline soils is typically a combination of vernal pool adapted species and annual ryegrass (Witham 2006; California Department of Fish and Game 2012b). Similar habitat exists in the central-western and southwestern portions of the Plan Area, and Boggs Lake hedge-hyssop habitat was extended into those alkaline soil areas as well. Also, because this species occurs in similar habitats with Heckard's peppergrass, which was recently discovered in the Stone Lakes area during the Delta Habitat Conservation and Conveyance Program surveys, the habitat range of Boggs Lake hedge-hyssop was extended into areas with vernal pool and swale microtopography along the eastern border of the Plan Area. The vegetation cover of the alkaline soils is typically a combination of vernal pool adapted species and annual ryegrass (Witham 2002, 2003, 2006; California Department of Fish and Game 2012b).

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide habitat for Boggs Lake hedge-hyssop.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii–Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

2A.52.8 Recovery Goals

Although Boggs Lake hedge-hyssop is not a federally listed taxon, it is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005).

The recovery plan explicitly states that its goal is to ensure the long-term conservation of this species and 32 other taxa by using an ecosystem level strategy that is based on current knowledge of the existing conditions of vernal pool communities, the distribution and status of the populations of each of the species, and current and anticipated process that impact vernal pool ecosystems. Because the goal of the recovery plan is primarily directed at habitat preservation, its implementation program specifically addresses factors that relate to habitat acquisition and management.

- Habitat protection
- Adaptive habitat management and monitoring
- Status surveys
- Research
- Public participation

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2A.52.9.1 Literature Cited

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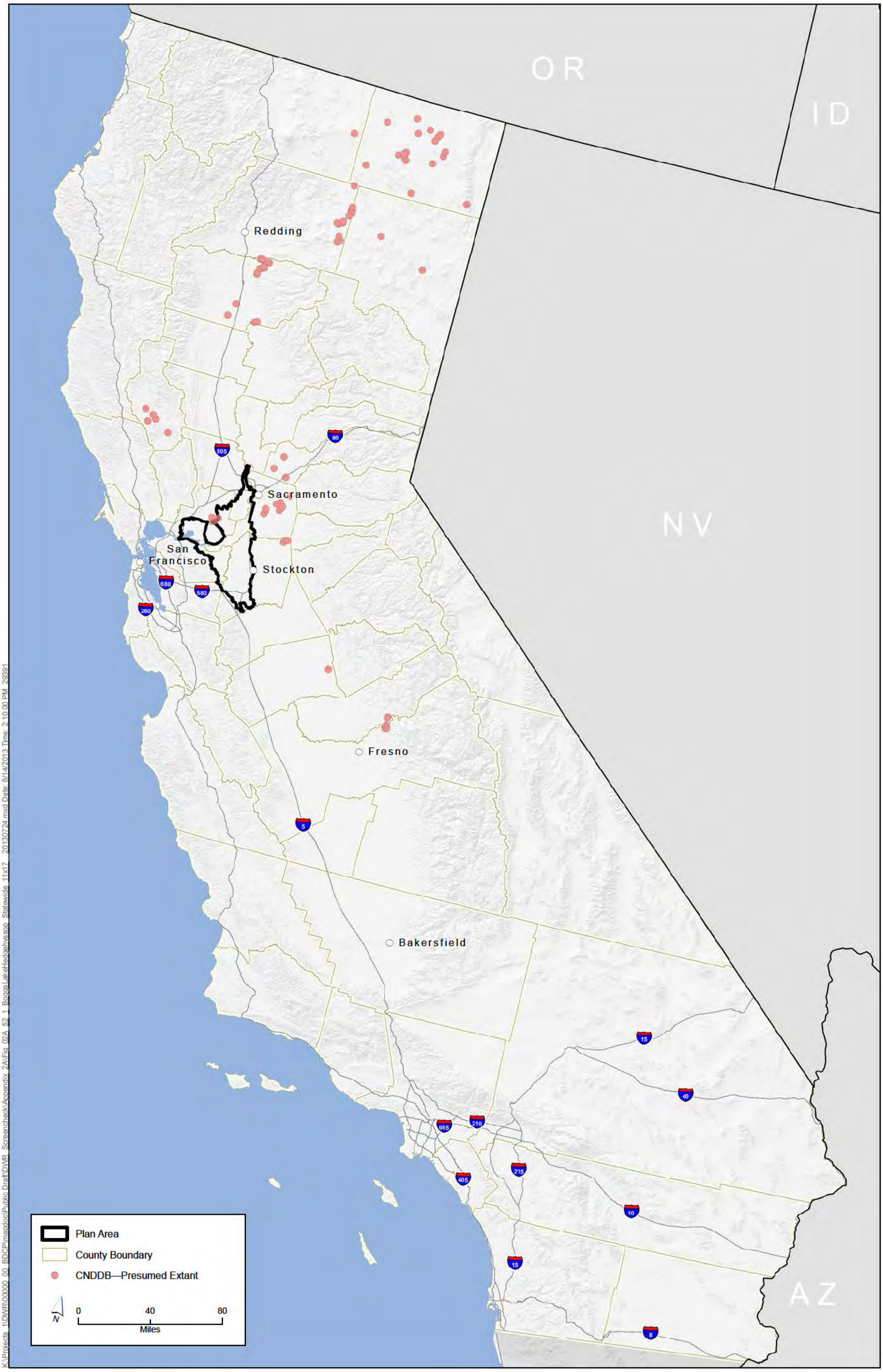
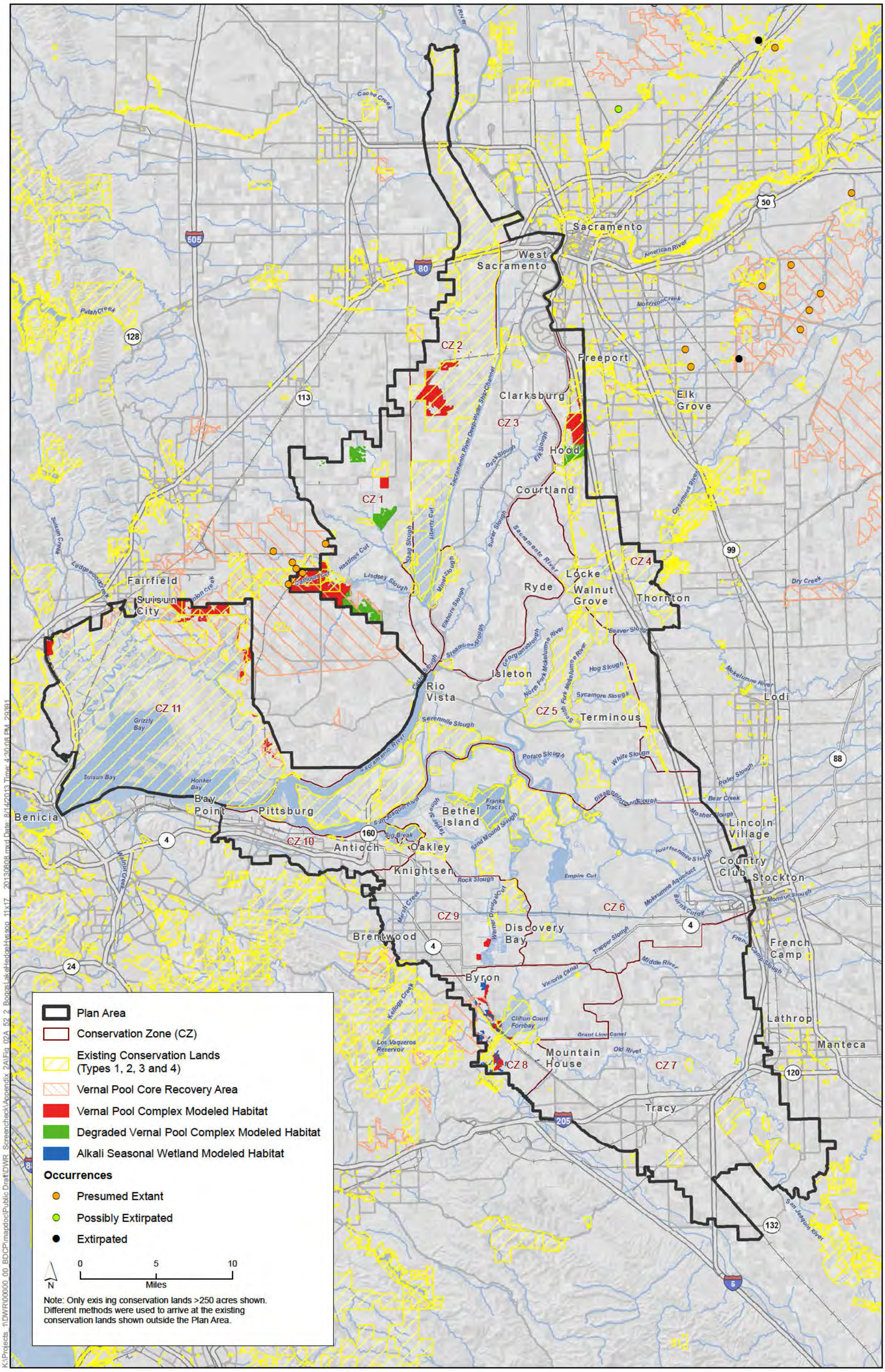


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.52-1
Boggs Lake Hedge-Hyssop Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013.

Figure 2A.52-2
Boggs Lake Hedge-Hyssop Habitat Model and Recorded Occurrences

Appendix 2A.53
Dwarf Downingia (*Downingia pusilla*)

2A.53.1 Legal Status

Dwarf downingia (*Downingia pusilla*) is not listed under either the federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2, which means that globally (G) and within the state (S) this species is imperiled and is at high risk for extinction as a result of restricted range, very few populations and steep decline (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 2.2 for dwarf downingia indicates that it is rare, threatened, or endangered in California but more common elsewhere. Its state threat level (.2) indicates that it is fairly endangered in California (California Department of Fish and Game 2012a). Plants with a rank of 2 are considered to meet the definitions of rare, threatened or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.53.2 Species Distribution and Status

2A.53.2.1 Range and Status

In California, dwarf downingia is known from 122 occurrences, of which 114 are presumed extant, in a range that extends from southern Tehama County to Fresno County and from Sonoma County to Placer County (Figure 2A.53-1); it is also found in Chile (California Native Plant Society 2012). It occurs on alluvial terraces and floodplains in the Sacramento Valley (California Department of Fish and Game 2012b). It has been reported from the northeastern part of the San Joaquin Valley, but not near the border of the Plan Area, and it is also found on valley floors and margins in Sonoma and Napa Counties (California Department of Fish and Game 2012b).

2A.53.2.2 Distribution and Status in the Plan Area

Dwarf downingia occurs in 12 occurrences in two areas of the Plan Area. It has been reported from vernal pools, vernal swales, alkaline seasonal wetlands, tire ruts, and hydrologically altered sloughs in the greater Jepson Prairie area, including existing conservation lands in the Jepson Prairie Preserve (managed by Solano Land Trust) and Calhoun Cut Ecological Reserve (managed by California Department of Fish and Game) (Figure 2A.53-2) (Witham 2006; Barbour et al. 2007; Lazar 2007; California Department of Fish and Game 2012b). During 2009 and 2010 field surveys (Delta Habitat Conservation and Conveyance Program 2011), dwarf downingia was found in vernal pools on the North Stone Lakes Unit of the Stone Lakes National Wildlife Refuge. No additional observations of dwarf downingia were made during the 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011).

2A.53.3 Habitat Requirements and Special Considerations

Throughout its distribution, dwarf downingia occurs in vernal pools, vernal swales, pools in seasonal streambeds, vernal marshes, tire ruts, hydrologically altered sloughs, and irrigation ponds (California Department of Fish and Game 2012b). At some occurrences, it is found with indicators of long-duration inundation such as pale spikerush (*Eleocharis macrostachya*), but on the clay soils of the greater Jepson Prairie area it is found across a range of microtopographic positions in vernal pools within grassland vegetation that typically has a high cover of ryegrass (*Festuca perennis*, formerly *Lolium multiflorum*) a nonnative grass (Witham 2006; Barbour et al. 2007; Lazar 2007). In the Stone Lakes areas, it is associated with vernal pools that form in the former headwaters of natural drainages propagating upslope from the Sacramento–San Joaquin River Delta (Delta). When present in a vernal pool, its population persistence has been found to be relatively constant when compared to other rare vernal pool species (Buck 2004; Barbour et al. 2007).

2A.53.4 Life History

Dwarf downingia is a small submerged to emergent aquatic annual plant in the bluebell family (Campanulaceae). It germinates during the wet season, when habitat is ponded and becomes a small 0.8- to 5-inch (2- to 12-centimeter)-tall (Munz and Keck 1959) terrestrial plant at the end of the wet season as the habitat dries. It has tiny awl-like leaves and very small white or light blue flowers (Schultheis 2012). It flowers from March to May (California Native Plant Society 2012; Schultheis 2012). Dwarf downingia seed dispersal is apparently aided by waterfowl, as it appeared spontaneously in vernal pools constructed as part of the Montezuma Wetlands Restoration Project (San Francisco Estuary Institute 2006). Nothing is known about its pollination biology, seed germination characteristics, or many other important biological and ecological characteristics.

2A.53.5 Threats and Stressors

Development, intensive agriculture, grazing, and invasive plant species, especially ryegrass are considered to be the primary threats to dwarf downingia (California Native Plant Society 2012). Additionally, the nonnative waxy mannagrass (*Glyceria declinata*) may pose a threat to this species and many other vernal pool species (Gerlach et al. 2009).

2A.53.6 Relevant Conservation Efforts

The known occurrences in the Plan Area are protected from development and intensified agriculture because of conservation easements or management by a public agency (Witham 2006; Barbour et al. 2007; Lazar 2007; U.S. Fish and Wildlife Service 2007; California Department of Fish and Game 2012b). Dwarf downingia is proposed for coverage under the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010).

2A.53.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.53.7.1 GIS Model Data Sources

The dwarf downingia model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; TAIC 2008 [Yolo Basin]); Using these data sets, the model maps the distribution of suitable dwarf downingia habitat in the Plan Area according to the species' two habitat types: vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.53.7.2 Habitat Model Description

Modeled habitat for dwarf downingia includes vernal pool complex, degraded vernal pool complex, and alkali seasonal wetland complex.

Vernal pool complex habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for dwarf downingia comprises the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex–all vegetation types

Areas mapped comprise the following natural community type.

- Vernal pool complex

Degraded vernal pool complex habitat ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. Modeled degraded vernal pool complex habitat for dwarf downingia comprises the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands-herbaceous
    - Degraded vernal pool–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum,* currently *Festuca perenne*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools

Modeled alkali seasonal wetland complex habitat for dwarf downingia includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the vernal pool complex natural community was assumed to provide dwarf downingia habitat.

2A.53.7.3 Assumptions

- **Assumption:** Dwarf downingia habitat is restricted to the vegetation types described in Section 2A.53.7.2, *Habitat Model Description*.

  Rationale: Historical and current records of this species in the Plan Area indicate that its current distribution is limited to alkaline or slightly alkaline claypan soil areas with vernal pool and swale microtopography along the western border of the Plan Area in the Jepson Prairie area (Figure 2A.53-2) (Witham 2006; California Department of Fish and Game 2012b) and areas with swales and vernal pools along the eastern boundary of the Plan Area (California Department of Fish and Game 2012b). The vegetation cover is typically a combination of vernal pool adapted species and annual ryegrass (Witham 2006; California Department of Fish and Game 2012b).

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide habitat for dwarf downingia.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii–Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

2A.53.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

2A.53.9 References Cited

2A.53.9.1 Literature Cited

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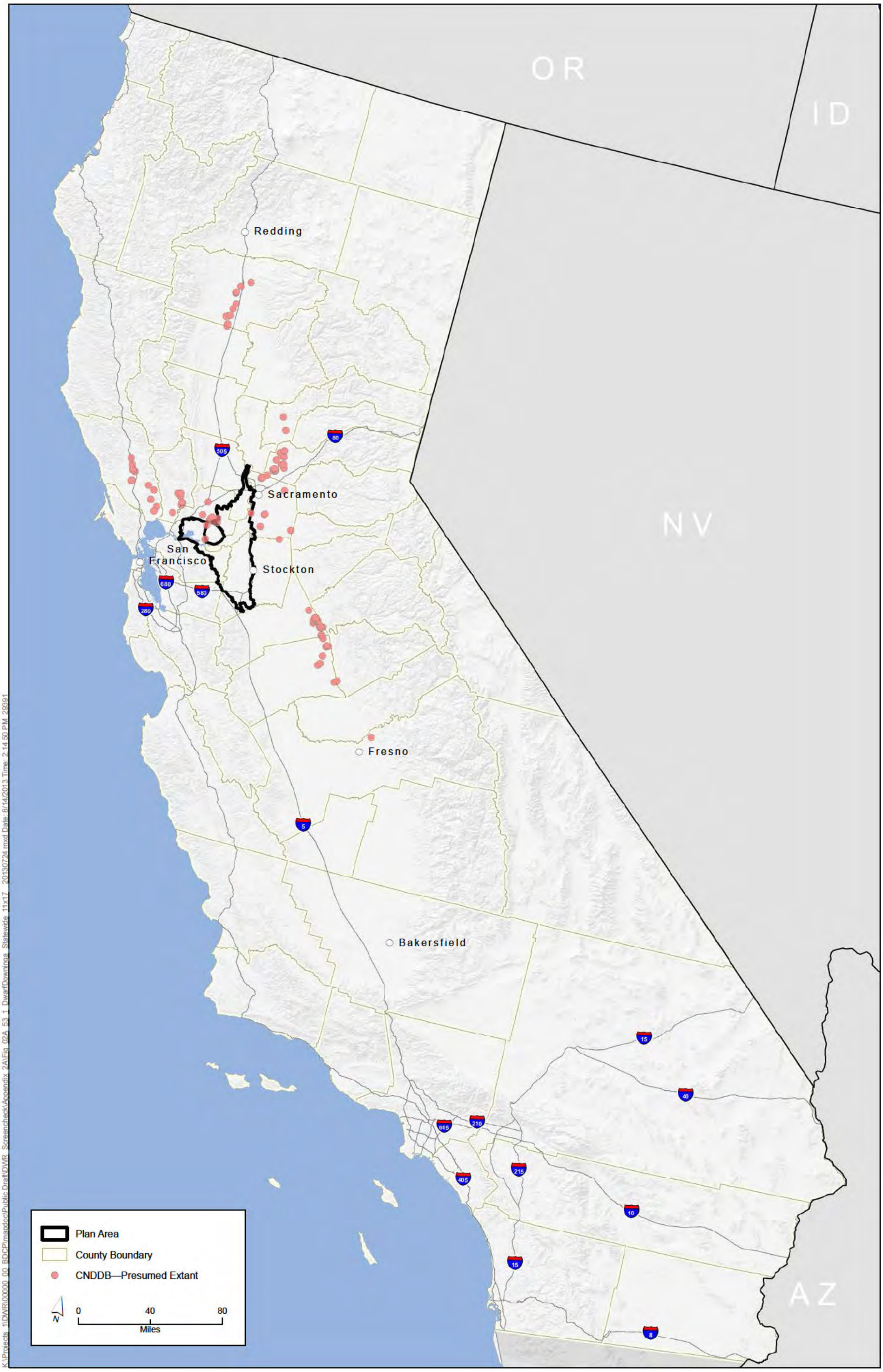
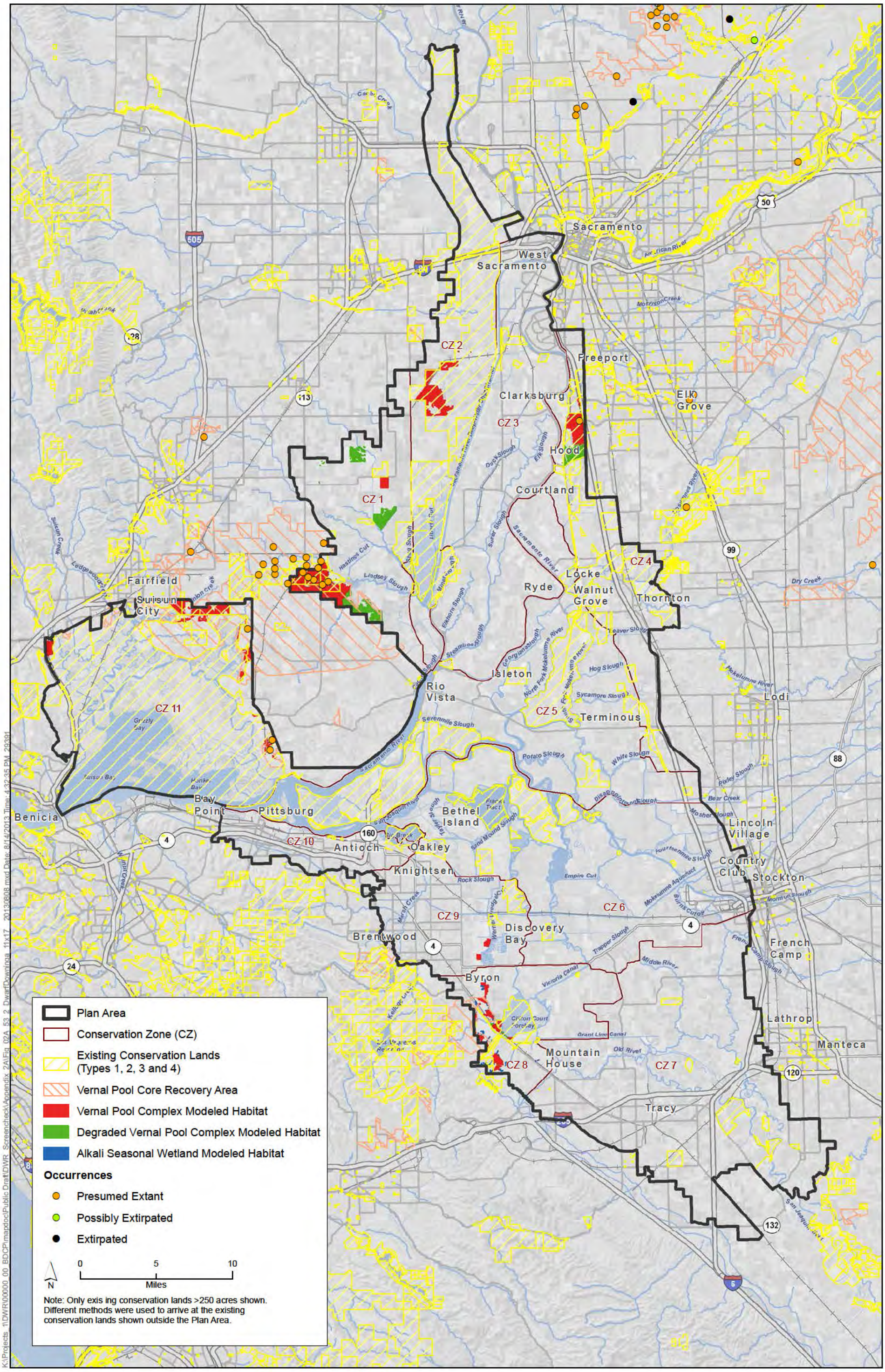


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.53-1
Dwarf Downingia Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.53-2
Dwarf Downingia Habitat Model and Recorded Occurrences

Appendix 2A.54

Heckard's Peppergrass (*Lepidium latipes* var. *heckardii*)

2A.54.1 Legal Status

Heckard's peppergrass (*Lepidium latipes* var. *heckardii*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G4T1/S1.2, which means that globally (G) the species as a whole is apparently secure across its overall distribution, but some factors of long-term concern are due to declines or other factors. This particular variety (T1) is critically imperiled because of extreme rarity due to very restricted range, very few populations (often five or fewer populations), very steep population declines, or other factors making it very vulnerable to extirpation (California Department of Fish and Game 2012a). The state rank (S) indicates that it is considered critically imperiled, with a threat level rank of threatened (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 for Heckard's peppergrass indicates that it is rare, threatened, or endangered in California and elsewhere, and it is considered to be fairly endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with a rank of 1B are considered to meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.54.2 Species Distribution and Status

2A.54.2.1 Range and Status

Heckard's peppergrass is endemic to California and is known from 15 occurrences (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b). The reported range of Heckard's peppergrass extends from Glenn and Colusa Counties to Merced County (Figure 2A.54-1) (California Department of Fish and Game 2012b; Burmester pers. comm.). Its distribution includes the alkaline soil areas to the southeast and south of the City of Woodland and at the California Department of Fish and Wildlife (CDFW) Tule Ranch unit of the CDFW Yolo Bypass Wildlife Area (Tule Ranch) in Yolo County (Showers 1996; Witham 2003; California Department of Fish and Game 2012b). Populations of Heckard's peppergrass at the Tule Ranch site are sparse but dispersed throughout the site (Witham 2003). In Solano County, Heckard's peppergrass has been reported from the East Wilcox and Gridley Ranches in the greater Jepson Prairie area (Witham 2006; California Department of Fish and Game 2012b) and along Haas Slough, but that occurrence was last observed by Jepson in 1891 (Consortium of California Herbaria 2008). Aerial imagery indicates that the Haas Slough occurrence is likely to have been extirpated by the spread of intensive agriculture along both sides of the slough.

Heckard's peppergrass was originally described by Rollins (1993) and included in Rollins' treatment of the Brassicaceae in the first edition of *The Jepson Manual* (Hickman 1993). The treatment of the

Brassicaceae in the second edition did not list Heckard's peppergrass as a separate variety, noting that the two varieties are sometimes found growing together (Al-Shehbaz 2012). However, California Native Plant Society (2012) and the CNDDB (California Department of Fish and Game 2012b) continue to recognize Heckard's peppergrass as a distinct variety.

2A.54.2.2 Distribution and Status in the Plan Area

Heckard's peppergrass has been observed in the Plan Area at five occurrences west of Yolo Bypass in Yolo County in the area of the Tule Ranch (Witham 2003; California Department of Fish and Game 2012b; Consortium of California Herbaria 2008), and in Solano County on the Wilcox and Gridley Ranches in the greater Jepson Prairie area (Figure 2A.54-2) (Witham 2006). The hydrology and vegetation of the Gridley Ranch site is described in Williamson et al. (2005). The occurrences in natural communities in the Plan Area are in vernal pool complexes on clay-rich alkaline soils that have not been intensively farmed.

One occurrence of Heckard's peppergrass was recorded during 2009 surveys (Delta Habitat Conservation and Conveyance Program 2011). This population contained 150 individuals and was located on a slope alongside a linear depression within a grazed grassland. This occurrence is located on lands managed by Stone Lakes National Wildlife Refuge. Associated species included Pacific foxtail (*Alopecurus saccatus*) and small stipitate popcornflower (*Plagiobothrys stipitatus* var. *micranthus*).

Three additional stands of Heckard's peppergrass were found during 2010 surveys (Delta Habitat Conservation and Conveyance Program 2011) in grassland with disturbed vernal pools on grazed lands managed by Stone Lakes National Wildlife Refuge.The stands ranged from 75 to 500 individuals. Heckard's peppergrass was found growing with common mouse-ear chickweed (*Cerastium fontanum*), small stipitate popcornflower , Great Valley gumplant (*Grindelia camporum*), spikeweed (*Centromadia* sp.), dwarf peppergrass (*Lepidium latipes* var. *latipes*), annual bluegrass (*Poa annua*), tiny mousetail (*Myosurus minimus*), redstem filaree (*Erodium cicutarium*), curly dock (*Rumex crispus*), pineapple weed (*Matricaria discoidea*), pale spikerush (*Eleocharis macrostachya*), and ryegrass (*Festuca perenne*).

Heckard's peppergrass was not found during 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011).

2A.54.3 Habitat Requirements and Special Considerations

Very little is known regarding the ecology of Heckard's peppergrass. Populations near the city of Woodland occur on alkaline flats and mesic alkaline grasslands that were once contour rice fields on Pescadero silty clay, saline-alkali Marvin soils, and Willows clay soils. On the Tule Ranch site in the Yolo Bypass, and on the East Wilcox and Gridley Ranches in Solano County, it occurs in grazed, slightly alkaline vernal pool grassland in areas that are dominated by ryegrass (Witham 2006; California Department of Fish and Game 2012b), a nonnative that is tolerant of alkaline soils (Dawson et al. 2007). Occurrence records and survey reports suggest that Heckard's peppergrass is closely associated with Sacramento Valley populations of alkali milk-vetch (*Astragalus tener* var. *tener*), another covered species (California Department of Fish and Game 2012b).

2A.54.4 Life History

Heckard's peppergrass is a 1- to 10-inch (3- to 25-centimeter)-tall herbaceous annual plant in the mustard family (Brassicaceae). It is differentiated from dwarf peppergrass (*L. latipes* var. *latipes*) based on its height, the distance between its leaf nodes, and its lack of a basal rosette (Rollins 1993). Heckard's peppergrass has dense foliage with 2- to 4-inch (5- to 10-centimeter)-long linear leaves. Small, greenish flowers occur in a raceme in fruit that is greater than basal leaves and the flat, oval fruits are deeply notched at their tops (Rollins 1993). Heckard's peppergrass flowers March through May (California Native Plant Society 2012). Studies are needed to shed light on basic biological and ecological requirements such as pollination systems, seed dormancy and germination cues, dispersal vectors, and seed predation.

2A.54.5 Threats and Stressors

Development, waterfowl management, agricultural conversion, urban development, and exotic plant species are considered the primary threats to Heckard's peppergrass (Showers 1988, 1996; Dawson et al. 2007; California Department of Fish and Game 2012b). All of these threats lead to the loss of habitat or the degradation of conditions the plant requires to survive.

2A.54.6 Relevant Conservation Efforts

The known populations of Heckard's peppergrass in Solano County are under conservation easements and those in Yolo County are protected on the CDFW Tule Ranch Reserve or by a conservation easement in the Spring Lakes area near the city of Woodland. The Tule Ranch and greater Jepson Prairie area populations are currently grazed.

Heckard's peppergrass is proposed for coverage under the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011).

2A.54.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.54.7.1 GIS Model Data Sources

The Heckard's peppergrass model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta]; Boul and Keeler-Wolf 2008 [Suisun Marsh]; and TAIC 2008 [Yolo Basin]). Using these data sets, the model maps the distribution of suitable Heckard's peppergrass habitat in the Plan Area according to the species' two habitat types: vernal pool complex and degraded vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

2A.54.7.2 Habitat Model Description

Modeled habitat for Heckard's peppergrass includes vernal pool complex, degraded vernal pool complex, and alkali seasonal wetland complex t.

Vernal pool complex habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for Heckard's peppergrass comprises the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex–all vegetation types

Areas mapped comprise the following natural community type.

- Vernal pool complex

Degraded vernal pool complex habitat ranges from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, discing, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. Modeled degraded vernal pool complex habitat for Heckard's peppergrass includes the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Lolium multiflorum*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools

Modeled alkali seasonal wetland complex habitat for Heckard's peppergrass includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the vernal pool complex natural community was assumed to provide Heckard's peppergrass habitat.

2A.54.7.3 Assumptions

- **Assumption:** Heckard's peppergrass habitat is restricted to the vegetation types described in Section 2A.54.7.2, *Habitat Model Description*.

  Rationale: Historical and current records of this species in the Plan Area indicate that its current distribution is limited to alkaline soil areas with vernal pool and swale microtopography along the northwestern border of the Plan Area (Figure 2A.54-2) (Witham 2002, 2003, 2006;

Environmental Science Associates and Yolo County Planning & Public Works Department 2005; Baraona et al. 2007; California Department of Fish and Game 2012b). The vegetation cover of the alkaline soils is typically a combination of vernal pool adapted species and annual ryegrass (Witham 2002, 2003, 2006; California Department of Fish and Game 2012b). Heckard's peppergrass was discovered in the Stone Lakes area as part of the Delta Habitat Conservation and Conveyance Program (2011) surveys, and its habitat range was extended into areas with vernal pool and swale microtopography along the northeastern border of the Plan Area. Additional habitat in the Suisun Marsh area was also included in the model. Because Heckard's peppergrass also frequently occurs in the same habitats as alkali milk-vetch (Witham 2002, 2003, 2006; California Department of Fish and Game 2012b), its habitat range was extended in the central-western and southwestern portions of the Plan Area to match that of alkali milk-vetch.

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide habitat for Heckard's peppergrass.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii–Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

2A.54.8 Recovery Goals

A U.S. Fish and Wildlife Service recovery plan has not been prepared for this species and no recovery goals have been established.

2A.54.9 References Cited

2A.54.9.1 Literature Cited

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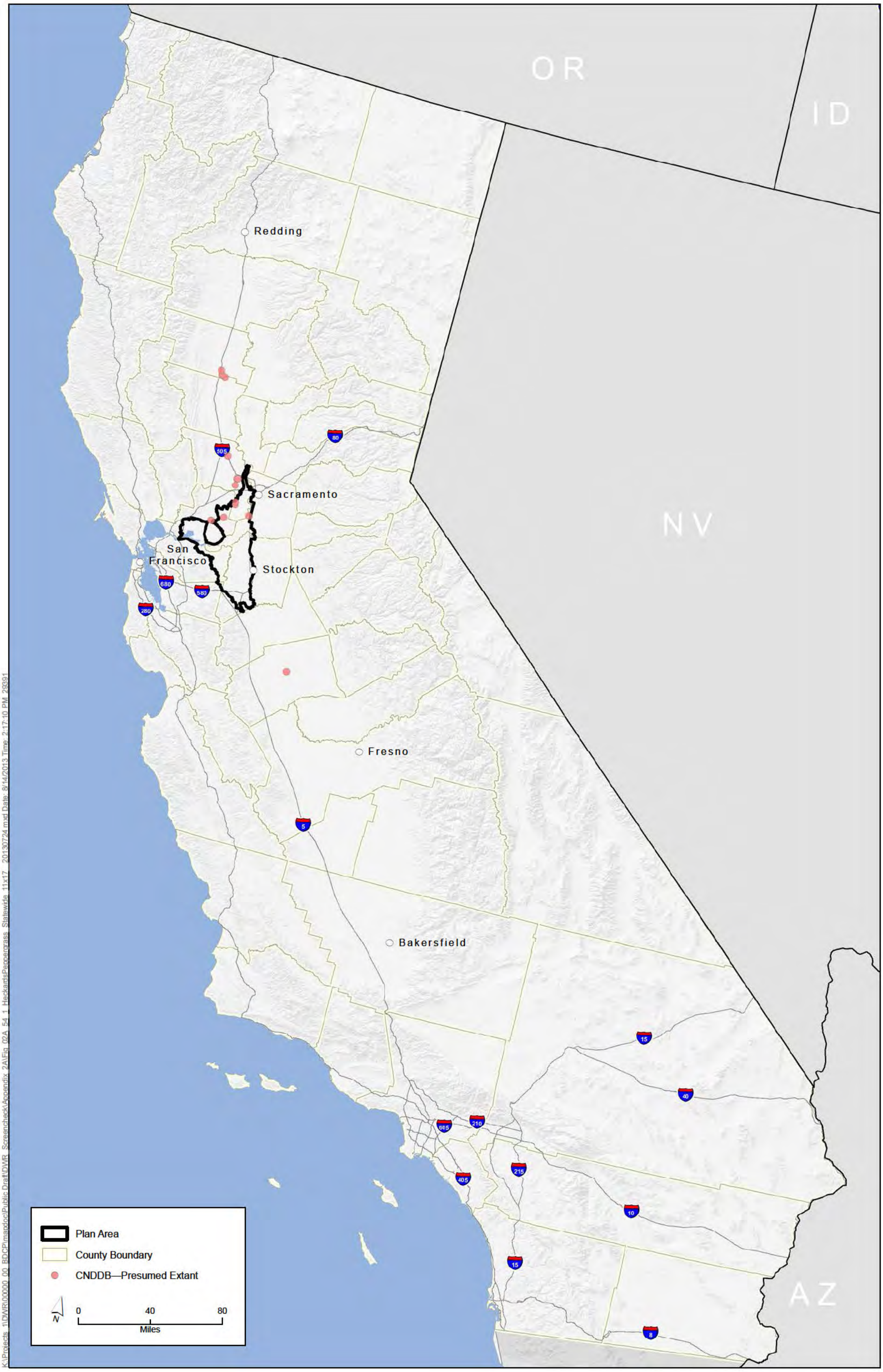
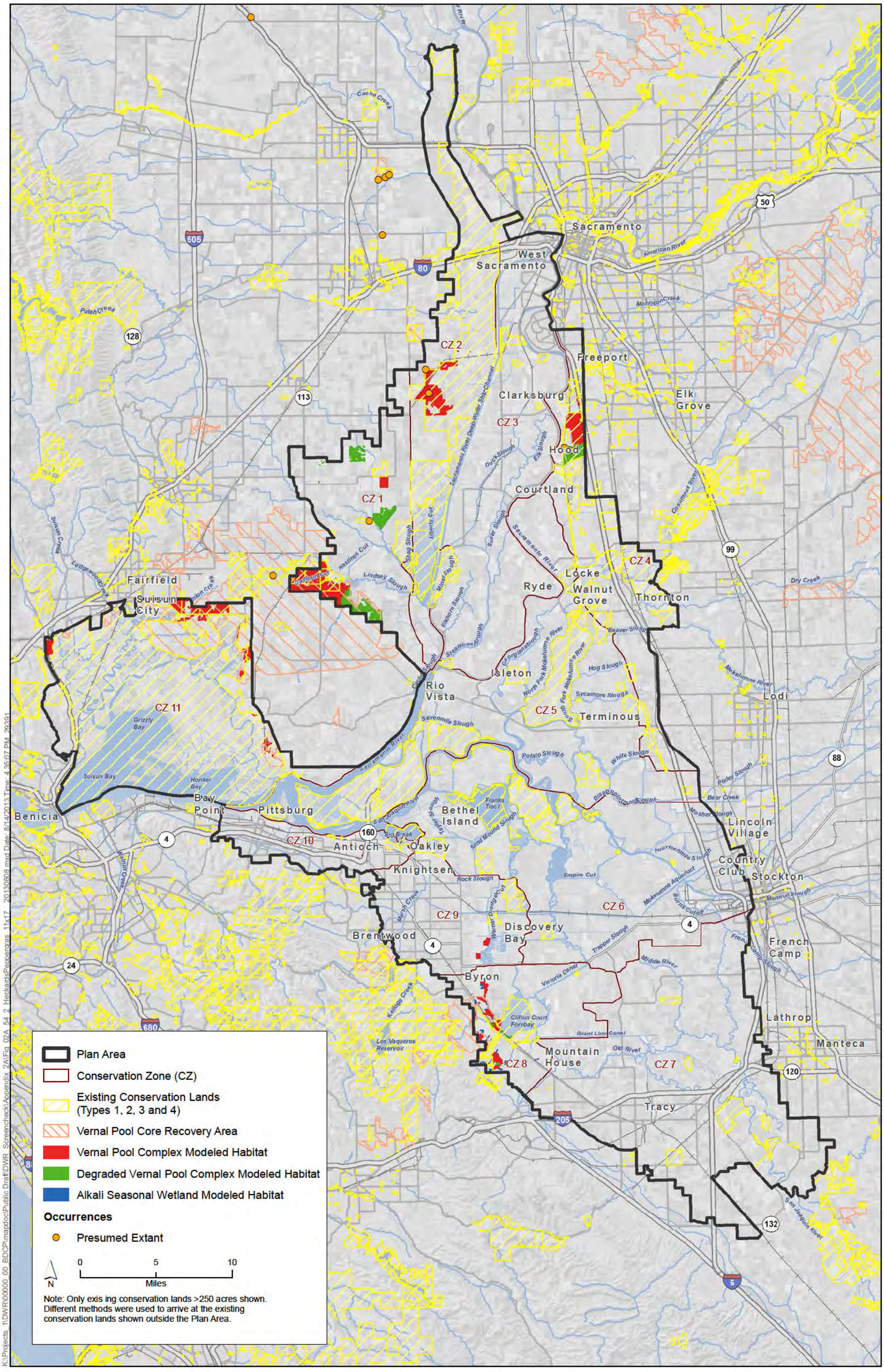


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.54-1
Heckard's Peppergrass Statewide Range and Recorded Occurrences



GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

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Figure 2A.54-2
Heckard's Peppergrass Habitat Model and Recorded Occurrences

Appendix 2A.55
Legenere (*Legenere limosa*)

2A.55.1 Legal Status

Legenere (*Legenere limosa*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2.2, which means that globally (G) and within the state (S) it is considered imperiled, or at high risk of extinction due to its very restricted range, very few populations (often 20 or fewer), steep population declines, or other factors making it vulnerable to extirpation; its state threat level identifies it as threatened (California Department of Fish and Game 2012a; California Native Plant Society 2012) .

The California Rare Plant Rank of 1B.1 for legenere indicates that it is rare, threatened, or endangered in California and elsewhere, and is seriously endangered in California , with a threat level (".1") of seriously endangered in California (California Native Plant Society 2012; California Department of Fish and Game 2012a). Plants with a rank of 1B are considered to meet the definitions of rare, threatened or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.55.2 Species Distribution and Status

2A.55.2.1 Range and Status

Legenere's range extends from southwestern Shasta County to southern Santa Clara County (Figure 2A.55-1). It is found on bottomlands and alluvial terraces in the Sacramento Valley with its distribution at the south end of the Sacramento Valley bifurcated by the Sacramento–San Joaquin River Delta (Delta) (California Department of Fish and Game 2012b). It occurs in the extreme northeastern part of the San Joaquin Valley and is also found on valley floors and margins in both the northern end of the South Coast Range in San Mateo, Alameda, and Santa Clara Counties and the southern end of the North Coast Range in Sonoma and Napa Counties (California Department of Fish and Game 2012b). The CNDDB records 69 extant occurrences (78 total occurrences, 7 of which are extirpated and 2 of which are possibly extirpated) (California Department of Fish and Game 2012b).

2A.55.2.2 Distribution and Status in the Plan Area

Legenere has been reported in the Plan Area from eight occurrences, one of which has been extirpated, in vernal pools, vernal swales, and alkaline flats in vernal pool grasslands in the greater Jepson Prairie area (Figure 2A.55-2) (Witham 2003, 2006; Buck 2004; Barbour et al. 2007; Lazar 2007; California Department of Fish and Game 2012b). Surveys in 2009 documented two stands of legenere growing in a roadside ditch in a vernal pool grassland on lands managed by the Stone Lakes National Wildlife Refuge (Delta Habitat Conservation and Conveyance Program 2011). These stands ranged in size from 20 to 50 individuals. Associated species included small stipitate popcornflower (*Plagiobothrys stipitatus* var. *micranthus*), white water-buttercup (*Ranunculus*

aquatilis), rayless goldfields (*Lasthenia glaberrima*), and bractless hedge-hyssop (*Gratiola ebracteata*). The nonnative competitor waxy mannagrass (*Glyceria declinata*), which also was found in the areas where legenere was documented, is considered a potential threat to the population. Additionally, the area where legenere was found is disked annually to provide a firebreak between the roadway and grassland.

Eighteen stands of legenere were found during the follow-up 2010 surveys at Stone Lakes National Wildlife Refuge (Delta Habitat Conservation and Conveyance Program 2011). Numbers of individuals ranged from 1 to more than 1,000 per stand. All stands were found in grassland or grassland with disturbed vernal pools on grazed lands. The dramatic increase in the abundance of legenere plants documented in 2010 was attributed to the significant increase in rainfall during winter 2009/2010. Legenere was found with water-starwort (*Callitriche* spp.), small stipitate popcornflower, rayless goldfields, curly dock (*Rumex crispus*), vernal buttercup (*Ranunculus bonariensis*), pale spikerush (*Eleocharis macrostachya*), Pacific foxtail (*Alopecurus saccatus*), and turkey tangle fogfruit (*Phyla nodiflora*).

No occurrences of legenere were documented during the 2011 surveys (Delta Habitat Conservation and Conveyance Program 2011).

Recorded occurrences in western Sacramento and San Joaquin Counties are immediately east of the eastern boundary of the Plan Area.

2A.55.3 Habitat Requirements and Special Considerations

Throughout its distribution, legenere occurs in vernal pools, vernal swales, pools in seasonal streambeds, vernal marshes, and stock ponds (California Department of Fish and Game 2012b). Occurrence records often state that it is found with long inundation indicator species such as pale spikerush (*Eleocharis macrostachya*), but on the clay soils of the greater Jepson Prairie area it is found in a range of microtopographic positions in vernal pool grassland vegetation that typically have a high cover of the nonnative ryegrass (*Festuca perennis*, formerly *Lolium multiflorum*) (Witham 2006; Barbour et al. 2007; Lazar 2007; California Department of Fish and Game 2012b).

In a large multiple-year vernal pool study, the occurrence of vegetative plants in particular vernal pools was found to fluctuate in response to environmental factors with the species disappearing and reappearing in some years (Buck 2004; Barbour et al. 2007). Legenere species may respond positively to dry season soil disturbances as one occurrence in Sacramento County was reported to support up to 1,000 to 10,000 plants in 1991 despite having been "…disked annually for firebreak," but no plants were observed during a 2007 survey (California Department of Fish and Game 2012b).

2A.55.4 Life History

Legenere is a small aquatic annual herbaceous plant in the bellflower family (Campanulaceae) that is submerged to emergent during the wet season when habitat is ponded. It becomes a 4- to 12-inch (10- to 30-centimeter) sprawling terrestrial plant at the end of the wet season as the habitat dries. The small, 0.1- to 0.5-inch (2- to 10-millimeter) long, narrow leaves support flowers in the upper

axils of the characteristic zigzag- appearing stems (Morin 2012). Because of its small size and inconspicuous white flowers, it is difficult to detect during field surveys and may be frequently overlooked (Anonymous 2008). Nothing is known about its pollination biology, seed germination characteristics, or many other important biological and ecological characteristics, although it typically blooms between April and June (California Native Plant Society 2012).

2A.55.5 Threats and Stressors

Development, grazing, intensive agriculture, and exotic plant species (especially ryegrass) are the primary threats to legenere (Showers 1988, 1996; Dawson et al. 2007; California Department of Fish and Game 2012b; California Native Plant Society 2012). Additionally, the nonnative waxy mannagrass (*Glyceria declinata*) may pose a threat to legenere and many other vernal pool species (Gerlach et al. 2009).

2A.55.6 Relevant Conservation Efforts

The known occurrences in the Plan Area are protected from development and intensified agriculture because of existingconservation easements (Witham 2006; Barbour et al. 2007; Lazar 2007; California Department of Fish and Game 2012b). Legenere is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005). Legenere is a covered species under the permitted *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* (San Joaquin Council of Governments 2000) and the *Natomas Basin Habitat Conservation Plan* (Natomas Basin Conservancy 2003) and it is proposed for coverage under the *Solano Multispecies Habitat Conservation Plan* (Solano County Water Agency 2009) and the *South Sacramento County Habitat Conservation Plan* (Sacramento County 2010).

The CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates legenere as a Maintain species (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects to the species created by program restoration actions. To the extent practicable, the program will improve species habitat conditions.

2A.55.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.55.7.1 GIS Model Data Sources

The legenere model uses vegetation types and associations from the following geographic information systems (GIS) data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), LiDAR elevation data (California Department of Water Resources 2007), aerial imagery (Google 2009), and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable legenere habitat in the Plan Area according to the species' two habitat types:

vernal pool complex and degraded vernal pool complex. Vegetation types were assigned based on the species' requirements as described above and the assumptions described below.

2A.55.7.2 Habitat Model Description

Modeled habitat for legenere includes vernal pool complex, degraded vernal pool complex, and alkali seasonal wetland complex.

Vernal pool complex habitat consists of vernal pools and uplands that display characteristic vernal pool and swale visual signatures that have not been significantly affected by agricultural or development practices. Modeled vernal pool complex habitat for legenere comprises the following vegetation subunits that were selected from the BDCP vernal pool complex natural community.

- Vernal pool complex–all vegetation types

Areas mapped comprise the following natural community type.

- Vernal pool complex

Degraded vernal pool complex habitat consists of low-value ephemeral habitat ranging from areas with vernal pool and swale visual signatures that display clear evidence of significant disturbance due to plowing, disking, or leveling to areas with clearly artificial basins such as shallow agricultural ditches, depressions in fallow fields, and areas of compacted soils in pastures. Modeled degraded vernal pool complex habitat for legenere includes the following vegetation subunits that were selected from the BDCP vernal pool complex community.

- Vernal pool complex
    - Degraded vernal pool complex–California annual grasslands–herbaceous
    - Degraded vernal pool complex–ruderal herbaceous grasses and forbs
    - Degraded vernal pool complex–Italian ryegrass (*Festuca perennis*)
    - Degraded vernal pool complex–rabbitsfoot grass (*Polypogon maritimus*)
    - Degraded vernal pool complex–vernal pools

Modeled alkali seasonal wetland complex habitat for legenere includes all vegetation subunits from the BDCP alkali seasonal wetland natural community in Conservation Zone 8 only.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas differ from the original methods and are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. In the new analysis areas, the vernal pool complex natural community was assumed to provide legenere habitat.

2A.55.7.3 Assumptions

- **Assumption:** Legenere habitat is restricted to the vegetation types described in Section 2A.55.7.2, *Habitat Model Description*.

Rationale: Historical and current records of this species in the Plan Area indicate that its current distribution is limited to alkaline soil areas with vernal pool and swale microtopography along the western border of the Plan Area (Figure 2A.55-2) (Witham 2006; California Department of Fish and Game 2012b) and areas with swales and vernal pools along the eastern boundary of the Plan Area (California Department of Fish and Game 2012b). The vegetation cover is typically a combination of vernal pool adapted species and annual ryegrass (Witham 2006; California Department of Fish and Game 2012b).

- **Assumption:** Alkali seasonal wetlands in Conservation Zone 8 provide habitat for legenere.

  Rationale: Vernal pools in the western part of the Plan Area tend to be alkali/saline pools of the *Lastenia fremontii-Distichlis spicata* alliance and *Frankenia salina* alliance (Sawyer et al. 2009). The alkali/saline vernal pool complexes in Conservation Zone 8 often occur in a mosaic with alkali seasonal wetlands. Many of the species that occur in the vernal pool complex in this area also occur in the alkali seasonal wetland complex within this mosaic of natural communities.

2A.55.8 Recovery Goals

Although legenere is not a federally listed species, it is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005). The recovery plan explicitly states that its goal is to ensure the long-term conservation of legenere and 32 other taxa by using an ecosystem level strategy that is based on the following elements.

- Current knowledge of the existing conditions of vernal pool communities.
- The distribution and status of the populations of each of the species.
- Current and anticipated processes that affect vernal pool ecosystems.

Because the goal of the recovery plan is primarily directed at habitat preservation, its implementation program specifically addresses the following factors that relate to habitat acquisition and management.

- Habitat protection
- Adaptive habitat management and monitoring
- Status surveys
- Research
- Public participation

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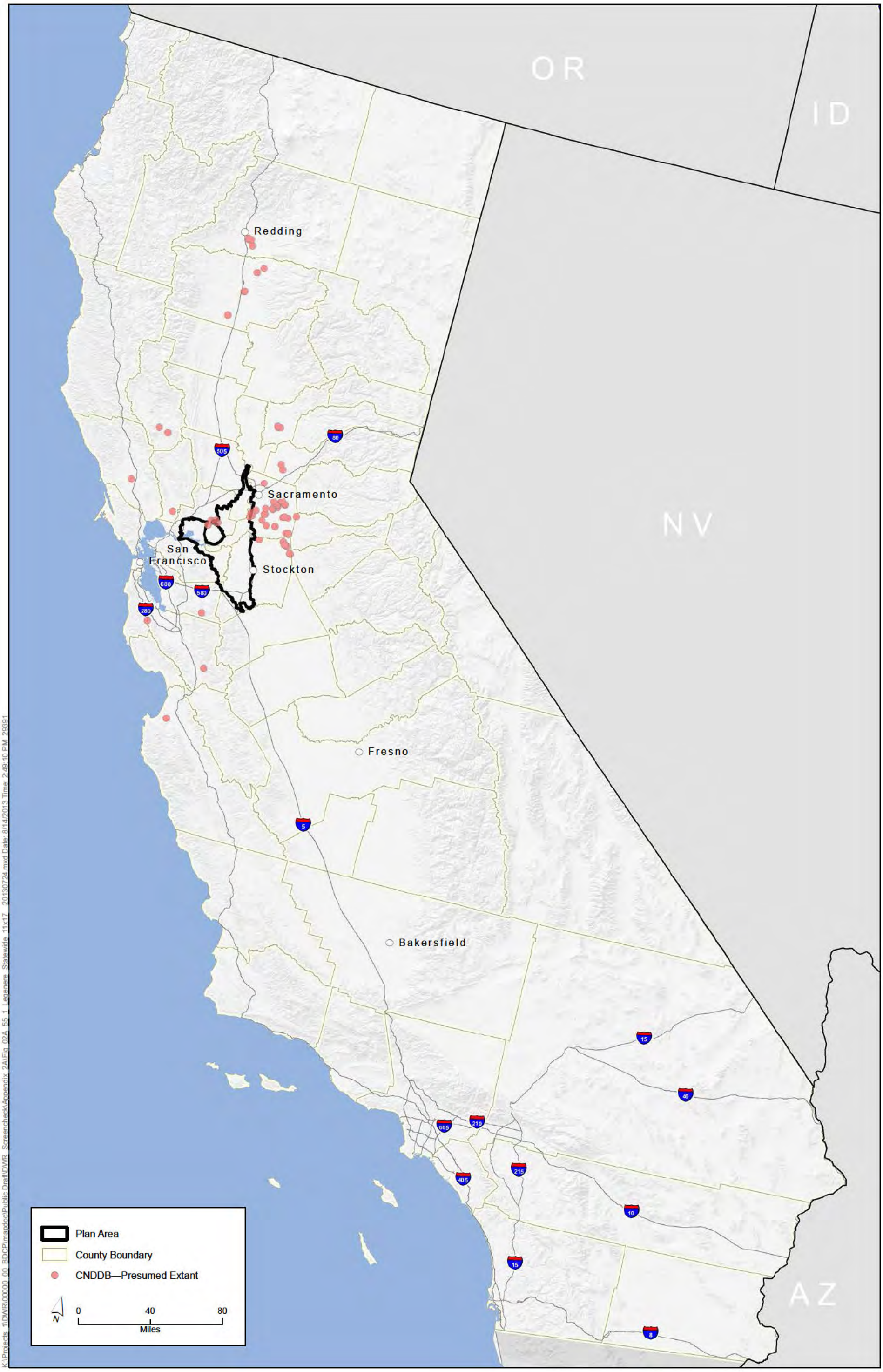
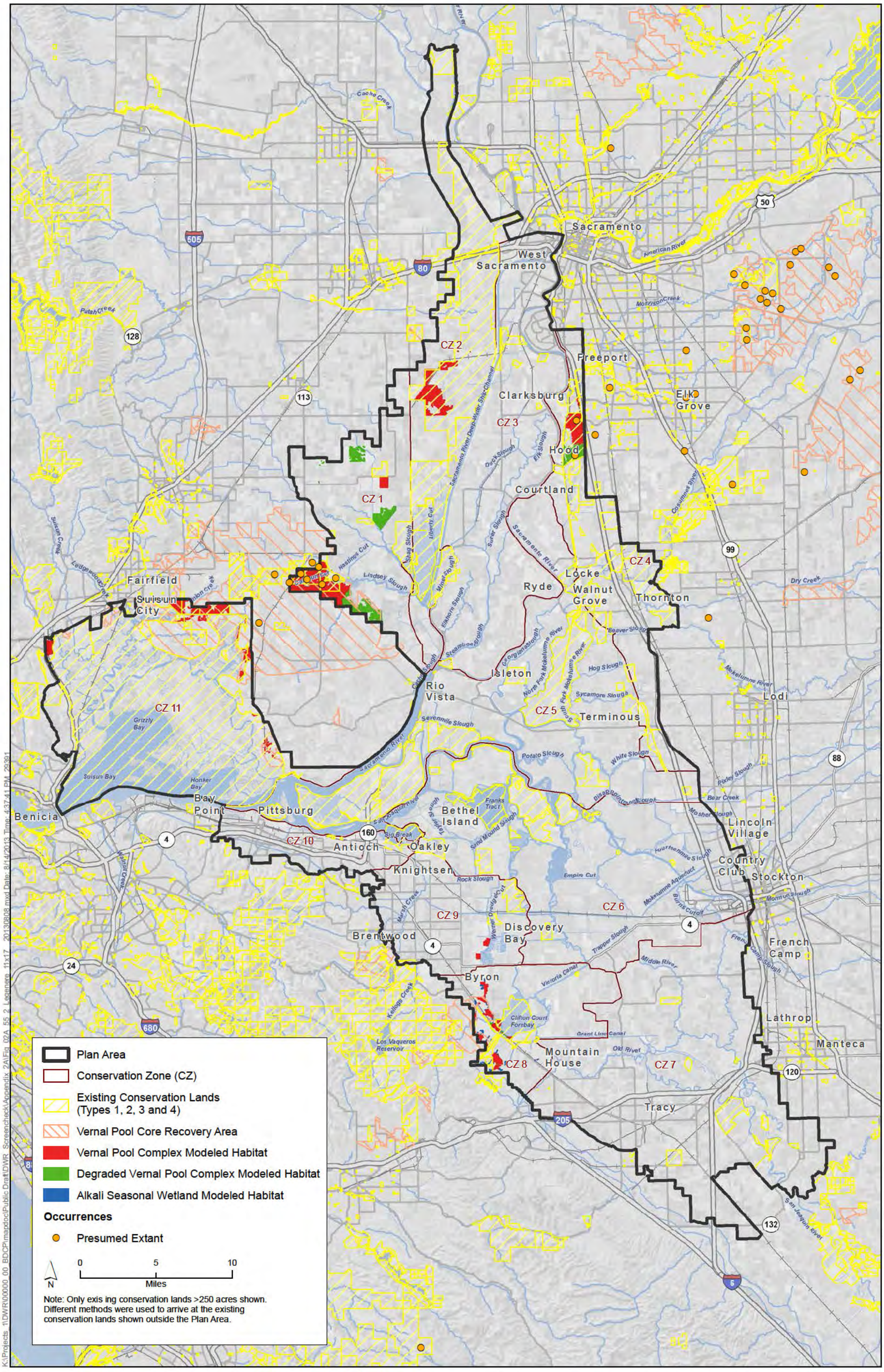


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.55-1
Legenere Statewide Range and Recorded Occurrences



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GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.55-2
Legenere Habitat Model and Recorded Occurrences

Appendix 2A.56
San Joaquin Spearscale (*Atriplex joaquinana*)

2A.56.1 Legal Status

San Joaquin spearscale (*Atriplex joaquinana*) is not listed under either federal or California endangered species acts. Its Heritage Ranking in the California Natural Diversity Database (CNDDB) is G2/S2, which means that globally (G) and within the state (S) there are either between 6 and 20 viable element occurrences of this species, 1,000 to 3,000 individuals of this species, or 2,000 to 10,000 acres (809 to 4,047 hectares) where this species occurs (California Department of Fish and Game 2012a).

The California Rare Plant Rank of 1B.2 indicates that San Joaquin spearscale is rare, threatened, or endangered in California and elsewhere, with a threat level (".2") of fairly endangered in California (California Department of Fish and Game 2012a; California Native Plant Society 2012). Plants with rank of 1B meet the definitions of rare, threatened, or endangered as defined in Section 1901, Chapter 10 (Native Plant Protection Act) or Sections 2062 and 2067 (California Endangered Species Act) of the California Fish and Game Code (California Department of Fish and Game 2012a).

2A.56.2 Species Distribution and Status

2A.56.2.1 Range and Status

Endemic to California, the range of San Joaquin spearscale includes Glenn, Colusa and Yolo Counties to the north; Contra Costa, Santa Clara, San Benito, Napa, Solano, and Alameda Counties to the west; and Sacramento, Fresno, Merced, and San Joaquin Counties to the south (Figure 2A.56-1). There are 109 occurrences, 106 of them extant (Delta Habitat Conservation and Conveyance Program 2011; California Department of Fish and Game 2012b).

San Joaquin spearscale historically has been collected in the Central Valley from Glenn County south to Merced County (Silveira 2000; California Department of Fish and Game 2012b). Specimens have also been collected in the inner North Coast Ranges in Glenn County and in the ranges of Alameda, Contra Costa and San Benito Counties (Silveira 2000; California Department of Fish and Game 2012b). It has been collected in, or adjacent to, salt marshes in Napa, Sacramento, San Luis Obispo, and Solano Counties and on the shore of a small lake in Solano County (California Department of Fish and Game 2012b). Populations remain extant at many of the collection sites, but population trends are unknown. There are 109 occurrences, 104 of them extant (California Department of Fish and Game 2012b).

2A.56.2.2 Distribution and Status in the Plan Area

In the Plan Area, San Joaquin spearscale is known from 20 extant occurrences and one extirpated occurrence, generally along the west side of the Sacramento Valley, adjacent to Suisun Marsh, and eastern Contra Costa County. It has been observed at the Tule Ranch Preserve and Main Prairie in Yolo County; in the Potrero Hills, near Hill Slough, and northwest of Collinsville, in Solano County;

and near Discovery Bay, Byron, and west of Clifton Court Forebay, in Contra Costa County (California Department of Fish and Game 2012b) (Figure 2A.56-2).

During 2009 surveys (Delta Habitat Conservation and Conveyance Program 2011), two stands of San Joaquin spearscale (10 and 2 plants, respectively) were located in alkaline wetland and grassland communities southwest of Clifton Court Forebay. An additional three stands were found during 2011 surveys in the same area, with populations ranging from 4 to 100 plants (Delta Habitat Conservation and Conveyance Program 2011).

2A.56.3 Habitat Requirements and Special Considerations

San Joaquin spearscale occurs in alkali grassland and meadows, and other seasonal wetlands with alkaline soils (California Department of Fish and Game 2012b). In the Central Valley of California, it appears to be restricted to alkaline soils along the rims of former basins . It is also found in alkaline and saline soils near creeks and seeps along the eastern flank of the inner North Coast Ranges (Zacharias 2012; California Department of Fish and Game 2012b). Similar soils occur in the alluvial fans of Brushy, Kellogg, and Marsh Creeks along the northeastern edge of the San Joaquin Valley. San Joaquin spearscale is generally found associated with other salt- or alkali-tolerant species, including saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), bush seepweed (*Suaeda nigra*), alkali weed (*Cressa truxillensis*), common spikeweed (*Centromadia pungens*), low barley (*Hordeum depressum*), and iodine bush (*Allenrolfea occidentalis*). In many instances the species occurs with or is found near populations of brittlescale (*Atriplex depressa*), a covered species, and it occasionally co-occurs with palmate-bracted bird's-beak (*Chloropyron palmatum*) (California Department of Fish and Game 2012b).

2A.56.4 Life History

San Joaquin spearscale was first collected in the vicinity of Altamont Pass by William Brewer in 1862 and described by Sereno Watson as *Atriplex spicata* in 1874. Because the name *Atriplex spicata* had been used earlier for a different species, Aven Nelson changed the name to *Atriplex joaquinana* (Nelson 1904). Although San Joaquin spearscale continues to be treated as *Atriplex joaquinana* in *The Jepson Manual* (Zacharias 2012), a recent study indicates that it should be placed in a different genus, *Extriplex* (Zacharias and Baldwin 2010).

San Joaquin spearscale is a 4- to 39-inch- (10- to 100-centimeter-) tall herbaceous annual plant in the goosefoot family (Chenopodiaceae) (Zacharias 2012). It has erect stems, with many branches that spread out as the plant ascends. The twigs are dense and finely scaled, becoming glabrous (hairless and smooth). The ovate to triangular-shaped leaves measure 0.4 to 2.8 inches (1 to 7 centimeters) (Zacharias 2012). The leaves are finely gray-scaled and may be green above. They are also generally irregularly wavy-toothed, with the base truncated and tapered in form (Zacharias 2012). The staminate inflorescence is spike- or panicle-like, which refers to branched clusters of flowers in which the branches are racemes. They are congested on the ends of the main stem and branches, resembling little "sausages." Species of Atriplex are most easily identified after flowering, when the fruiting bracts enclose the seed (Zacharias 2012). San Joaquin spearscale blooms from April through October, depending on environmental conditions (California Native Plant Society

2012). The seeds are approximately 0.04 to 0.06 inch (1 to 1.5 millimeters) in length and are dark brown (Zacharias 2012).

Very little is known about the biology and germination patterns of the species; however, San Joaquin spearscale is known to produce a long-lived seed bank that germinates in response to soil disturbances and can persist in weedy grasslands dominated by exotic species (EDAW 2004).

2A.56.5 Threats and Stressors

Development, intensive agriculture, waterfowl management, and exotic plant species are considered to be the primary threats to the species (Showers 1996; EDAW 2004; California Department of Fish and Game 2012b). All of these impacts lead to loss of habitat and degradation of the specific soils the plant requires to survive. Research should be directed toward invasive species control methods and techniques for establishing the appropriate hydrological regime to maintain the saline and alkaline soils.

2A.56.6 Relevant Conservation Efforts

San Joaquin spearscale is a covered species under the *East Contra Costa County Habitat Conservation Plan/Natural Community Conservation* Plan (East Contra Costa County 2006), which includes measures to protect populations and habitat. San Joaquin spearscale is proposed for coverage under the *Yolo Natural Heritage Program Plan Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2011).

2A.56.7 Species Habitat Suitability Model

The methods used to formulate species habitat suitability models, and the limitations of these models, are described in Section 2A.0.17, *Species Habitat Suitability Model Methods*.

2A.56.7.1 GIS Model Data Sources

The San Joaquin spearscale model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), LiDAR elevation data (California Department of Water Resources 2007), aerial imagery (Google 2009) and aerial photography (U.S. Department of Agriculture 2005). Using these data sets, the model maps the distribution of suitable San Joaquin spearscale habitat in the Plan Area according to the species' preferred habitat types, intersected with soil series and slope aspect. soil series, and slope position. Land uses that are incompatible with the species' habitat requirements, such as modeled habitat polygons falling on leveled or developed lands, were removed from the model.

2A.56.7.2 Habitat Model Description

San Joaquin spearscale requires high-value, permanent habitat that consists of alkali seasonal wetlands, vernal pool complex that displays characteristic vernal pool and swale visual signatures, and grasslands that have not been significantly affected by agricultural or development practices.

Soil types associated with San Joaquin spearscale were determined by overlaying the occurrence locations from the CNDDB onto the Soil Survey Geographic Database (SSURGO) (U.S. Department of Agriculture 2009). Soils mapped at occurrence locations are either clay or clay loam and generally alkaline. The following soil series in the Plan Area show occurrences of San Joaquin spearscale and were used to create the habitat model.

- Altamont
- Alviso
- Brentwood
- Capay
- Clear Lake
- Conejo
- Cropley
- Diablo
- Egbert
- Kimball
- Linne
- Marcuse
- Omni
- Pescadero
- Positas
- Reyes
- Rincon
- Riz
- San Ysidro
- Solano
- Sycamore
- Willows

Additionally, a constraint layer was created in the geographic information system (GIS) to remove candidate habitat areas that were deemed unsuitable after inspection of aerial site photography.

In 2011, and again in 2012, the species habitat models were updated to include previously unmapped portions of the Plan Area. The methods used to map these new analysis areas are described in Section 2A.0.1.7, *Species Habitat Suitability Model Methods*. For most areas newly mapped, vegetation data were not available at the alliance level as in the rest of the Plan Area and so most of the new analysis areas were mapped at the natural community level. Areas mapped comprise portions of the following natural community types that contain the soils series listed above.

- Alkali seasonal wetland complex
- Grassland
  - Upland annual grasslands & forbs formation
- Vernal pool complex

2A.56.7.3 Assumptions

- **Assumption:** San Joaquin spearscale habitat is restricted to the vegetation types described in Section 2A.56.7.2, *Habitat Model Description*.

  Rationale: Historical and current records of this species in the Plan Area indicate that its current distribution is limited to alkaline soil areas with shallow basin or swale microtopography along the western border (Figure 2A.56-2) (California Department of Fish and Game 2012b). The vegetation cover of the alkaline soils is typically a combination of alkaline soil

adapted species and annual grasses, including ryegrass (*Festuca perennis*) and Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*) (California Department of Fish and Game 2012b).

2A.56.8 Recovery Goals

A U.S. Fish and Wildlife recovery plan has not been prepared for this species and no recovery goals have been established.

2A.56.9 References Cited

2A.56.9.1 Literature Cited

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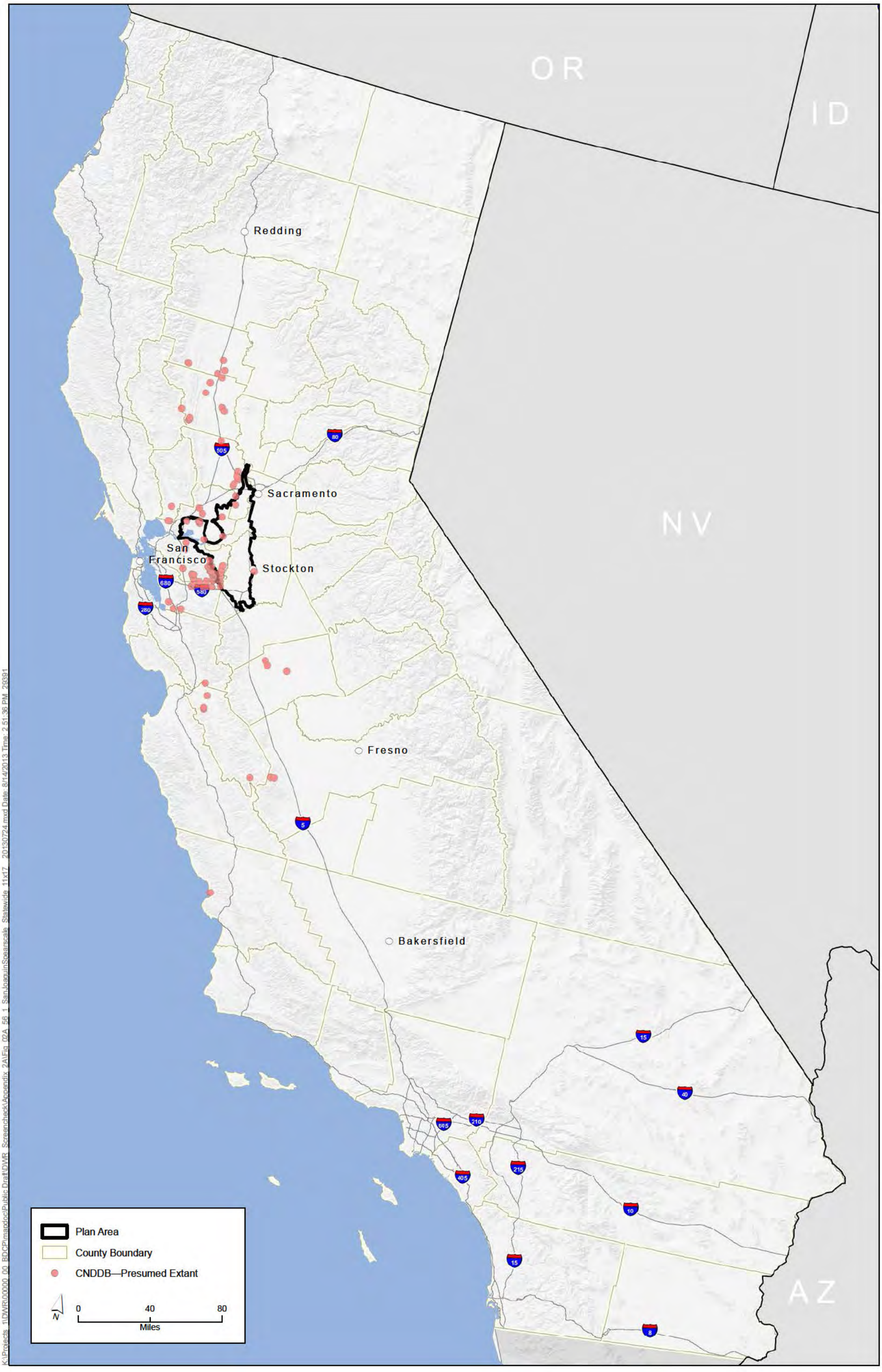
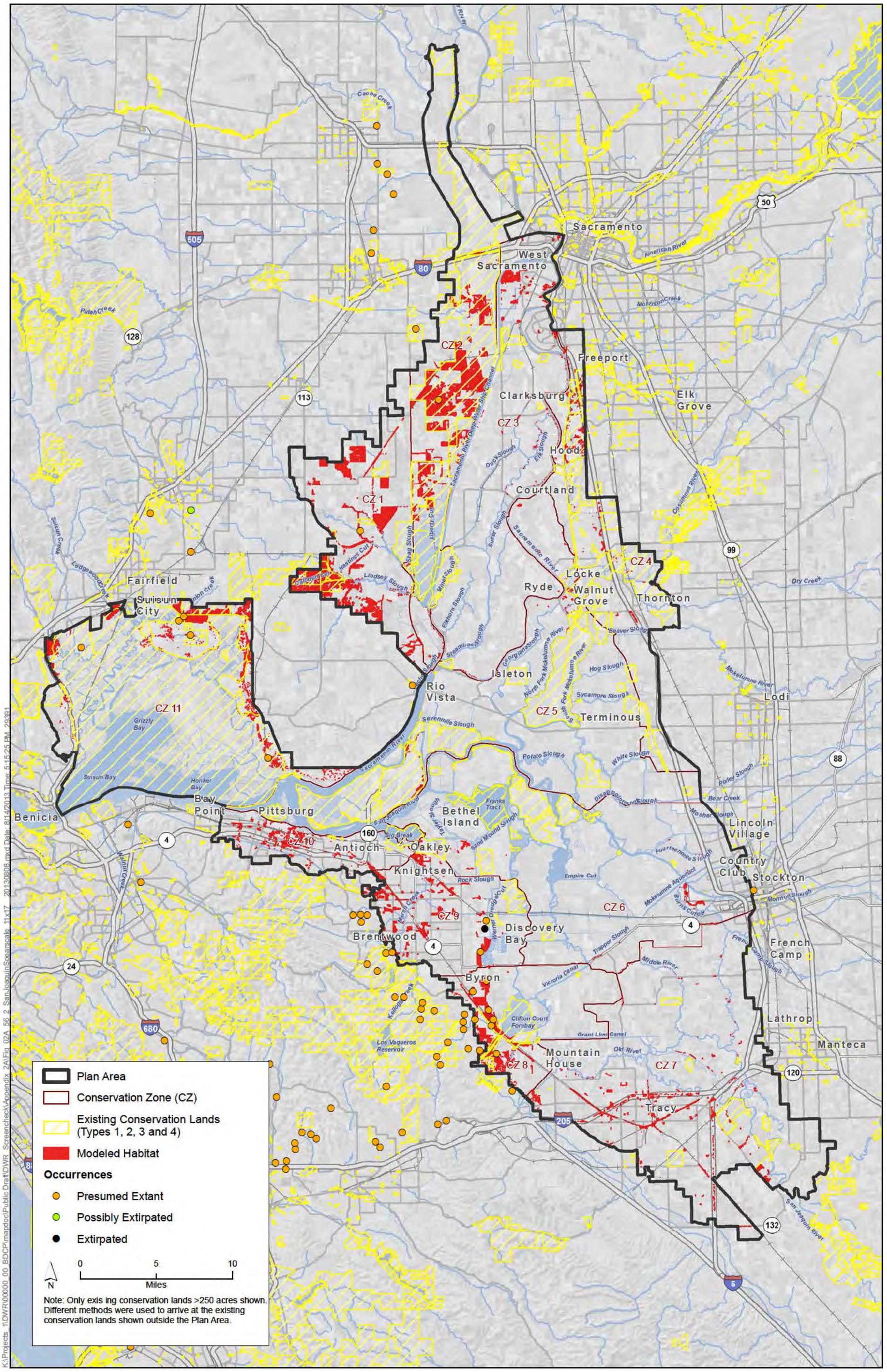


GIS Data Sources: Occurrences, CNDDB June 2013.

Figure 2A.56-1
San Joaquin Spearscale Statewide Range and Recorded Occurrences



K:\Projects_1\DWR\00000_00_BDCP\mapdoc\Public Draft\DWR_Screencheck\Appendix 2A\Fig_02A_56_2_SanJoaquinSpearscale_11x17_20130808.mxd Date: 8/14/2013 Time: 5:15:25 PM_20391

GIS Data Source: Existing Conservation Lands Outside Plan Area, CPAD 2013 and CDFG-WCB 2011; Occurrences, CNDDB June 2013 and DHCCP 2009-2011.

Figure 2A.56-2
San Joaquin Spearscale Habitat Model and Recorded Occurrences