# Appendix 6.C, Suisun Marsh Species

# 6.C Terrestrial Effects Analysis Methods

This appendix describes the status of the species, environmental baseline, and effects of the PA on federally listed species occurring in Suisun Marsh. These include salt marsh harvest mouse, California Clapper rail, soft bird's beak, and Suisun thistle. Each of these species may be affected by operation of the Suisun Marsh salinity control gates.

## 6.C.1 Salt Marsh Harvest Mouse

### 6.C.1.1 Status of the Species/Environmental Baseline

The U.S. Fish and Wildlife Service (USFWS) listed the salt marsh harvest mouse (*Reithrodontomys raviventris*) as endangered in 1970 (35 *Federal Register* [FR] 16047). A recovery plan for the species was initially prepared in 1984 but has since been revised under the USFWS (2010a) *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Draft Tidal Marsh Recovery Plan). Critical habitat has not been designated for this species.

Reported occurrences of the salt marsh harvest mouse in the legal Delta and Suisun Marsh are restricted to salt and brackish diked and tidal wetlands and adjacent uplands of Suisun Marsh and the Delta west of Sherman Island.

Salt marsh harvest mice depend on dense cover of native halophytes (salt-tolerant plants). Deep (60 to 75 centimeters) and dense pickleweed (*Salicornia pacifica*, formerly *Salicornia virginica*), intermixed with fat-hen (*Atriplex prostrata [triangularis]* or *A. patula*) and alkali heath (*Frankenia salina*), is preferred in many areas. Salt marsh harvest mice are rarely found in alkali bulrush (*Bolboschoenus* maritimus subsp. *paludosus*, formerly *Scirpus maritimus*), pure stands of salt grass (*Distichlis spicata*), or cordgrass (*Spartina* spp.) (Shellhammer et al. 1982), which can displace pickleweed. However, more recent research has documented the species in dense stands of three-square bulrush (*Schoenoplectus americanus*) (U.S. Fish and Wildlife Service 2010b), as well as other kinds of dense halophytic vegetation. Thick thatch is apparently an important habitat component found in three-square bulrush communities (Shellhammer pers. comm.;U.S. Fish and Wildlife Service 2010b). Nonsubmerged escape cover is also required during high tides (Shellhammer et al. 1982). Fisler (1965) reported that populations can be concentrated on high marsh levels during periods of high tides. They have also been found in the top zone of tidal marshes and in transitional zones, which rarely flood (Shellhammer 1989). They will also move into adjacent grasslands during high tides. Fisler (1965) and Shellhammer (1982) reported that the species will occupy adjoining grasslands during the highest winter tides and will occasionally use grasslands during spring and summer, when new growth affords sufficient cover. Basson (2009) also reported use of nontidal uplands adjacent to wetland edge habitat.

Loss and degradation of tidal marsh habitats continue to be the most significant threats to the salt marsh harvest mouse and other tidal marsh species. Tidal marshes have been reduced by 84% since historical times (Dedrick 1989). The loss and fragmentation of suitable habitats from commercial and residential development in South Bay and San Pablo Bay have isolated populations and reduced dispersal opportunities. The loss of tidal marsh habitat through filling and diking has largely been curtailed. Cover removal from adjacent upland habitat by cattle grazing is a threat to salt marsh harvest mouse survival.

However, other current factors associated with declining populations include the conversion of salt marshes to brackish marshes as a result of freshwater discharges from sewage treatment plants; introduction of nonnative cordgrass, saltgrass, and other plant species; predation by nonnative red foxes and feral cats; and invasion of runoff, industrial discharges, and sewage effluent (Shellhammer et al. 1982; California Department of Fish and Game 2000; LSA Associates 2007). Probably the most significant long-term issue is the predicted sea level rise as high as 1.2 meters within this century.

### 6.C.1.2 Effects of the Proposed Action

The extent and characteristics of salt and brackish marshes in the Suisun Marsh are influenced by the amount of freshwater inflow. Freshwater inflow also can influence the concentration and residency time of various contaminants discharged to the San Francisco Bay. The degree of exposure to contaminants and risk of toxicological effects to salt marsh harvest mice has not been determined.

Predicted Delta inflow, Delta outflow and the location of X2 in the San Francisco Bay/Estuary were used to assess effects of implementation of PA facilities operations at the future level of development relative to the level of development in 2008, for the purpose of the CVP/SWP biological opinion (CH2MHill 2008). This analysis showed that Delta outflow and inflow would not change significantly in the future level of development. Furthermore, comparing the 82-year monthly averages, it was found that the Delta Outflow in the future scenario would decrease by less than 9% and the Delta inflow would decrease by less than 6%, with respect to 2008 conditions. Over the 82 years, on an average, the X2 position was predicted to shift just 0.4 km (0.25 mile) upriver relative to existing conditions. Comparing the water year type monthly averages, the farthest monthly average upriver shift was predicted to occur in September of wet years by 1.9 km, and the farthest monthly average downriver shift was predicted to occur in July of above normal years by 0.8 km (CH2MHill 2008). Only very small differences in Delta inflow, Delta outflow and X2 were found between the 2008 and future level of development indicating that implementation of the PA would not substantially change hydrologic conditions in the Delta and Bay (CH2MHill 2008).

Operation of the salinity control gates has the potential to modify the salinity regime in Suisun Marsh which could potentially affect salt marsh harvest mouse by modifying the vegetative components of its habitat. Operational criteria for the Suisun Marsh salinity control gates would not change under the PA relative to the no-action alternative, however and, as previously shown, operations modeling suggested that there would be little difference between the PA and the no-action alternative in terms of Suisun Marsh salinity control gate opening (see Table 5.B.5-29 in Appendix 5.B, *DSM2 Methods*). Since there would be negligible change in the operation of the control gates, the salt marsh harvest mouse habitat composition is not expected to change, therefore effects to this species, if any would be negligible.

### 6.C.1.3 Conclusion and Determination

The PA would result in only very small changes in Delta inflow, Delta outflow, and X2. Changes in the operation of the salinity control gates would have negligible effects. Thus, no substantial changes in the extent or quality of habitat or in the risk of toxicological effects from exposure to contaminants are expected. Based on the very small changes predicted between the current and future level of development, the PA may affect, but is not likely to adversely affect salt marsh harvest mouse.

## 6.C.2 California Clapper Rail

### 6.C.2.1 Status of the Species/Environmental Baseline

The California clapper rail (*Rallus longirostris obsoletus*) was listed by the USFWS as endangered pursuant to the federal Endangered Species Act on October 13, 1970 (35 *Federal Register* [FR] 16047). Critical habitat has not been designated for this species. Recovery for this species is addressed under the USFWS (2010a) *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Draft Tidal Marsh Recovery Plan).

Harvey (1980) reported the first California clapper rail in Suisun Marsh at Cutoff Slough in 1978, which extended their range east of the San Francisco Bay Area. A coordinated clapper rail survey was conducted by the San Francisco Bay Bird Observatory throughout the estuary between 1983 and 1986, resulting in two detections at the upper end of First Mallard Branch. Subsequent surveys, conducted by the California Department of Fish and Wildlife (CDFW) and the California Department of Water Resources (DWR), confirmed the presence of the species in several locations in Suisun Marsh including Hill Slough, Cutoff Slough, First and Second Mallard Branches, Suisun Slough from Goodyear Slough to Suisun Bay, Suisun Bay shoreline at the Suisun Marsh Reserve Fleet, Ryer Island, Point Edith Marsh, mouth of Boynton Slough, Union Creek, McCoy Creek and Suisun Slough at Morrow Island (California Department of Water Resources 1994) (Figure 2A.18-2). Liu et al. (2009) conducted additional surveys for California clapper rails in Suisun Marsh between 2005 and 2008 but found rails only at First Mallard Branch, Rush Ranch, and Goodyear Slough. They estimated the Carquinez Strait/Suisun Bay population at less than 13 individuals.

Throughout their distribution, California clapper rails occur within a range of salt and brackish marshes. In south and central San Francisco Bay and along the perimeter of San Pablo Bay, rails typically inhabit salt marshes dominated by pickleweed (*Salicornia pacifica,* formerly *S. virginica*) and Pacific cordgrass (*Spartina foliosa*). Pacific cordgrass dominates the middle marsh zone throughout the south and central Bay (U.S. Fish and Wildlife Service 1998).

Loss and degradation of tidal marsh habitats continue to be the most significant threats to California clapper rail. Tidal marshes have been reduced by 84% since historical times (Dedrick 1989). While the loss of tidal marsh habitat through filling and diking has largely been curtailed, other current factors associated with declining populations include the conversion of salt marshes to brackish marshes as a result of freshwater discharges from sewage treatment plants, a progressive rise in sea level, invasion of runoff, industrial discharges, and sewage effluent

(Ohlendorf and Fleming 1988; Ohlendorf et al. 1989; Harvey 1999; Lonzarich et al. 1990; Leipsic-Baron 1992; Takekawa et al. 2006).

The suitability of many marshes for clapper rails is further limited, and in some cases precluded, by their small size, fragmentation, and lack of tidal channel systems and other microhabitat features. These limitations render much of the remaining tidal marsh acreage unsuitable or of low value for the species. In addition, tidal amplitudes are much greater in South San Francisco Bay than in San Pablo or Suisun Bays (Atwater et al. 1979). Consequently, many South Bay tidal marshes are completely submerged during high tides and lack sufficient escape habitat, likely resulting in nesting failures and high rates of predation. The reductions in carrying capacity in existing marshes necessitate the restoration of larger tracts of habitat throughout the current range of the species to maintain stable populations.

### 6.C.2.2 Effects of the Proposed Action

California clapper rails are endemic to salt and brackish marshes of San Francisco Bay. The amount of freshwater inflow to the Bay can influence the extent and characteristics of salt and brackish marshes as well as affect the concentrations and residency times of various contaminants discharged to the Bay. In particular, if freshwater inflows to the Bay are reduced, the extent of salt and brackish marshes could be reduced and/or the clapper rails could be exposed to higher concentrations of contaminants such as silver, copper, mercury, and selenium. These contaminants can have toxicological effects in birds (USFWS 2000).

Delta inflow, Delta outflow, and the location of X2 were used to assess potential effects of the facilities operation on California clapper rail (CH2MHill 2008). As described for the salt marsh harvest mouse, the future level of development is predicted to have only very small effects on these parameters. Thus, no substantial changes in the extent or characteristics of habitat for salt marsh harvest mouse or in potential exposure to contaminants are expected under the proposed action.  Therefore, the effects of the proposed action on California clapper rail are expected to be insignificant.

Operation of the salinity control gates has the potential to modify the salinity regime in Suisun Marsh which could potentially affect California clapper rail by modifying the vegetative components of its habitat. Operational criteria for the Suisun Marsh salinity control gates would not change under the PA relative to the no-action alternative, however and, as previously shown, operations modeling suggested that there would be little difference between the PA and the no-action alternative in terms of Suisun Marsh salinity control gate opening (see Table 5.B.5-29 in Appendix 5.B, DSM2 Methods). Since there would be negligible change in the operation of the control gates, the California clapper rail habitat composition is not expected to change.

Because hydrologic conditions in the Delta would be substantially similar under the future level of development, the extent of salt and brackish marsh would not be affected and the risk of exposure of California clapper rails to harmful levels of contaminants would not change. Therefore, the effects of the proposed action on California clapper rail are expected to be insignificant.

### 6.C.2.3 Conclusion and Determination

The PA would result in only very small changes in Delta inflow, Delta outflow, and X2. Changes in the operation of the salinity control gates would have negligible effects. Thus, no substantial changes in the extent or quality of habitat or in the risk of toxicological effects from exposure to contaminants are expected. Based on the very small changes predicted between the current and future level of development, the PA may affect, but is not likely to adversely affect California clapper rail.

## 6.C.3 Soft Bird's-Beak

### 6.C.3.1 Status of the Species/Environmental Baseline

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). 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 Suisun Marsh 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).

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).

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 (Fiedler et al. 2007; Grewell et al. 2003; Grewell 2005). 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).

### 6.C.3.2 Effects of the Proposed Action

The PA could affect this species through hydrologic or salinity changes that influence the extent or characteristics of its marsh habitat. Delta inflow, Delta outflow, and the location of X2 were used to assess potential effects of the facilities operation on soft bird's-beak (CH2MHill 2008). As described for the salt marsh harvest mouse, the future level of development is predicted to have only very small effects on these parameters. Thus, no substantial changes in the extent or characteristics of habitat for soft bird's-beak are expected under the proposed action. Therefore, the effects of the PA on soft bird's-beak are expected to be insignificant.

Operation of the salinity control gates has the potential to modify the salinity regime in Suisun Marsh which could potentially affect soft bird's beak by modifying its habitat. Operational criteria for the Suisun Marsh salinity control gates would not change under the PA relative to the no-action alternative, however and, as previously shown, operations modeling suggested that there would be little difference between the PA and the no-action alternative in terms of Suisun Marsh salinity control gate opening (see Table 5.B.5-29 in Appendix 5.B, DSM2 Methods). Since there would be negligible change in the operation of the control gates, the soft bird's beak habitat conditions are not expected to change, therefore effects to the species or its critical habitat would be negligible, if any.

### 6.C.3.3 Conclusion and Determination

The PA would result in only very small changes in Delta inflow, Delta outflow, and X2. Changes in the operation of the salinity control gates would have negligible effects. Thus, no substantial changes in the extent or quality of habitat are expected. Based on the very small changes predicted between the current and future level of development, the PA may affect, but is not likely to adversely affect soft bird's-beak or its critical habitat.

## 6.C.4 Suisun Thistle

### 6.C.4.1 Status of the Species/Environmental Baseline

Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) is listed as endangered under the federal Endangered Species Act (November 1997; 62 *Federal Register* [FR] 61916). The 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 2012). 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).

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 Wildlife 2013).

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).

### 6.C.4.2 Effects of the Proposed Action

As a tidal marsh associated plant, Suisun thistle is sensitive to changes in hydrology (i.e., changes in the timing and duration of inundation) and salinity. Delta inflow, Delta outflow, and the location of X2 were used to assess potential effects of the facilities operation on Suisun thistle (CH2MHill 2008). As described for the salt marsh harvest mouse, the future level of development is predicted to have only very small effects on these parameters. Thus, no substantial changes in the extent or characteristics of habitat for Suisun are expected under the proposed action. Therefore, the effects of the proposed action on Suisun thistle are expected to be insignificant.

Operation of the salinity control gates has the potential to modify the salinity regime in Suisun Marsh which could potentially affect Suisun thistle by modifying its habitat. Operational criteria for the Suisun Marsh salinity control gates would not change under the PA relative to the no-action alternative, however and, as previously shown, operations modeling suggested that there would be little difference between the PA and the no-action alternative in terms of Suisun Marsh salinity control gate opening (see Table 5.B.5-29 in Appendix 5.B, DSM2 Methods). Since there would be negligible change in the operation of the control gates, Suisun thistle habitat conditions are not expected to change.

### 6.C.4.3 Conclusion and Determination

The PA would result in only very small changes in Delta inflow, Delta outflow, and X2. Changes in the operation of the salinity control gates would have negligible effects. Thus, no substantial changes in the extent or quality of habitat or in the risk of toxicological effects from exposure to contaminants are expected. Based on the very small changes predicted between the current and future level of development, the PA may affect, but is not likely to adversely affect Suisun thistle.

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