

Cordylanthus mollis ssp. *mollis*
(Soft Bird's-Beak)

**5-Year Review:
Summary and Evaluation**



Photo by Valary Bloom

**U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California**

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5-YEAR REVIEW

***Cordylanthus mollis* ssp. *mollis* (Soft Bird's-Beak)**

I. GENERAL INFORMATION

Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview

Cordylanthus mollis ssp. *mollis* is a hemiparasitic annual herb in the Orobanchaceae (broomrape) family. It grows in the coastal salt marshes and brackish marshes of San Pablo and Suisun Bays, in Solano, Contra Costa, Sonoma, and Marin Counties. Historically, *C. mollis* ssp. *mollis* ranged from the Petaluma River near the City of Novato in Marin County, in the west, to the mouth of the Sacramento River in Sacramento County, in the east. The species is currently restricted to widely scattered populations in Napa, Solano, and Contra Costa Counties, from Point Pinole and Fagan Slough marsh through the Carquinez Strait to Suisun Bay. Much of its original habitat has been lost or fragmented due to marsh alteration and development. Extant populations are threatened by muting (damping) of tides and salinity, invasive non-native plants, seed predation, sea level rise predicted to result from global climate change, mosquito abatement, oil spills, and (for these small populations) random events.

I.A. Methodology Used to Complete this Review

This review was conducted by a fish and wildlife biologist within the Sacramento Fish and Wildlife Office, using information from species survey and monitoring reports and peer-reviewed journal articles. Survey information, peer reviewed publications, and personal communications with experts on the species were the primary sources of information used to update the species status and threats section of this review.

Contact Information

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Federal Register Notice citation announcing initiation of this review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on February 14, 2007 (72 FR 7064). We received no information from the public in response to this notice.

Listing History

Original Listing

FR notice: 62 FR 61916

Date listed: November 20, 1997

Entity listed: *Cordylanthus mollis* ssp. *mollis*, a plant subspecies.

Classification: Endangered

State Listing

Cordylanthus mollis subsp. *mollis* (soft bird's-beak) was listed as a rare species by the State of California in 1979.

Associated Rule makings

In the final listing rule for *Cordylanthus mollis* ssp. *mollis* and *Cirsium hydrophilum* var. *hydrophilum*, we determined that the designation of critical habitat was not prudent because the designation would not be beneficial to the conservation of the two subspecies (U.S. Fish and Wildlife Service 1997). In November 17, 2003, the Center for Biological Diversity and others filed a lawsuit in the Northern District of California against the Secretary of the Interior, challenging the not prudent determination of critical habitat for the two subspecies (Center for Biological Diversity, *et al.* v. Gale Norton, Secretary of the Department of the Interior, *et al.*, CV 03-5126-CW). On June 14, 2004, the U.S. District Court Judge signed an Order granting a stipulated settlement agreement between the two parties. The Service agreed to propose critical habitat for the two plant subspecies on or before April 1, 2006, and finalize the designation on or before April 1, 2007. A proposed rule to designate critical habitat for the two plant subspecies was published in the Federal Register on April 11, 2006 (71 FR 18456).

On April 12, 2007, the Service published a final rule in the Federal Register to designate critical habitat for *Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle) and *Cordylanthus mollis* ssp. *mollis* (72 FR 18517; U.S. Fish and Wildlife Service 2007). Sites designated for *C. mollis* ssp. *mollis* were Fagan Slough Ecological Reserve; Hill Slough Wildlife Area; Point Pinole Regional

Park; Rush Ranch/Grizzly Island Wildlife Area; and Benicia State Recreation Area (BSRA; U.S. Fish and Wildlife Service 2007).

Review History. No relevant reviews have previously been conducted since listing.

Species' Recovery Priority Number at Start of 5-Year Review.

The recovery priority number for *Cordylanthus mollis* subsp. *mollis* is 9c according to the Service's 2007 Recovery Data Call for the Sacramento Field Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a subspecies that faces moderate degree of threat and has a high potential for recovery. The "c" indicates conflict with construction or other development projects or other forms of economic activity.

Recovery Plan or Outline

The Sacramento Fish and Wildlife Office is currently preparing a draft recovery plan for this species.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) policy

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. Because the species under review is a plant, the DPS policy is not applicable, and the application of the DPS policy to the species' listing is not addressed further in this review.

Information on the Species and its Status

Cordylanthus mollis ssp. *mollis* occurs in salt and brackish tidal marshes fringing San Pablo and Suisun Bays in the San Francisco Bay area of northern California.

Abundance

At the time of listing, there were nine occurrences of *Cordylanthus mollis* ssp. *mollis* scattered throughout coastal salt or brackish tidal marshes fringing San Pablo and Suisun Bays, in Solano and Contra Costa Counties (CNDDDB 1994). In the final listing rule, it was reported that the number of individuals within the populations varied from 1 to 150,000 plants and that most sites varied between 1,000 and 6,000 plants (CNDDDB 1996). We also noted that individual populations fluctuate in size from year to year, as is typical of annual plants (U.S. Fish and Wildlife Service 1997).

Past surveys have shown that many extant locations support high densities of plants numbering in the thousands to the tens of thousands within small, localized populations (Stromberg and Villasenor 1986; Rugyt 1994; CNDDDB 2005). Other locations consist of widely scattered populations with few individual plants. Some populations may fail to appear entirely for several years and reappear later in the same general area. The reasons for the population fluctuations are not well known.

Since listing, it is thought that there are 11 populations with documented occurrences in eight general areas: Rush Ranch, Hill Slough, Benicia State Recreation Area (BSRA; also called Southampton Marsh), Joice Island, and Denverton in Solano County, Point Pinole, Concord Naval Weapons Station, and McAvoy Boat Harbor in Contra Costa County, and Fagan Slough in Napa County. The Rush Ranch population described in the final listing rule was extirpated around 1999 due to trampling by cattle; however, a new population was established the following year at a nearby location (B. Grewell, University of California, Davis, in litt. 2008).

Rangewide, no recent comprehensive status survey has been conducted for *Cordylanthus mollis* ssp. *mollis*. The most recent near-comprehensive population census was conducted in 2000 by Brenda Grewell *et al.* (2003). This census covered Hill Slough marsh and Rush Ranch, both in Suisun Marsh, Solano County. It also included California Department of Parks and Recreation's (CDPR) BSRA, and Fagan Slough Ecological Reserve (Napa County) (Grewell *et al.* 2003). The largest population in that 2000 survey was found at Hill Slough Wildlife Area and covered approximately 4.7 acres (1.9 hectares). The status of the Hill Slough population and threats facing it is unknown.

A more recent population survey was conducted in 2004 (Grewell 2005). This study, funded by the Solano Water Agency, was a population distribution and status evaluation strictly for reference populations at BSRA and the population at the site of the experimental reintroduction at Rush Ranch (discussed further below). In the 2004 survey, the Rush Ranch population was estimated to be 95,510 individuals, occupying 0.2 acre (0.08 hectare). The estimated population at BSRA had the highest numbers ever recorded for a population of *Cordylanthus mollis* ssp. *mollis* (99,005 individuals), occupying a total area of 0.77 acre (0.31 hectare) (Grewell 2005). Many annual plants, including *C. mollis* ssp. *mollis*, are known to have high fluctuations in population sizes among years, and the high numbers recorded in 2004 may be a reflection of this characteristic. The high numbers may also be a reflection of refined survey efforts, this being the most thorough search ever conducted, based on specific micro-habitats surveyed (Grewell 2005). According to Grewell (2005), although population monitoring at Rush Ranch and BSRA indicated continued population growth from 2000 to 2004, seed production of the reintroduced population at Rush Ranch plummeted for unknown reasons in 2004.

Though one population at Point Pinole Regional Park (Contra Costa County) was extirpated in approximately 2004, overall, there has been a slight increase over the last three years in the number of populations. However, given the annual variation in population numbers, this may not be indicative of the long-term trend. The extirpated population existed on an approximately three to four foot high heavy clay bank that was undergoing slumping, as described in the final listing rule (Stromberg and Villasenor 1986). It appears that the plants were sloughed off during bank erosion (W. Legard, East Bay Regional Parks District, pers comm. 2007). The overall

Cordylanthus mollis ssp. *mollis* population at Point Pinole Regional Park seems to have remained stable over recent years (Legard, pers comm. 2007).

In July and August of 2005, surveys of *Cordylanthus mollis* ssp. *mollis* were conducted at U.S. Department of Navy's Concord Naval Weapons Station (CNWS; Contra Costa County). Approximately 8,429 individuals were identified at 25 locations during the survey. No other recent data are available from CNWS.

A population of *Cordylanthus mollis* ssp. *mollis* exists at California Department of Fish and Game's (CDFG's) Fagan Slough Ecological Reserve. However, its status there since Grewell's 2000 survey is unknown. The status of those populations and threats facing them is unknown.

Occurrences near Denverton Slough (Suisun Marsh, Solano County) thought to be erroneous at the time of listing, were proven legitimate in 2000. That year also, occurrences at McAvoy Boat Harbor (Contra Costa County) were confirmed. Both populations exist on private land and the status of them since 2000 is unknown.

In summary, in the absence of long-term monitoring data, it is difficult to give a meaningful estimate of abundance for *Cordylanthus mollis* ssp. *mollis*. Several of the known locations have not been surveyed in over 5 years and the others have only been surveyed once within that period. Using the best scientific and commercial data available, we must assume that there have not been significant increases or decreases in abundance at any locations since the final listing rule.

Reintroduction of *Cordylanthus mollis* ssp. *mollis*

The extant populations include a reintroduced population of *Cordylanthus mollis* ssp. *mollis* at Rush Ranch established by Brenda Grewell and funded by the CALFED Bay Delta Program in 2000. This population constitutes an additional population beyond the one mentioned at Rush Ranch in the final listing rule which was later extirpated, as described above and under Factor E below. The new site is one mile from the extirpated population, was screened for appropriateness for reintroduction through analysis of parameters such as soil biogeochemistry, hydrology, and plant community composition and structure (Grewell, in litt. 2008). Propagules for reintroduction were collected from the nearby Joice Island population (Grewell, in litt. 2008). Emergent *C. mollis* ssp. *mollis* seedlings resulting from the reintroduction were first observed at Rush Ranch in April 2001. An experimental reintroduction, this project was conducted on a small scale to inform future larger scale reintroduction projects, none of which have occurred to date.

Spatial distribution, trends in spatial distribution, or historic range:

At the time of listing, there were nine known occurrences of *Cordylanthus mollis* ssp. *mollis*, including Point Pinole, Rush Ranch, Joice Island, Fagan Slough, Hill Slough, CNWS, and McAvoy Boat Harbor, scattered throughout coastal salt or brackish tidal marshes fringing San Pablo and Suisun Bays, in Napa, Contra Costa, and Solano Counties (CNDDDB 1994).

Although no recent comprehensive status surveys have been conducted, the latest information indicates that 11 extant populations of *Cordylanthus mollis* ssp. *mollis* are currently distributed within 50 percent of the historical range and that a large percentage of the remaining plants are in Solano County (Grewell *et. al.* 2003). Some areas within the remaining 50 percent of the historic habitat could presumably still support the species, however, many areas have been altered so that they are no longer suitable.

Results of Brenda Grewell's 2004 field census at Rush Ranch and BSRA revealed a wider distribution and greater number of *Cordylanthus mollis* ssp. *mollis* population patches at BSRA than were previously known (Grewell 2005). Grewell (2004) found that the majority (65 percent) of *C. mollis* ssp. *mollis* population patches at BSRA were at the high elevation tidal marsh-upland transition. However, the greatest abundance of the rare plants was near first order tidal creek banks.

Though the number of occurrences has increased since the final listing rule, the increase appears to be due to the fact that the occurrences near Denverton Slough (Suisun Marsh, Solano County) thought to be erroneous at the time of listing, were proven legitimate in 2000, as mentioned above. Using the best scientific and commercial data available, we must assume that there have not been significant increases or decreases in spatial distribution since the final listing rule.

Disturbance-gap manipulation

Grewell (2004) provided new evidence that disturbance management can have a positive effect on the established density of *Cordylanthus mollis* ssp. *mollis*. Specifically, disturbance-gap manipulation coupled with direct seeding into appropriate communities shows promise as a reintroduction technique. However, disturbance-gap management also resulted in high rates of non-native plant invasions that were linked to rare plant seedling mortality (Grewell 2004).

Seed bank and dispersal

Since the time of listing, research into both persistence of the seed bank and short-distance seed dispersal has been conducted. Results of an experimental seed bank study showed that *Cordylanthus mollis* ssp. *mollis* maintains at least a short-term persistent seed bank that can greatly influence population dynamics and persistence (Grewell 2005). Limited information exists on seed dispersal mechanisms for *C. mollis* ssp. *mollis*. Seeds may disperse short distances from parent plants by tidal inundations or animals (Grewell *et al.* 2003), but successful long-distance dispersal by these or other means has not been documented.

Pollination

Grewell *et al.* (2003) observed bees determined to represent five genera and one bee-fly acting as potential pollinators on the flowers of *Cordylanthus mollis* ssp. *mollis* at the reintroduced population at Rush Ranch and a natural population at Hill Slough marsh. Although the presence of pollinators is necessary for seed reproduction, it is important to recognize that some floral visitors may not be pollinating (Grewell *et. al.* 2003). Confirmation of pollination requires observation of pollen transfer from the visitor to the stigma, pollen transfer between flowers or

amongst plants, and determination of pollen viability (Kearns and Inouye 1993). This knowledge would require a dedicated in-depth study and is recommended as a potential step toward recovery.

Habitat or Ecosystem Conditions

Cordylanthus mollis ssp. *mollis* is found predominantly in the high marsh (upper reaches) of salt grass-pickleweed marshes at or near the limits of tidal action (Stromberg and Villasenor 1986) and is associated with *Salicornia virginica* (pickleweed), *Distichlis spicata* (salt grass), *Jaumea carnosa* (fleshy jaumea), *Frankenia salina* (alkali heath), and *Troglochin maritima* (arrow-grass) (Stromberg and Villasenor 1986).

As a hemiparasitic plant, seedling survival in *Cordylanthus mollis* ssp. *mollis* is critically dependent on establishing an early connection with a suitable host plant. Hemiparasites are parasitic plants that are capable of some photosynthesis, but receive crucial host subsidies of water, nitrogen, fixed carbon, and mineral compounds through underground organ connections to vascular tissues in host plant roots for water and soil nutrients (Ruygt 1994; Grewell *et al.* 2003).

Most known *Cordylanthus mollis* ssp. *mollis* occurrences are found in regularly flooded and permanently saturated habitats within mixed halophytic plant communities, that is, communities where plants are adapted to live and reproduce in salt or brackish water (NWI 2005). Tidal events are important for regulating tidal marsh plant communities and may be a critical factor in decreasing granivory (see Factor C) and regulating the life cycle phases of the subspecies. The species' dependence on establishing a connection to a suitable host plant is explained further below under Factor E.

In addition to tidal inundation and salinity regimes, a 2008 study by Grewell found that parasitic plants, including *Cordylanthus mollis* ssp. *mollis*, may also influence plant community organization. Grewell states that presence of parasitic plants reduced the abundance of competitive dominant plants, yet also reduced abiotic stress and increased local plant species richness (Grewell 2008). Hemiparasites may have played a larger role as habitat modifiers in San Francisco Estuary under historic tidal regimes prior to modern reduction of tidal prism following water diversions and extensive diking of wetlands. Even under today's muted regimes, if a suitable host community is in place, the ability of hemiparasites to generate spatial heterogeneity by ameliorating physical stress throughout their patchy distribution within the high intertidal zone could be of practical use in the restoration of species-rich salt marshes (Grewell 2008).

Though most locations supporting *Cordylanthus mollis* ssp. *mollis* have not undergone detailed assessments of habitat or ecosystem conditions, it is clear that most locations do not support full ecosystem function due to muted tidal action, increased freshwater inflow or invasive species issues.

Changes in Taxonomic Classification or Nomenclature

In 2001, all *Cordylanthus* taxa were moved from the Scrophulariaceae to the Orobanchaceae family (Olmstead *et. al.* 2001).

Five-Factor Analysis

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

In the final listing rule, threats under this factor all related to alteration of the natural tidal regime (*i.e.*, diking and filling involved in agricultural land conversion and urbanization, changes to freshwater inflow, waste disposal, salt production, changes in freshwater inflow, and habitat fragmentation). Since the time of listing, new habitat conversion for purposes of urbanization or from tidal marsh to new seasonal wetlands has ceased to occur in habitat for *Cordylanthus mollis* ssp. *mollis* on public land, but not necessarily on privately owned land. The widening of Highway 37, listed as a potential threat in the final listing rule has occurred since listing, however the extent of effects, if any, to suitable *C. mollis* ssp. *mollis* habitat upstream is not known. The proposed widening of Highway 12 near Suisun Marsh, also listed as a potential threat in the final listing rule, has not occurred to date.

Since listing, continuation of altered tidal regimes still occurs in much of the potential habitat and represents both the most significant historical and current threat to *Cordylanthus mollis* ssp. *mollis* and its habitat. With respect to effects to *C. mollis* ssp. *mollis*, alteration of tidal regime includes muting of tidal flows, increases in freshwater runoff, or decreases in freshwater inflows such as diversion of freshwater for agricultural and municipal uses, that increase salinity, a fact not cited in the final listing rule. *Cordylanthus mollis* ssp. *mollis* habitat in the San Francisco estuary has dwindled over the last 200 years, San Pablo Bay and Suisun Bay having experienced 70 and 79 percent reductions in tidal marsh, respectively (Goals Project 1999). Historically, a large portion of tidal marshes in San Pablo Bay were diked and managed for agricultural production and livestock grazing (discussed further under Factor E), whereas, in Suisun Bay, most historical tidal marshes were diked and managed for waterfowl, though cattle grazing also occurred. These historical reductions of habitat have affected the extent and composition of tidal marsh communities. As a result, many native halophytic (salt-tolerant) plants are exceedingly rare in tidal marshes within the estuary (Goals Project 1999).

Some *Cordylanthus mollis* ssp. *mollis* occurrences exist in muted tidal marshes around the perimeter of high tidal areas near Hill Slough and Fagan Slough marshes, where they were once completely diked and managed. They are likely able to persist because just enough tidal flow reaches the population. The occurrences of *C. mollis* ssp. *mollis* populations in muted marshes, though, may likely be a result of dormant seed banks and associated marsh conditions that still promote their establishment. These populations face the risk of extirpation if the levee fails or is unmaintained in the future. Also, future land use and management activities that further mute tidal flows in these marshes may rapidly alter marsh conditions to further restrict or exclude the subspecies from the local plant community (Goals Project 1999).

Muting of tidal flows is known to have extirpated *Cordylanthus mollis* ssp. *mollis* in at least one instance. Mitigation for the expansion of the Potrero Hills Landfill, initiated in 2002, involved extending tidal flows into a mitigation area to support vernal pool species, thereby reducing, and in some cases eliminating, tidal flows from the Hill Slough area which supported *C. mollis* ssp. *mollis*. Continuous hydrologic recorders in place at the site since 2001 to support local restoration research documented the change in hydrology that resulted in negative impacts to *C. mollis* ssp. *mollis*. Remedial actions did not occur and the local population of the plant was extirpated as an indirect result of muting of tidal flows associated with the landfill expansion and mitigation (Grewell, in litt. 2008). With the exception of this situation, there are generally no longer areas where tidal circulation is being *newly* eliminated or reduced near existing populations.

Changes to freshwater inflow have also modified the habitat for this species. For example, at BSRA, increased freshwater runoff from nearby urban development has replaced halophytic communities (including species such as *Salicornia virginica* (pickleweed) with freshwater emergent marsh communities not appropriate as host plants (Grewell, pers comm. 2007).

Alternatively, agricultural and municipal uses have diverted much historical annual inflow of freshwater from the Suisun Marsh and Delta, creating a more saline environment. In addition, artificially variable soil salinities may threaten *Cordylanthus mollis* ssp. *mollis* by reducing the distribution and abundance of its host plants. However, while the *natural* hydrological cycles of fresh and salt water are imperative, Grewell *et al.* (2003) found that soil salinity (and soil physical type [texture, bulk density, organic matter content]) was not predictive of *C. mollis* ssp. *mollis* occurrence. The species, like its outer coast salt marsh congeners, colonizes a wide range of soil types and is not soil specific. Host community composition and vigor (*i.e.*, healthy host plants that live long enough for their parasitizing *C. mollis* ssp. *mollis* plants to set seed) to support the hemiparasite load are much more important habitat variables, as are host canopy light or disturbance gaps to facilitate germination (Grewell *et al.* 2003). In fact, as long as tidal inundation and soil salinity are not wildly variable, as mentioned above, hemiparasites can help to ameliorate physical stress conditions. Conversely, the loss of an endangered parasitic plant has the potential to reduce habitat heterogeneity and change the distribution and abundance of other species in the salt marsh (Grewell 2008).

Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of *Cordylanthus mollis* ssp. *mollis*. Conservation of high marsh zones in the face of sea level rise requires landward migration of the marsh profile on broad, sloping plains (Field *et al.* 1999, Baye 2006). Many alluvial terraces and valleys adjacent to the estuary are bordered by steep levees or are already converted to intensive agriculture, residential, or commercial development. In Suisun and northern San Pablo Bay, however, some undeveloped grazing land remains. Conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could cease to support *C. mollis* ssp. *mollis* habitat (Grewell 2006). Land use planning and economic pressures that favor conversion of “underdeveloped” grazing lands contribute to the loss of potential transgressive high marsh habitat for long-term viability of the species (Baye 2006).

Mosquito abatement activities noted in the final listing rule continue to threaten *Cordylanthus mollis* ssp. *mollis* populations, though to a lesser degree than the above threats. Specifically, ditch cleaning and dredging along first order channels for mosquito abatement purposes alter the natural hydrology of the habitat and chemical spraying of vegetation threatens the species as well.

In summary, removal of necessary hydrology via alteration of tides and exclusion of necessary host plants via the associated alteration of soil salinity present the most significant threats under Factor A. Though a lesser threat in terms of immediate time horizon, sea level rise threatens to compress the tidal marsh zones to a point at which they cease to support *Cordylanthus mollis* ssp. *mollis*. Mosquito abatement activities continue to threaten the species to a lesser degree (Grewell 2006).

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

As stated in the final listing rule, overutilization currently is not known to be a factor for this species. Increased collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants was expected to potentially result from increased publicity resulting from publication of the final listing rule (U.S. Fish and Wildlife Service 1997). We have no new information regarding this threat.

FACTOR C: Disease or predation:

In the final listing rule, intense seed predation by insects was reportedly observed at Joice Island and Hill Slough within the Suisun Marsh in Solano County (U.S. Fish and Wildlife Service 1997). Insect predation reportedly was responsible for decline in one of the largest populations of *Cordylanthus mollis* ssp. *mollis*. Since the time of listing, much light has been shed on the specifics of *C. mollis* ssp. *mollis* seed predation which still poses a threat to populations in Suisun Marsh.

Cordylanthus mollis ssp. *mollis* seed production can be significantly influenced by pre-dispersal seed predation from moth larvae (*Saphenista* spp., Tortricidae and salt marsh snout moth, *Lipographis fenestrella*, Pyralidae) (Ruygt 1994; Grewell *et al.* 2003). Areas with muted tidal regimes can support the subspecies (CDWR 1999), but increased tidal muting can constitute a threat to *C. mollis* ssp. *mollis* by increasing the prevalence of unsuitable host plants, and by changing the balance of seed production to seed predation maintained between the plant and seed-eating moths, such as various *Saphenista* species (Grewell 2004; Grewell 2006). The moth larvae burrow in the sediment during part of their life cycle, so reduced tidal flooding may improve their survivorship. Under full tidal regimes, the interaction between the rare Lepidopteran moth (*Cordylanthus mollis* specialist) and its rare plant host appears to be in balance (Grewell *et al.* 2003; Grewell 2004).

The extent of granivory at BSRA and Fagan Slough Ecological Reserve were low and these populations did not appear to be limited by granivores. However, at sites where hydrology was muted, pre-dispersal granivory was extremely high. This has been especially problematic in the

Hill Slough area of Suisun Marsh, where the *Cordylanthus mollis* ssp. *mollis* population remains persistent, but under muted tidal regimes population fecundity has continued to decline (Grewell 2006).

Over the next decade, through various regional conservation planning efforts it is expected that several projects aimed at restoring natural tidal regimes will be initiated at sites where natural tidal flows are currently muted. As more areas with muted tides are restored to more natural tidal habitat in the San Pablo and Suisun Bay areas, it is reasonable to expect that the threat from seed granivores may decrease, for reasons discussed above.

In summary, though the final listing rule acknowledged seed predation as a threat to *Cordylanthus mollis* ssp. *mollis*, since listing we have learned that increased muting of tides increases rates of granivory. The best available information tells us that seed predation remains a significant threat, especially in areas where the natural tidal regime has been muted.

FACTOR D: Inadequacy of existing regulatory mechanisms:

Although the final listing rule listing *Cordylanthus mollis* ssp. *mollis* stated that Section 404 of the Clean Water Act represents the primary Federal law that affords some protection to the species since it occurs in wetlands, it also stated that the Clean Water Act, by itself, does not provide adequate protection to the species. The Service, as part of the Section 404 review process, provides comments to the U.S. Corps of Engineers on nationwide permits and individual permits, however, the Service's comments are only advisory. In practice, a rare plant species would likely not receive any special consideration with regard to conservation or protection unless it was listed under the Act (62 FR 61916).

The final listing rule described *Cordylanthus mollis* ssp. *mollis* as being state-listed as rare under the California Endangered Species Act (chapter 1.5 sec. 2050 et seq. of the California Fish and Game Code and Title 14, California Code of Regulations 670.2) in July 1979. Although CDFG requires a permit to "take" the species, no permit is needed to take the plant via habitat modification or land use changes by the landowner. The only protection in this regard is that the California Native Plant Protection Act requires that the landowner notify the agency at least 10 days in advance of changing the land use to allow salvage of the plant (NPPA Division 2, Chapter 10, section 1913). Salvaging is unlikely to be beneficial for *C. mollis* ssp. *mollis*, an annual species, as no evidence exists that the species would survive transplantation (62 FR 61916).

Several *Cordylanthus mollis* ssp. *mollis* occurrences identified in the final listing rule were located on lands not in Federal, State or other conservation ownership at that time. All of these locations remain in private ownership today and, therefore, are not likely being managed for protection of the habitat. Potential habitat near the occurrences at Fagan Slough and Hill Slough marshes is in private ownership (U.S. Fish and Wildlife Service 2007). In addition, occurrences at Denverton Slough and McAvoy Boat Harbor are in private ownership. We do not know whether populations on private land face the same threats as those occurring on public land or whether those threats are being addressed if they exist. As is the case at BSRA, even on public land, threats have yet to be fully controlled.

At the time *Cordylanthus mollis* ssp. *mollis* was listed as endangered (62 FR 61916), although California Environmental Quality Act (CEQA) required disclosure of potential environmental impacts of proposed projects and identification of opportunities for conservation efforts, it did not guarantee that such conservation efforts would occur. Protection of listed species through CEQA was, therefore, dependent upon the discretion of the lead agency involved.

Absent the listing of the species as endangered under the Act, no changes in the adequacy of protections of section 404 of the Clean Water Act, the California Endangered Species Act or CEQA are known to have resulted since the time of listing.

Two regional planning efforts provide (or will provide upon completion) some degree of conservation. The Suisun Marsh Protection Plan of 1976 (SMPP) establishes a “primary management area” in Suisun Marsh that encompasses, among others, the privately and publicly owned areas proposed as critical habitat units 2 and 4 for *Cordylanthus mollis* ssp. *mollis*. The plan recommends that areas within the primary management area “should be protected and managed to enhance the quality and diversity of the habitats”. It further recommends that “the tidal marshes in the primary management area should be preserved” and that “where feasible, historic marshes should be returned to wetland status”. This plan has been generally successful in limiting and defining development in the area.

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan (SMHMP) is being developed by the Suisun Marsh Charter Group (Charter Group), a collaborative effort among Federal, State, and local agencies with primary responsibility for actions in the Suisun Marsh. The Charter Group was formed in 2001 to resolve issues of amending the Suisun Marsh Preservation Agreement (SMPA), obtain a Regional General Permit from the U.S. Army Corps of Engineers, implement the Suisun Marsh Levee Program, and recover local populations of threatened and endangered species. The Charter Group has been charged with developing a regional plan that would outline the actions needed in Suisun Marsh to preserve and enhance managed seasonal wetlands, restore tidal marsh habitat, implement a comprehensive levee protection and improvement program, and protect ecosystem and drinking water quality. The proposed SMHMP also would provide for simultaneous protection and enhancement of: (1) the Pacific Flyway and existing wildlife values in managed wetlands; (2) threatened and endangered species; (3) tidal marshes and other ecosystems; and (4) water quality, including, but not limited to, the maintenance and improvement of levees. The SMHMP is expected to be completed (via Notice of Determination and Record of Decision) by October 2009.

In addition, the CNWS prepared and is implementing an Integrated Natural Resource Management Plan (INRMP) at the CNWS (USDN 2002) which, among other things, protects *Cordylanthus mollis* ssp. *mollis* and its habitat. Management of the tidal habitat supporting *C. mollis* ssp. *mollis* will be transferred to the U.S. Army in the near future (Wallerstein 2006). The U.S. Army has agreed to carry out the existing INRMP (Rouhafza 2002).

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

In the final listing rule, hybridization with *Cordylanthus mollis* ssp. *hispidus*, chronic pollution

and associated clean-up efforts (including oil spills and heavy metal contamination from point and non-point sources), unpermitted seed harvesting and planting, mosquito abatement activities, foot traffic, erosion, grazing, and increased risk of extinction from random events due to habitat fragmentation were described as threats under this factor.

Since listing, it is believed that all of these threats continue to occur in some degree within habitat of *Cordylanthus mollis* ssp. *mollis*, however some threats are better understood and described below. The most significant threat under Factor E, however, was not specifically mentioned in the final listing rule. Aside from the alteration of natural tidal cycles, the most significant threat to the species is that from invasion of non-native plants, especially winter annuals, which are inappropriate host plants. Since the time of listing, the threat posed by non-native plant competitors and winter annuals as inappropriate host plants has become more defined.

As a hemiparasitic plant, seedling survival in *Cordylanthus mollis* ssp. *mollis* is critically dependent on establishing a connection with a suitable host plant before seed reserves are depleted. Typical host plants include *Distichlis spicata* (salt grass) and *Salicornia virginica* (pickleweed) (Grewell *et al.* 2003, Grewell 2004). Demographic monitoring data indicate that *C. mollis* ssp. *mollis* is most vulnerable at the emergent seedling stage. High levels of premature mortality were found to be correlated with the presence of non-native winter annual grasses in the immediate vicinity of *C. mollis* ssp. *mollis* seedlings (Grewell *et al.* 2003). Non-native winter annuals such as *Hainardia cylindrica* (bargrass) and *Polypogon monspeliensis* (annual rabbitsfoot grass) or native winter annuals such as *Juncus bufonius* (toad rush) are not suitable hosts since they typically die before *C. mollis* ssp. *mollis* can flower and produce seeds (Grewell *et al.* 2003, 2004). The prevalence of inappropriate plant hosts is correlated with muted tidal regimes (Grewell *et al.* 2003, 2004).

Lepidium latifolium (perennial pepperweed) and *Spartina patens* (salt-meadow cord grass) are two non-native species endangering native tidal marsh ecosystems in the range of *Cordylanthus mollis* ssp. *mollis* (Grewell 2005). Both plants are highly invasive, however *L. latifolium* is thought to be a more significant threat due to its proximity to *C. mollis* ssp. *mollis* occurrences, especially in Suisun Marsh. *Lepidium latifolium* is also of particular concern because it forms large monospecific patches that displace native marsh vegetation. L.C. Lee and Associates (2003) observed that one of the five most dominant associates of *C. mollis* ssp. *mollis* at Rush Ranch, based on canopy coverage in sample plots, was *L. latifolium*. *Lepidium latifolium* is a highly invasive non-native plant that forms monospecific stands that are very difficult to remove. It occurs along the high marsh edge in San Francisco Bay, especially in disturbed areas, deposits of sand or tidal litter, or levee slopes. In brackish marshes with lower salinity, it invades the middle marsh plain and channel edges. A perennial herb, it grows from rhizomes or adventitious root-buds and is a prolific seed producer. It is considered the most problematic and widespread invasive plant in Suisun Marsh (Grewell 2005). A *L. latifolium* control plan is currently being developed by Solano Land Trust for implementation at Rush Ranch. Though a threat to populations at Hill Slough and BSRA also, the degree of threat to populations at other locations is not known. Currently there is no known effective control or eradication plan for *Lepidium latifolium* that is operative within the range of *Cordylanthus mollis* ssp. *mollis*.

Spartina patens also exists in the general vicinity of *Cordylanthus mollis* ssp. *mollis* habitat. It presents a more minor threat to *C. mollis* ssp. *mollis* because it is not known to exist along the high marsh edge. However, it does present a threat to the high marsh plant community in general in that the species displaces native habitat essential for a fully functioning ecosystem. *Spartina patens* is a fine-stemmed, creeping, matted grass, which forms dense turfs with tussocky (clumping) peaks in salt or brackish marshes (Blum 1968). It has been present at BSRA since at least the 1960's (Munz 1968). There it occurs as a relatively continuous colony on the marsh plain adjacent to the south bank of a tidal creek, and as numerous, dense, essentially monotypic colonies on the marsh plain. The distribution and abundance of *Spartina patens* colonies at BSRA suggests that it has been reproducing both by seed and clonal growth for many years, and is continuing to spread.

Off-road vehicle traffic associated with mosquito control (discussed under Factor A) continues to threaten *Cordylanthus mollis* ssp. *mollis* populations in most known locations (Grewell 2005; CNDDDB 2006). Foot traffic in Suisun Marsh at the time of listing was believed to contribute to habitat degradation via trampling. Foot traffic remains a threat today, specifically via excessive recreational and research access (Grewell, pers. comm. 2007).

Oil spills and chronic pollution from point and non-point sources are unavoidable occurrences that continue to occur in or near habitat for *Cordylanthus mollis* ssp. *mollis* (U.S. Fish and Wildlife Service 2007). In particular, because of their location, Point Pinole and BSRA populations are the most threatened by oil spills and pollution (U.S. Fish and Wildlife Service 2006). On April 27, 2004, Kinder Morgan Energy Partners, L.P. spilled approximately 84,714 gallons of diesel fuel through a ruptured pipeline in western Suisun Marsh near Roos Cut. Although the spill occurred within potential habitat for *C. mollis* ssp. *mollis*, no known populations were affected. The Cosco Busan container ship hit the Bay Bridge in November 2007, spilling over 50,000 gallons of fuel. Monitoring was not specifically conducted at known *C. mollis* ssp. *mollis* sites, however, given the prevailing ebb flow and location of contaminated shorelines, it is not believed *C. mollis* ssp. *mollis* habitat was affected (McBride, pers. comm. 2008).

Cattle grazing still occurs and introduced feral hogs (*Sus scrofa*) roam *Cordylanthus mollis* ssp. *mollis* habitat in some locations (Grewell *et al.* 2003). Cattle and feral hogs can degrade habitat for the species by trampling and can also damage the plant itself by crushing fragile underground connections (haustoria) to host plants. These connections are critical to the hemiparasitic life history of *C. mollis* ssp. *mollis*. In fact, the Rush Ranch population described in the final listing rule was extirpated due to trampling by cattle around 1999 (Grewell, in litt. 2008). Populations at Hill Slough and Rush Ranch (the reintroduced population) are currently subject to rooting, wallowing, trampling, and grazing impacts from livestock and feral hogs that could result in damage or loss to *C. mollis* ssp. *mollis* populations or soil disturbance and compaction leading to a disruption in natural marsh ecosystem processes (U.S. Fish and Wildlife Service 2006).

Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, fire, oil spills, genetic

or demographic problems or a combination of these events. For example, human-caused fires present a continual threat of at least temporary habitat loss in Suisun Marsh. Three fires have occurred recently within potential *Cordylanthus mollis* ssp. *mollis* habitat in Suisun Marsh (Grewell, pers comm. 2007). Arsonists set fire to Peytonia Slough Ecological Reserve in 2001 and 2007, the former of which burned the only remaining previously known local population of *Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle), a generally associated federally endangered plant. It is not known how fire affects the viability of *Cordylanthus mollis* ssp. *mollis* seed, but it is considered a minor threat nonetheless.

No new information exists regarding the threat of hybridization with *Cordylanthus mollis* ssp. *hispidus*, so we must assume the threat is still present. Also, though a *permitted* reintroduction effort involving seed harvesting and planting has been conducted (Grewell *et. al.* 2003), no new information exists regarding the threat of *unpermitted* seed harvesting and planting. We must also assume this threat still persists.

In summary, the greatest threat to *Cordylanthus mollis* ssp. *mollis* under Factor E, though not mentioned in the final listing rule, is the invasion of non-native winter annuals which serve as inappropriate host plants to the hemiparasite. In descending magnitude of threat, competition from non-native plants and trampling from cattle and feral hogs continue to threaten the species. Though oil spills and chronic pollution and risk of extinction of small populations due to random events are less frequent and/or less likely to occur than the above threats, they would have more catastrophic results, should they materialize. Off road vehicle and foot traffic, hybridization with *Cordylanthus mollis* ssp. *hispidus* and unpermitted seed harvesting and planting remain threats to a lesser degree.

III. Recovery Criteria

Does the species have a final, approved recovery plan containing objective, measurable criteria? No.

IV. Synthesis

While populations appear generally stable at the major population centers where status surveys have been recently conducted, at other populations centers no recent surveys have been conducted, making current population estimates difficult. Muting of tidal cycles, seed predation, and invasion of non-native competitor plants continue to threaten all the species occurrences to some degree, as noted in the final listing rule. Furthermore, although not noted in the final listing rule, along with muting of tidal cycles, inappropriate host plants in *Cordylanthus mollis* ssp. *mollis* habitat is likely the most significant threat to all occurrences of the species. These are immediate, ongoing, widespread and significant threats which show no sign of being ameliorated in the near future. Though itself not a threat of immediate consequence, the significant ramifications of sea level rise due to global climate change demands proper planning now to avoid loss of populations and habitat in the future. To a lesser degree, trampling from cattle and feral hogs, off-road vehicle and foot traffic, mosquito abatement activities, oil spills, chronic pollution, hybridization with *C. mollis* ssp. *hispidus*,

unpermitted seed harvesting and planting, and extirpation of small populations due to random events also threaten the survival of *C. mollis* ssp. *mollis*.

These threats face the species regardless of whether ownership is public or private. Where *Cordylanthus mollis* ssp. *mollis* exists on private land, threats to the species or habitat are not likely being managed at all. Although regional management and/or restoration planning efforts are underway for tidal habitat in public ownership, it is too soon to know whether those efforts will result in increased populations of *C. mollis* ssp. *mollis*. Functional habitat management plans are not yet being implemented fully and, in some cases, are still in the development stages. Moreover, tidal restoration efforts are often dependant upon economic and political climates. Therefore, these efforts represent potential, but not current amelioration of the significant threats facing *C. mollis* ssp. *mollis*. The ultimate status of the species depends heavily on full implementation of management plans. Maintaining stable populations will depend upon future diligent management by CDFG, USDN, Solano Land Trust, C DPR, and other involved landowners, particularly to control non-native plants.

After reviewing the best available scientific and commercial data, the Service concludes that *Cordylanthus mollis* ssp. *mollis* should remain classified as endangered. The threat posed by invasive plant species and muting of tidal cycles and associated seed predation remains an immediate, widespread, significant and ongoing threat to all *C. mollis* ssp. *mollis* populations. Compounding all of the threats is the fact that *C. mollis* ssp. *mollis* often exists as small populations, making it susceptible to extinction due to random events.

V. RESULTS

Recommended Classification:

- Downlist to Threatened
- Uplist to Endangered
- Delist (*Indicate reasons for delisting per 50 CFR 424.11*):
 - Extinction
 - Recovery
 - Original data for classification in error
- No change is needed

New Recovery Priority Number 9c (No change)

It is recommended that the recovery priority number remain 9c. The species continues to have a moderate degree of threat, a high potential for recovery, and some degree of potential conflict with construction or other development projects or economic activity.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT FIVE YEARS

- 1) A recovery plan for *Cordylanthus mollis* ssp. *mollis* should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft

recovery plan for this species and five other listed tidal marsh species is currently in development at SFWO.

- 2) Control of non-native competitor species and non-native winter annual species should be conducted at all appropriate sites. *Lepidium latifolium* should be targeted at Hill Slough Wildlife Area, Rush Ranch, BSRA, and other population locations where it presents a threat and *Spartina patens* (salt-meadow cord grass) should be targeted at BSRA. Non-native winter annuals that invade upper tidal marsh habitats at the known locations should be controlled to increase survival of *Cordylanthus mollis* ssp. *mollis* seedlings (Grewell *et al.* 2003). Initially, surveys for these invasive plants should occur at each site in order to document the extent of spread and prioritize treatment efforts.
- 3) Natural tidal cycles of San Pablo and Suisun Bays should be maintained or restored to the extent possible because middle to high marsh areas with periodic tidal flooding provide appropriate hydrology and help retain the healthy extent and composition of tidal marsh communities, including *Cordylanthus mollis* ssp. *mollis*. Additionally, natural tidal regimes encourage low abundance of damaging non-native winter annuals and seed predators.
- 4) Surveys should be conducted within potential *Cordylanthus mollis* ssp. *mollis* habitat as well as at known population centers to identify potential new occurrences as well as to provide an updated species status with which to make management decisions.
- 5) Management of *Cordylanthus mollis* ssp. *mollis* habitat should involve reducing trampling and breaking of haustorial connections to host plants by grazed cattle and feral hogs. Removal of cattle and feral hogs or other protection of the populations from grazing should occur at Hill Slough and Rush Ranch populations, as well as other locations where trampling presents a threat to *C. mollis* ssp. *mollis*. A regional-scale feral hog eradication effort should be coordinated with CDFG to decrease that species' impact on habitat for sensitive plants.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Cordylanthus mollis* ssp. *mollis* (Soft Bird's Beak)

Current Classification Endangered
Recommendation resulting from the 5-Year Review

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Review Conducted By Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Susan YC Moore Date 1/16/09

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Fish and Wildlife Service

Approve Millon 2/11/09