A.1 Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)

A.1.1 Legal Status

The U.S. Fish and Wildlife Service listed the salt marsh harvest mouse (*Reithrodontomys raviventris*) as endangered in 1970 (35 FR 16047). The State of California listed the mouse as endangered in 1971 (Fish and Game Code, Sections 2050 et seq.). A recovery plan for the species was prepared in 1984 that is currently under revision.

Critical habitat has not been designated for this species.

A.1.2 Species Distribution and Status

Range and Status

The salt marsh harvest mouse is a small native rodent endemic to the salt marshes of San Francisco, San Pablo, and Suisun Bays (Figure A.1.1). The historical range of the species likely included most of the marshland in the San Francisco Bay Area. Closely associated with saline habitats, their eastern distribution is generally considered to extend as far as approximately Collinsville. The waters of wetlands and marshes east of this point are considered too fresh to support the habitat of this species (USFWS 2001).

The species has been divided into two subspecies. The southern subspecies (*R.r. raviventris*) occurs in the marshes of Corte Madera, Richmond, and South San Francisco Bay. The northern subspecies (*R.r. halicoetes*) is found in the marshes of San Pablo and Suisun Bays, from San Rafael Bridge to approximately Collinsville on the north and from Martinez to Pittsburg on the south (USFWS 2001).

Today, the species potentially occupies an area representing approximately 15 percent of the historical salt marsh habitat that formerly occurred in the San Francisco Bay Area (Dedrick 1989). Much of this remaining habitat, isolated by dikes and landfill, is subject to backfilling, subsidence, and vegetation changes, making it unable to support harvest mice (Shellhammer 1989). Thus, remaining populations are small and separated by large areas of unsuitable habitat.

Distribution and Status in the Planning Area

Reported occurrences of the salt marsh harvest mouse from within the BDCP Planning Area are restricted to salt and brackish tidal marshes along the northern edge of the Sacramento River and the southern edge of the San Joaquin River as far east as the vicinity of Collinsville and Antioch, west of Sherman Island (Figure A.1.2). This is consistent with the range of the species as described by USFWS (2001). WESCO (1991) also included freshwater marshes as possible habitat for this species. While there are several isolated patches of tidal freshwater emergent wetland east of Sherman Island; the species is not known to occur in these habitat patches and they are not included within the range of the species.

A.1.3 Habitat Requirements and Special Conditions

Salt marsh harvest mice are dependent on thick cover of native halophytes. Salt marsh harvest mice use pickleweed as their primary habitat as long as they have non-submerged, salt tolerant vegetation for escape during the highest tides. The mice prefer the deepest (60 to 75 centimeters

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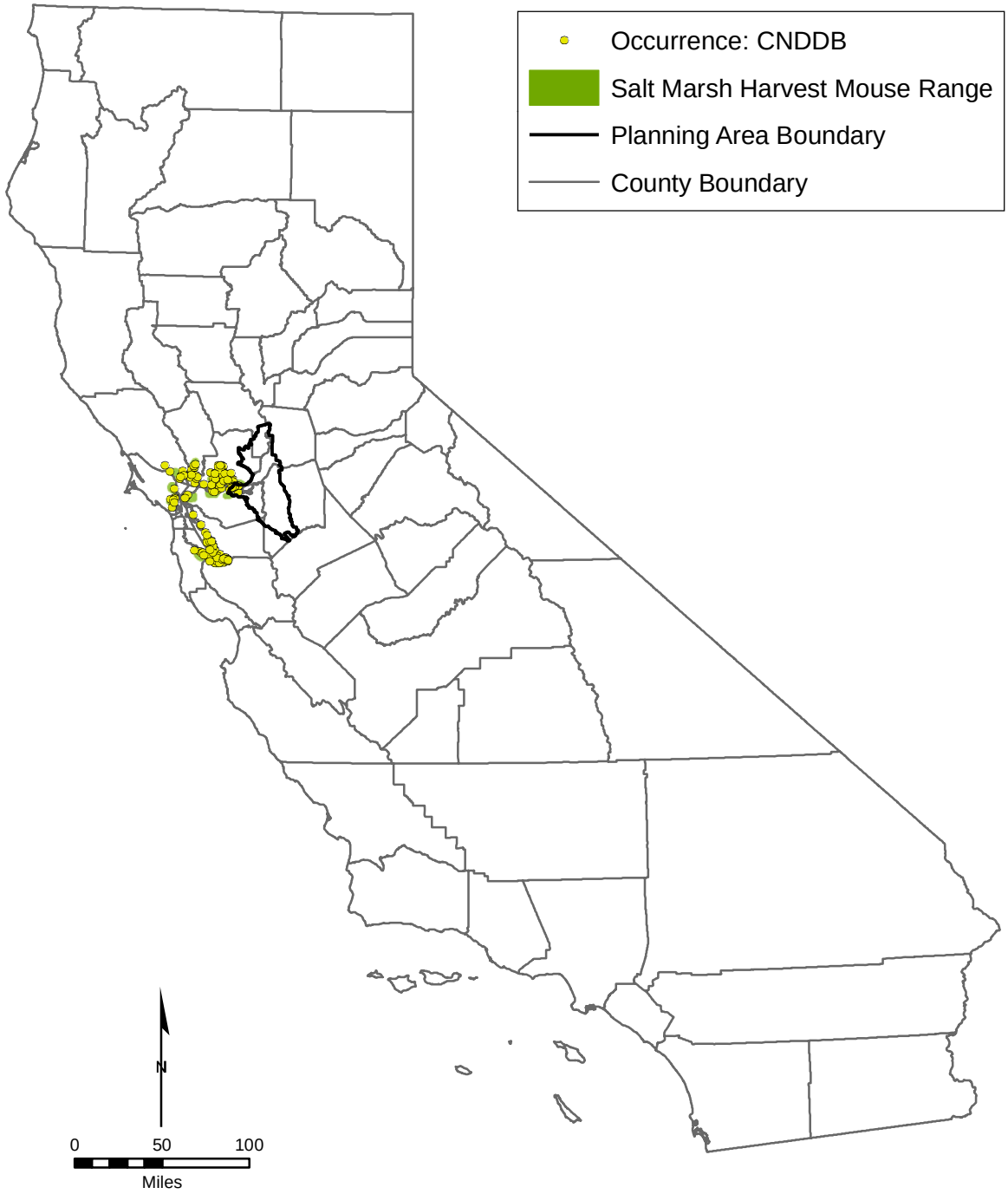

Source: California Department of Fish and Game, WHR, 2006.
California Department of Fish and Game, CNDDB, 2008.

Figure A.1.1. Salt Marsh Harvest Mouse Statewide Range and Recorded Occurrences

[cm] tall), most dense pickleweed (*Salicornia virginica*); intermixing with fat hen (*Atriplex patula*) and alkali heath (*Frankenia grandifolia*). Because this species has a non-aggressive nature toward other members of its own species, populations can be concentrated on high marsh levels during periods of high tides (Fisler 1965). Refuge is taken from these high tides in the upper zones of most marshes, usually in stands of fat hen and Australian salt bush (*Atriplex semibaccata*). These mice have also been found in the top zone of tidal marshes, and in transitional zones, which rarely flood (Shellhammer 1989). As a pure stand, salt grass (*Distichlis spicata*) has little habitat value for this species, though it may be advantageous as part of a component mixture (Shellhammer et al. 1982). Marshlands with low salinities and sparse pickleweed populations are not used by the salt marsh harvest mouse. This is important, because most diked marshes exist within the Suisun Marsh where less saline conditions are encouraged to optimize habitat for waterfowl (Shellhammer et al. 1982). Though previous reports have claimed this mouse is strictly confined to salt marshes, a recent study (WESCO 1991) placed them in salt, brackish, and freshwater marshes, and occupying nontidal uplands up to 150 feet (ft) from the wetland edge. However, tidal salt marshes with dense pickleweed cover are considered optimal habitat for this species. (California Department of Water Resources 2001)

The California Department of Water Resources (2001) assessment considered salinity requirements of salt marsh harvest mouse and determined that while the species can survive on salinities near or that of salt water for long periods (Fisler 1965), the southern subspecies (*R.r. raviventris*) in particular has adapted by developing a preference for a greater amount of salt in its diet (Fisler 1965). However, survival will not occur if sea water is the only drinking fluid available (Fisler 1965). The habitat for the northern subspecies (*R.r. halicoetes*) has been subjected to salinity ranges from fresh water to essentially sea water and therefore experiences greater fluctuations in water salinities than that of *R.r. raviventris*.

Salt marsh harvest mice have shown an ability to disperse considerable distances (Geissel et al. 1988); however, they apparently do not move through unvegetated areas, and thus, fragmentation of salt marsh habitats has limited dispersal opportunities. A corridor of suitable vegetation is required for movement and dispersal into adjacent habitats.

A.1.4 Life History

Description. The salt marsh harvest mouse is similar to the western harvest mouse (R. megalotis), in that it has a long bicolored tail, large ears, grooves in the outer surface of its upper incisors, and buff or brownish in color. The two species are differentiated by coloration (R. megalotis is typically found in grassland habitats and is considered to be the progenitor of the marsh species [Fisler 1965]). The underside of the western harvest mouse is, including its tail, ranges from white to dark gray, while the underside of the salt marsh harvest mouse is variable ranging from white to a cinnamon- or rufous-colored belly. The backs and ears of the salt marsh harvest mouse tend to be darker and its tail tends to be slightly thicker, less pointed, and more uncolored (USFWS 1999 in: LSA 2007). Adult salt marsh harvest mice are 118 to 175 millimeters (mm) in length and weigh between 0.28 and 0.42 ounces (8 and 12 grams).

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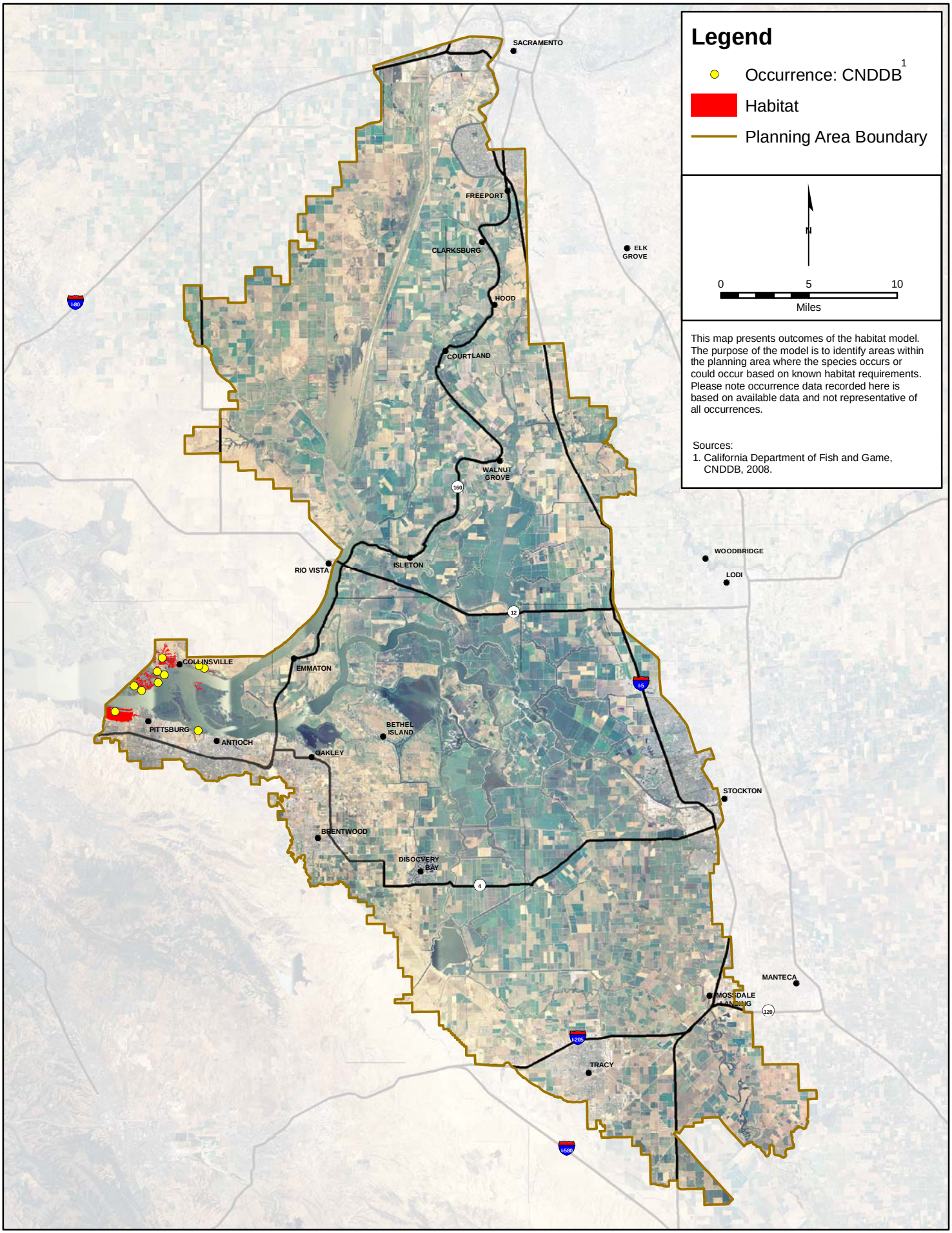

Figure A.1.2. Salt Marsh Harvest Mouse Habitat Model and Recorded Occurrences

Activity. The maximum life expectancy for salt marsh harvest mice is approximately 1 year; however, most survive less than 8 months. A generally solitary animal outside of the breeding season, this species typically remains beneath the canopy of dense low-lying vegetation and will sometimes use the ground runways of other rodents. Active year-round and primarily at night, this species responds to tidal action and can escape tidal or seasonal flooding by swimming or climbing, and will move into adjoining grasslands during the highest winter tides. Grasslands are otherwise used as habitat only when new grass growth affords suitable cover in spring and summer months. These movements probably occur only on a daily basis and do not represent a seasonal shift in habitat use. Young are able to disperse considerable distances, but are restricted today due to the fragmentation of suitable marsh habitats (Fisler 1965, Shellhammer et al 1982 in: LSA 2007).

Reproduction. Salt marsh harvest mice breed from spring through autumn, with females reproductively active from March to November. The breeding season for *R. r. raviventris* usually begins in March, while the breeding for *R. r. halicoetes* begins approximately 2 months later in May (Fisler 1965). Adults typically construct an aboveground nest of grasses and sedges about 150 to 175 mm in diameter. They sometimes construct the nest on top of bird nests and have been reported to use the nests of song sparrows. Females have a relatively low reproductive potential, bearing an average of four young per litter following a gestation period of 21 to 24 days. Also, while *R. r. raviventris* often produces two litters per year, *R. r. halicoetes* usually produces only one due to the shorter breeding season (Fisler 1965). Adults comprise the majority of the population.

Reproduction can also be suppressed by increasing populations of California meadow voles (*Microtus californicus*), which respond to decreasing salinities and vegetative cover. In years when *Microtus* populations are high, breeding for salt marsh harvest mice is suppressed further into the spring. If *Microtus* populations are high enough in a give area, populations of harvest mice can be reduced to the point of local extirpation. However, when water salinities and vegetative cover increase, harvest mice have a competitive edge due to their ability to withstand higher salinities in the water and food, and populations can recover (Geissel et al. 1988).

Diet. The diet of the salt marsh harvest mouse consists of seeds, grasses, forbs, and insects. They eat fresh green grasses in the winter and the stems and leaves of pickleweed and saltgrass during the rest of the year (Fisler 1965). As noted, this species can tolerate high salinities in both food and drink intake, which can give them a competitive advantage over Microtus when the salinity of the marsh increases (Geissel et al. 1988 in: LSA 2007).

A.1.5 Threats and Stressors

Loss and degradation of tidal marsh habitats continues to be the most significant threat to the salt marsh harvest mouse and other tidal marsh species. Tidal marshes have been reduced by 84 percent since historical times (Dedrick 1989). The loss and fragmentation of suitable habitats from commercial and residential development has isolated populations and reduced dispersal opportunities. The loss of tidal marsh habitat through filling and diking has largely been curtailed. However, other current factors associated with declining populations include the conversion of salt marshes to brackish marshes due to freshwater discharges from sewage treatment plants; introduction of non-native cordgrass, bulrush, saltgrass, and other plant species, predation by non-native red foxes and feral cats; and invasion of runoff, industrial discharges, and sewage effluent (Shellhammer 1982, DFG 2000, as cited in LSA 2007). Probably the most

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significant long-term issue is the predicted sea level rise as high as 1.2 meters within this century.

A.1.6 Relevant Conservation Efforts

The CALFED Bay-Delta Ecosystem Restoration Program Plan's Multi-Species Conservation Strategy (MSCS) designates the salt marsh harvest mouse as "Contribute to Recovery" (CALFED Bay-Delta Program 2000). This means that CALFED 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 ESAs.

The Suisun Marsh has been the subject of various conservation efforts for many years, particularly with respect to development and water quality-related issues within its boundaries. The following from the California Department of Water Resources Suisun Marsh Program (http://www.iep.water.ca.gov/suisun/program/index.html) summarizes the major agreements, management plans, and legislation that have directed management of the Suisun Marsh since the mid-1970s. These efforts focus on the preservation and restoration of tidal marsh habitats.

The Nejedly-Bagley-Z'Berg Suisun Marsh Preservation Act (1974). The California Legislature enacted the Suisun Marsh Preservation Act that protects the marsh from urban development. It required the San Francisco Bay Conservation and Development Commission to develop a plan for the Marsh and provides for various restrictions on development within Marsh boundaries.

Suisun Marsh Protection Plan (1976). This plan was developed by the Bay Conservation and Development Commission (BCDC) and defines and limits development within primary and secondary management areas for the "future of the wildlife values of the area as threatened by potential residential, commercial and industrial development". The Plan recommends that the state purchase 1,800 acres, and maintain water quality. While the focus of the Plan is on maintaining waterfowl habitat, the Plan also addresses the importance of tidal wetlands and recommends restoring historical marsh areas to wetland status (managed or tidal).

The Suisun Marsh Protection Act (1977). This bill adopts and calls for implementation of the Suisun Marsh Protection Plan. AB 1717 designates the BCDC as the State agency with regulatory jurisdiction of the Marsh and calls for the Suisun Resource Conservation District to have responsibility for water management in the Marsh. The bill identifies (and focuses on) actions for the preservation of waterfowl needs along with the retention of the diversity of wildlife. The Act states that land within the Suisun Marsh should be acquired for public use or resource management if it is suitable for restoration to tidal or managed marsh but that such restoration cannot be required as a condition of private development.

SWRCB Water Rights Decision 1485 (1978). SWRCB adopted the Water Quality Control Plan for the Sacramento San Joaquin Delta and issued Water Rights Decision 1485. The Decision includes: channel water salinity standards from October to May and preserves the area as brackish water tidal marsh. Set water quality standards in the Marsh as a condition of export pumping and were based on DFG's recommendations, which were based on 1) the relative value of marsh plants as duck food; 2) the influence of soil salinity and other factors on distribution and growth of marsh plants; and 3) the relationships between channel water salinity and soil salinity. DFG concluded that improved management practices, improved drainage, water control facilities, and adequate quality of water were needed to achieve desired soil salinity conditions for waterfowl food plants.

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Plan of Protection for the Suisun Marsh (1984). DWR and the USBR developed and began implementing the Plan of Protection (POP) in accordance with D-1485. The POP implementation strategy was to construct large facilities and distribution systems to meet salinity standards (lower channel water salinity), in lieu of significant Central Valley Project/State Water Project storage releases estimated as high as 2 million acre-feet in dry/critical water years. The six-phase Plan of Protection was the programmatic blue print (required by the SWRCB and embodied in the original Suisun Marsh Preservation Agreement). Two of the six phases were completed including the Initial Facilities and the Suisun Marsh Salinity Control Gates.

Suisun Marsh Preservation Agreement (1987). This contractual agreement between DWR, USBR, DFG and SRCD contains provisions for DWR and USBR to mitigate the effects on Suisun Marsh channel water salinity from the State Water Project and Central Valley Project operations and other upstream diversions. The Suisun Marsh Preservation Agreement requires DWR and USBR to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements. The Suisun Marsh Monitoring Agreement and the Suisun Marsh Mitigation Agreement were also signed at this time. The Suisun Marsh Mitigation Agreement defined habitat requirements to mitigate effects of facilities and operations and the Suisun Marsh Monitoring Agreement defines requirements for monitoring salinity and species in the Marsh.

Bay-Delta Accord (1994). On December 15, 1994, state and federal agencies, working with agricultural, environmental and urban stakeholders, reached agreement on water quality standards and related provisions that would remain in effect for 3 years. This agreement, known as the Bay-Delta Accord, was based on a proposal developed by the stakeholders. Elements of the agreement include:

- Springtime export limits expressed as a percentage of Delta inflow.
- Regulation of the salinity gradient in the estuary so that a salt concentration of two parts per thousand (X_2) is positioned where it may be more beneficial to aquatic life.
- Specified springtime flows on the lower San Joaquin River to benefit Chinook salmon.
- Intermittent closure of the Delta Cross Channel gates to reduce entrainment of fish into the Delta.

SWRCB Water Quality Control Plan (1995-1998). In 1994, wildlife and fishery agencies and urban water users expressed concerns about the appropriateness of western Suisun Marsh channel water salinity standards. The SWRCB, in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, May 1995, modified the Suisun Marsh salinity objectives. Modeling analysis by the Suisun Marsh Planning Program showed that Suisun Marsh standards would be met most of the time at all Suisun Marsh compliance stations. Some standard exceedances would be expected in the Western Marsh that participants to the SMPA agreed could be mitigated by more active water control by landowners.

SWRCB Water Rights Decision 1641 (1999). The SWRCB issued Decision 1641 in December 1999, which updated salinity standards for Suisun Marsh. Increased outflow and salinity requirements for the Bay-Delta provided indirect benefits to the Suisun Marsh. DWR proposed that the SWRCB adopt the Amendment Three actions for Suisun Marsh in this Decision. The SWRCB was unable to adopt Amendment Three actions because the Section 7 consultation with the USFWS had not concluded. However, the SWRCB did relieve USBR and DWR of its responsibility in meeting salinity objectives at S-35 and S-97 in the western Marsh.

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Suisun Marsh Charter Implementation Plan (2001). The Suisun Marsh Charter was completed in 2001 and commenced development of an Implementation Plan. Charter participants collaborated on a joint presentation to the State of the Estuary Conference on the principles of the Charter Plan including coordinated water quality, endangered species, and heritage value protection in the Suisun Marsh.

Habitat Management, Preservation, and Restoration Plan (2003). The expansion of the Charter process to include additional federal and state agencies to develop a Suisun Marsh Plan that will balance the goals and objectives of the Bay-Delta Program, Suisun Marsh Preservation Agreement (SMPA), and other management and restoration programs within the Suisun Marsh in a manner that is responsive to the concerns of all stakeholders and is based upon voluntary participation by private landowners.

In addition, several facilities have been constructed in the Suisun Marsh to protect and improve water quality and protect and enhance wildlife habitat including:

- Roaring River Distribution System (1979-80)
- Morrow Island Distribution System (1979-80
- Goodyear Slough Outfall (1979-80)
- Suisun Marsh Salinity Control Gates (1988)
- Cygnus and Lower Joyce Facilities (1991)

Several tidal marsh restoration projects are also planned or being implemented within the range of the salt marsh harvest mouse. These projects, implemented through the direction or support of the San Francisco Bay National Wildlife Refuge, National Biological Service, East Bay Regional Park District, Regional Water Quality Control Board, California Department of Fish and Game, and the City of San Jose include the following:

- Restoration of the 1,500 acre Napa Marsh Unit in the Napa River in the north bay;
- Restoration of the Knapp Property, a 452-acre former salt pond in the Alviso area, on the edge of the bay, between Alviso and Guadalupe Sloughs.
- Enhancement of the 325-acre Oro Loma Marsh, an area of diked salt marsh and adjacent uplands located along the shore of Hayward. The area will be restored to tidal marsh and seasonal wetland habitat.
- Restoration of the Baumberg Tract, a 835-acre inactive salt evaporator in Hayward to tidal marsh and seasonal wetlands.
- Restoration of the Moseley Tract located just north of the west approach to the Dumbarton Bridge from the Port of Oakland.

A.1.7 Species Habitat Suitability Model

Habitat. Salt marsh harvest mouse habitat includes *Salicornia*-dominated natural seasonal wetlands. Vegetation types designated as species habitat in this model correspond to the mapped vegetation associations in the BDCP GIS vegetation data layer.

Assumptions. Historical and current records of this species indicate that its distribution extends eastward to approximately Collinsville and Antioch (Figure A.1.2). This species is dependent on dense cover of native halophytes (salt-tolerant plants), and prefer pickleweed-dominated (*Salicornia virginica*) saline emergent wetlands as their habitat (Shellhammer et al. 1982). For purposes of this model, all *Salicornia*-dominated habitats along the western edge of Sherman Island westward are included within the potential range of the species. Suitability of habitat may

also be dependent on other factors, such as patch size, tidal connectivity (diked marshes), and proximity to other land uses. However, there is insufficient data on these issues relative to their effects on potential occupancy and thus potential habitat for the salt marsh harvest mouse is not further restricted in this habitat model on the basis of these factors.

A.1.8 Recovery Goals

The Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan was finalized in 1984. It is considered outdated and is under revision by the USFWS. Both species will be covered under the Tidal Marsh Ecosystem Recovery Plan.

Literature Cited

CALFED Bay-Delta Program. 2000. Ecosystem Restoration Program Plan. Volume II: Ecological Management Zone Visions. Final Programmatic ESI/EIR Technical Appendix. Available at: http://www.delta.dfg.ca.gov/erp/docs/reports_docs/ERPP_Vol_2.pdf.

California Department of Fish and Game (DFG). 2000. California's plants and animals: salt marsh harvest mouse. Habitat Conservation Planning Branch, Sacramento, CA. (http://www.dfg.ca.gov/hcpb/species/jsp/more_info.jsp?specy=mammals&idNum=47.)

California Department of Water Resources. 2001. Suisun Ecological Workgroup; Wildlife of the Suisun Marsh, Salt Marsh Harvest Mouse. Final Report to the State Water Resources Control Board. Sacramento, CA. Available at: http://www.iep.ca.gov/suisun_eco_workgroup/workplan/report/wildlife/shmouse.html.

Dedrick, K.G. 1989. San Francisco Bay tidal marshland acreages: recent and historic values. Proceedings of the 6th Symposium in Coastal and Ocean Management (Coastal Zone 1989). American Society of Engineers. pp. 383-398.

Fisler, G.F. 1965. Adaptations and speciation in harvest mice of the marshes of San Francisco Bay. University of California Publications in Zoology, Vol. 77. University of California Press, Berkeley, CA.

Geissel, W.H., H.S. Shellhammer, H.T. Harvey. 1988. The ecology of the salt marsh harvest mouse (*Reithrodontomys raviventris*) in a diked salt marsh. Journal of Mammalogy. 69: 696-703.

LSA Associates. 2007. Salt Marsh Harvest Mouse. Working Draft 2.2, Solano County Habitat Conservation Plan, Natural Community and Species Accounts. Prepared for the Solano County Water Agency.

Shellhammer, H.S. 1989. Salt marsh harvest mice, urban development, and rising sea levels. Conservation Biology. 3(1):59-65.

Shellhammer, H.S., R. Jackson, W. Davilla, A.M. Gilroy, H.T. Harvey, L. Simons. 1982. Habitat preferences of salt marsh harvest mice (*Reithrodontomys raviventris*). The Wasmann Journal of Biology. 40 (1-2): 102-114.

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USFWS (U.S. Fish and Wildlife Service). 1999. Biological Opinion for the Solano project water service contract renewal. U.S. Fish and Wildlife Service, Sacramento, CA. 107 pp.

USFWS (U.S. Fish and Wildlife Service). 2001. Salt marsh harvest mouse. Endangered Species Division, Sacramento Fish and Wildlife Office, Sacramento, CA. Available at: http://sacramento.fws.gov/es/animal_spp_acct/salt_marsh_harvest_mouse.htm.

WESCO. 1991. Final White Slough Retention Pond Enhancement Plan. Prepared for the City of Vallejo and the California Coastal Conservancy.

Federal Register Notices Cited

35 FR 16047. United States List of Endangered Native Fish and Wildlife. Federal Register. 35: 16047.

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