California clapper rail
(*Rallus longirostris obsoletus*)

5-Year Review:
Summary and Evaluation

Photo by Allen Edwards

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

April 2013

5-YEAR REVIEW

California clapper rail (*Rallus longirostris obsoletus)*

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. The California clapper rail was listed as endangered under the Endangered Species Preservation Act in 1970, so was not subject to the current listing processes and, therefore, did not include an analysis of threats to the California clapper rail. In this 5-year review, we will consider listing of this species as endangered or threatened 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 this species. We will consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed. 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:

The California clapper rail (*Rallus longirostris obsoletus*) belongs to the order Gruiformes, in the family Rallidae, which includes rails, gallinules, and coots. The genus *Rallus* consists primarily of marsh-dwelling birds with short rounded wings, large feet, and long toes. California clapper rails occur almost exclusively in tidal salt and brackish marshes with unrestricted daily tidal flows, adequate invertebrate prey food supply, well developed tidal channel networks, and suitable nesting and escape cover as refugia during extreme high tides.

Historically, the range may have extended from salt marshes of Humboldt Bay to Morro Bay. The salt marshes of San Francisco Bay have been the center of its abundance. The California clapper rail now occurs only within the tidal salt and brackish marshes around San Francisco Bay where it is restricted to less than 10 percent of its former geographic range. Densities reached an historical low of about 500 birds in 1991, then rebounded somewhat. Results of an estuary-wide survey estimated a minimum average population between 2005 and 2008 of 1,425 California clapper rails (Liu *et al*. 2009), however, densities declined during that period at a per-year rate of 20 percent and current numbers are likely lower.

As described in the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Recovery Plan) (U.S. Fish and Wildlife Service 2010), lack of extensive blocks of tidal marsh with suitable structure is the ultimate limiting factor for the species' recovery; vulnerability to predation by native and non-native predators is exacerbated by reduction of clapper California clapper rail habitat to narrow and fragmented patches close to urban edge areas that diminish habitat quality. Further, anticipated sea level rise presents a high magnitude threat in the long-term, especially in the central and south San Francisco Bay where opportunities for landward migration of habitat are nearly absent. Levees provide artificial access for terrestrial predators, and displace optimal cover of high marsh vegetation. The rapid invasion of San Francisco Bay by exotic *Spartina alterniflora* (smooth cordgrass) and its hybrids with the native *S. foliosa* (Pacific cordgrass) has presented a unique challenge. In the near-term, eradication poses a severe threat to California clapper rails and their habitat. Finally, contaminants, particularly methylmercury, are a significant factor affecting viability of California clapper rail eggs.

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Draft Recovery Plan, survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDB 2011) maintained by the California Department of Fish and Game (CDFG). The Draft Recovery Plan and personal communications with experts were our primary sources of information used to update the species' status and threats. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing. We focus on current threats to the species that are categorized by the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

Lead Regional Office: Larry Rabin, Deputy Division Chief for Listing, Recovery, and Environmental Contaminants, Pacific Southwest Region; (916) 414-6464.

Lead Field Office: Josh Hull, Recovery Division Chief, Sacramento Fish and Wildlife Office, (916) 414-6600.

Cooperating Field Office(s): Bay Delta Fish and Wildlife Office

Federal Register (FR) 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 May 21, 2010 (75 FR 28636). We received no comment letters in response to the Federal Register Notice initiating this 5-year review.

Listing History:

<u>Original Listing</u>
FR Notice: 35 FR 16047
Date of Final Listing Rule: October 13, 1970
Entity Listed: California clapper rail (*Rallus longirostris obsoletus*), a bird subspecies
Classification: Endangered

<u>State Listing</u>
The California clapper rail (*Rallus longirostris obsoletus)* was listed by the State of California as endangered in 1971 and it is a CDFG Fully Protected Species.

Associated Rulemakings: No critical habitat has been designated for the California clapper rail.

Review History: No formal status review has been conducted since the species was listed in 1970.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number is based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (U.S. Fish and Wildlife Service 1983). The recovery priority number for the California clapper rail is 3C according to the Service's 2011 Recovery Data Call for the Sacramento Fish and Wildlife Office. The priority number of 3C is based on a high degree of threat, a high potential of recovery, and its taxonomic standing as a subspecies. The additional "C" ranking indicates some degree of conflict between the conservation needs of the species and economic development (U.S. Fish and Wildlife Service 1983).

Recovery Plan or Outline

Name of Plan: Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California
Date Issued: February 2010
Dates of Previous Revisions: Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan (Service 1984).

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. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

The California clapper rail is a vertebrate that is not listed as a DPS. No relevant new information regarding the application of the DPS policy to the California clapper rail is under review. Because the DPS policy is not applicable to the California clapper rail, the application of the DPS policy to the species' listing is not addressed further in this review.

Information on the Species and its Status

Species Biology and Life History

Feeding Ecology. The California clapper rail is an omnivore with a relatively broad feeding niche. Animal matter has been consistently emphasized as a major component of the diet (Moffitt 1941, Heard 1982, Zembal and Fancher 1988). Food items found in California clapper rails stomachs include introduced ribbed horse mussel (*Ischadium demissum*), spiders (*Lycosidae* spp.), clams (*Macoma balthica*), yellow shore crabs (*Hemigrapsus oregonensis*), amphipods (shrimp-like crustaceans), a polychaete worm (*Nereis vexillosa*), and striped shore crab (*Pachygrapsus crassipes*; Williams 1929, Applegarth 1938, Test and Test 1942, Varoujean 1972). California clapper rails occasionally have been seen capturing and consuming rodents, particularly during higher tides; small birds are also occasionally taken (Spendelow and Spendelow 1980, Jorgenson and Ferguson 1982).

Reproduction. California clapper rails are at least seasonally monogamous, and defend overlapping year-round territories (Zembal *et al.* 1989, Albertson 1995, Garcia 1995). It is not known whether California clapper rails retain their mates between years. Pair bonding and nest building are generally initiated by mid-February. Nesting may begin as early as late February or early March (Evens and Page 1983), and extend through July in the South Bay, and into August in the North Bay (DeGroot 1927, U.S. Fish and Wildlife Service unpubl. data 1990). Both sexes share in incubation, which lasts from 18-29 days (Taylor 1996). Mean clutch sizes of 7.1 (U.S. Fish and Wildlife Service unpubl. data 1990) to 7.5 (Foerster *et al.* 1990) have been reported. Chicks soon depart the incubation nest, and one to three brood nests are typically constructed nearby (Applegarth 1938, Johnson 1973). Brood nests are high tide refuges for young rails, and consist of a platform of woven stems without a substantial canopy (Harvey 1980). Adults remain with the chicks to forage with them for up to 5 to 6 weeks (Applegarth 1938, Meanley 1985).

Nest Site. California clapper rails require an intricate network of sloughs to provide abundant invertebrate populations (Grinnell *et al.* 1918, DeGroot 1927, Harvey 1988, Collins *et al.* 1994) and escape routes from predators, particularly for vulnerable flightless young (Taylor 1894, Adams 1900, DeGroot 1927, Evens and Page 1983, Foerster *et al.* 1990, Evens and Collins 1992). In addition, the small natural berms along tidal channels with relatively tall vegetation, such as *Grindelia stricta* var. *angustifolia* (gumplant), provide elevated nesting substrate. Nests must be built at an elevation that protects the bowl from complete inundation during high tides (Evens and Collins 1992, Collins *et al.* 1994). However, some nests are built directly on the ground. Inundated nests result in abandonment and failure (U.S. Fish and Wildlife Service unpubl. data 1990).

California clapper rail nests consist of a platform surrounded by vegetation that has been pulled together to form a canopy. In the South Bay, most nests are located in *G. stricta* var. *angustifolia* and *Sarcocornia pacifica* (pickleweed), with platforms constructed from *Spartina foliosa* and *S. pacifica* (Harvey 1980, Foerster *et al.* 1990, U.S. Fish and Wildlife Service unpubl. data 1990). Foerster *et al.* (1990) found evidence of preferential use of *Spartina* spp. for nest platforms. In the brackish reaches of the northern Bay Area, many California clapper rail nests are located in *Schoenoplectus* spp. (bulrush). North Bay platforms typically consist of *S. pacifica*, mixed *Distichlis spicata* (saltgrass) and *S. pacifica*, or *Schoenoplectus* spp. (Garcia 1995, Albertson and Evens 2000, U.S. Fish and Wildlife Service unpubl. data 1990). Throughout the bay, variations in nest materials used by California clapper rails have been reported (DeGroot 1927, Zucca 1954, Gill 1972, Harvey 1980, Foerster *et al.* 1990, Garcia 1995).

Productivity. Reproductive success of the California clapper rail is much reduced from the natural potential (Harvey 1988, Foerster *et al.* 1990, Schwarzbach *et al.* 2006). Information on reproductive success (hatch, nest, and fledge success) is available from three studies conducted in the South Bay (Harvey 1980, Foerster *et al*. 1990, U.S. Fish and Wildlife Service unpubl. data 1991-1992) and one study in the Central Bay (U.S. Fish and Wildlife Service unpubl. data 1991-1992). During the period of these studies, predation accounted for a loss of 38 percent of the eggs, flooding for 1.4 percent, abandonment for 3.3 percent, 16 percent of the eggs were non-viable, and the fate of 1.3 percent of the eggs was unknown. South Bay marshes evaluated in 1991-1992 produced 2.5 hatched eggs per nesting attempt.

Hatchability for California clapper rails in San Francisco Bay varies with marsh. In the 1991-1992 South Bay investigations, hatchability ranged from 62.5 to 75.6 percent, with Laumeister Marsh having the lowest hatchability. Hatchability at Central Bay marshes in 1998-99 was 60 percent and 69 percent for Wildcat and Heerdt Marshes, respectively. Normal hatch success and hatchability of California clapper rail eggs is much higher (Jorgensen 1975). A study of clapper rails in New Jersey indicated an 87.3 percent hatch success (Kozicky and Schmidt 1949). The hatching success and hatchability of the California clapper rail is likely impaired. Reasons for low hatchability of eggs could include contamination, loss of genetic diversity, and reduced incubation of eggs due to disturbance.

***Behavior*.** The California clapper rail is sensitive to disturbance (Evens and Page 1983). When evading discovery, California clapper rails typically freeze, hide in small sloughs or under overhangs, or run rapidly through vegetation or along slough bottoms (U.S. Fish and Wildlife Service 1984). When flushed, they normally fly only a short distance before landing (Zucca 1954). California clapper rails swim well, although swimming is only used to cross sloughs or escape immediate threats at high tide (Sibley 1955, Todd 1986). Activity peaks in the early morning and late evening (Zembal and Massey 1983, Zembal *et al.* 1989), when California clapper rails forage in marsh vegetation in and along creeks and mudflat edges.

Territoriality/Site Fidelity. California clapper rails exhibit strong territorial defense, particularly during the late winter and early breeding seasons (Williams 1929, Albertson 1995, Garcia 1995).

Territoriality weakens during extreme high tides when cover is limited, and during the post-breeding season. California clapper rails have been observed in groups of 10 or more during winter high tide surveys (U.S. Fish and Wildlife Service unpubl. data 1990).

Home Range. A 1991-1992 radiotelemetry study in south San Francisco Bay indicated an average home range of 4.7 hectares (11.6 acres) and an average core use area of 0.9 hectare (2.2 acres; Albertson 1995). Home range sizes were maintained throughout the year, but varied among marshes and seasons. During the breeding season, average home ranges expanded from 2.9 hectares (7.1 acres) in January-February, to 3.7 hectares (9.1 acres) in May-July.

Dispersal. Post-breeding dispersal has been documented during the fall and early winter (Lindsdale 1936, Orr 1939, Albertson 1995). There is no clear evidence of migratory behavior in the California clapper rail. However, infrequent long distance dispersal does occur. Vagrant California clapper rails have been found in areas not known to support individuals throughout the year, such as the Farallon Islands (Bryant 1888), the rocky shores of Pacific Grove (Kimball 1922), and Pescadero Marsh (Orr 1942). These birds have been found primarily in late summer and fall, and are assumed to be dispersing subadults.

Survivorship. The only estimates of annual adult California clapper rail survivorship were relatively low, ranging from 0.49 to 0.52 (Albertson 1995). Increased predation occurs during extreme winter high tides, probably due to increased movement of California clapper rails at this time when little cover is available (Albertson and Evens 2000). Adult survivorship has been suggested as the key demographic variable associated with survival of California clapper rail populations (Foin *et al.* 1997).

Predators. Predators known to prey on California clapper rails and their eggs include the native gopher snake (*Pituophis melanoleucus*), great blue heron (*Ardea herodias*), red-tailed hawk (*Buteo jamaicensis*), peregrine falcon (*Falco peregrinus*), northern harrier (*Circus cyaneus*), barn owl (*Tyto alba*), great horned owl (*Bubo virginianus*), short-eared owl (*Asio flammeus*), common raven (*Corvus corax*), raccoon (*Procyon lotor*), and California ground squirrel (*Spermophilus beechyii*) (Johnston 1956). Non-native predators identified to date include the Norway rat (*Rattus novegicus*), red fox (*Vulpes vulpes*), domestic cat (*Felis catus*), and feral pigs (*Sus scrofa*; Grewell *in litt.* 2006). Adult California clapper rails may be preyed upon by all of the above species except gopher snakes, ravens, raccoons, ground squirrels, and rats, which prey on eggs or chicks.

Of these predators, raptors, Norway rats, domestic cats, and red fox are the most significant (DeGroot 1927, Foerster 1989, Albertson 1995, Harding *et al.* 1998). Studies in 1991-1992 found a negative correlation between red fox numbers and California clapper rail densities (Harding *et al.* 1998, Albertson 1995). The most severe California clapper rail population declines and highest fox numbers were found in the East Bay marshes (*e.g.,* Dumbarton, Mowry, Ideal, and Calaveras). Winter airboat surveys in 1992-1993 documented a California clapper rail population increase in many South Bay marshes in apparent response to predator control that began in 1991 (Harding *et al.* 1998).

Spatial Distribution and Abundance

Historical Distribution. California clapper rails were historically abundant in all tidal salt and brackish marshes in the San Francisco Bay vicinity (Cohen 1895), as well as in all of the larger tidal estuaries from Marin to San Luis Obispo counties. The salt marshes of south San Francisco Bay, including portions of San Mateo, Santa Clara, and Alameda counties, supported the largest populations of California clapper rails (Grinnell 1915, DeGroot 1927, Williams 1929, Grinnell and Miller 1944). Gill (1979) identified the Napa River as a North Bay population center, which supported approximately 40 percent of the entire population.

Small populations existed in San Pablo Bay at Point Isabel (Williams 1957) and along Wildcat Creek/San Pablo Creek in western Contra Costa County (Grinnell and Miller 1944). Newberry (1857) reported California clapper rails as very common in the marshes of Petaluma. Bryant (1931) reported rails in Richardson Bay, and an egg set was collected from Corte Madera in 1931 (Gill 1979). In Solano and Sonoma counties, Gill (1979) and Harvey (1980) observed rails at numerous locations in the Napa Marsh complex.

According to survey data, the historical distribution of clapper rails within San Francisco Bay was restricted to marshes west of Suisun Bay. However, systematic survey data from the Suisun Marsh area were not available until the 1970s. Clapper rails have been consistently detected in the Suisun Marsh area since the 1970s, although abundance has been low (Gould 1973, Harvey 1980). It is likely that low numbers of clapper rails were present in this area prior to large-scale marsh reclamation.

North of the San Francisco Bay Area (Bay Area), clapper rails have occasionally been observed in Humboldt Bay, Humboldt County (Grinnell and Miller 1944, Gill 1979), and in the Marin-Sonoma embayments, which include Bodega Harbor, Tomales Bay, Drakes/Limantour Esteros, and Bolinas Lagoon (Storer 1915, Brooks 1940, Grinnell and Miller 1944). The last record for Humboldt Bay was in 1947 (Wilbur and Tomlinson 1976). There have been several records of clapper rails in Tomales Bay in the late 1990s (Evens *in litt.* 2007). Prior to these observations, clapper rails had not been documented in Tomales Bay since 1914, and were presumed extirpated as of 1973 (Storer 1915).

South of the San Francisco Bay Area (Bay Area), clapper rails formerly occurred in Elkhorn Slough, Monterey County (Silliman 1915), and Morro Bay, San Luis Obispo County (Brooks 1940). Clapper rails were consistently detected in Elkhorn Slough up to 1972, when an estimated 10 pairs were observed (Varoujean 1972). Subsequently, rails were observed only sporadically (Winter and Laymon 1979), and were last documented there in 1980 (Roberson 1985).

There are isolated records of rails occurring in urbanized areas of San Francisco (Orr 1939), Oakland, and Berkeley (Lindsdale 1936). Transient California clapper rails have been occasionally observed at other locations along the coast of California, including the Farallon Islands (Bryant 1888), Pacific Grove (Kimball 1922), Pescadero Marsh (Orr 1942), and Bolinas Lagoon (Harvey 1980).

Current Distribution. California clapper rails are now restricted almost entirely to the marshes of the Bay Area where the only known breeding populations occur (Figure 1). The California clapper rail population was estimated at 4,200 to 6,000 birds between 1971-1975, of which 55 percent occurred in the South Bay and 38 percent in the Napa Marshes (Gill 1979). Although the population was estimated at only 1,500 birds between 1981-1987 (Harvey 1988), the difference between these two estimates is believed to be partially due to survey intensity. Breeding season density data indicate that populations remained stable during the 1970s (Gill 1979, Harvey 1980), but reached an estimated all-time historical low of about 500 birds in 1991, with about 300 rails in the South Bay (Harding *et al.* 1998). Rail numbers have rebounded slightly since the early 1990s. However, substantial increases in population may be difficult to achieve due to the current disjunct distribution of their habitat (Albertson and Evens 2000).

PRBO Conservation Science conducted estuary-wide surveys of the Bay Area for California clapper rail between 2005 and 2008. Results of this survey estimate a minimum average population between 2005 and 2008 of 1,425 rails (Liu *et al*. 2009), however, densities declined during that period at a per-year rate of 20 percent. The downward trend for 2005 to 2008 is driven by a negative change (-57%) from 2007 to 2008 in the South Bay. The population appeared relatively stable from 2005 to 2007. However, the decrease from 2007 to 2008 likely represents a true decrease in the Estuary-wide population. A number of factors could be contributing to the drop, including extreme weather events, predation, heavy construction and pollutants (*e.g*., mercury contamination, the *Cosco Busan* oil spill, and raw sewage releases). However, the emerging consensus among experts appears to be that the largest contributor to falling rail numbers is the ongoing control and removal (through chemical and mechanical means) of invasive *Spartina* (Takekawa *et al.* 2011). Declining rail numbers have been most dramatic in the areas that were heavily infested with hybrid *Spartina* and then chemically treated. At those sites, over 300 rails were lost between 2007 and 2010 (State Coastal Conservancy 2011).

PRBO Conservation Science's 2010 surveys resulted in detection of 601 clapper rails at 52 sites, specifically showing increases in number of detections in San Pablo and South San Francisco Bays (Liu and Wood 2011). However, the Invasive Spartina Project found declining numbers of detections in other parts of the Estuary, such as the San Francisco peninsula (Liu and Wood 2011). The PRBO Conservation Science estimate represents a minimum estimate, as they did not calculate densities based on the detections and apply the densities to non-surveyed suitable habitat at the sites (Liu and Wood 2011). Also, an updated Bay-wide population estimate was not developed as part of that study.

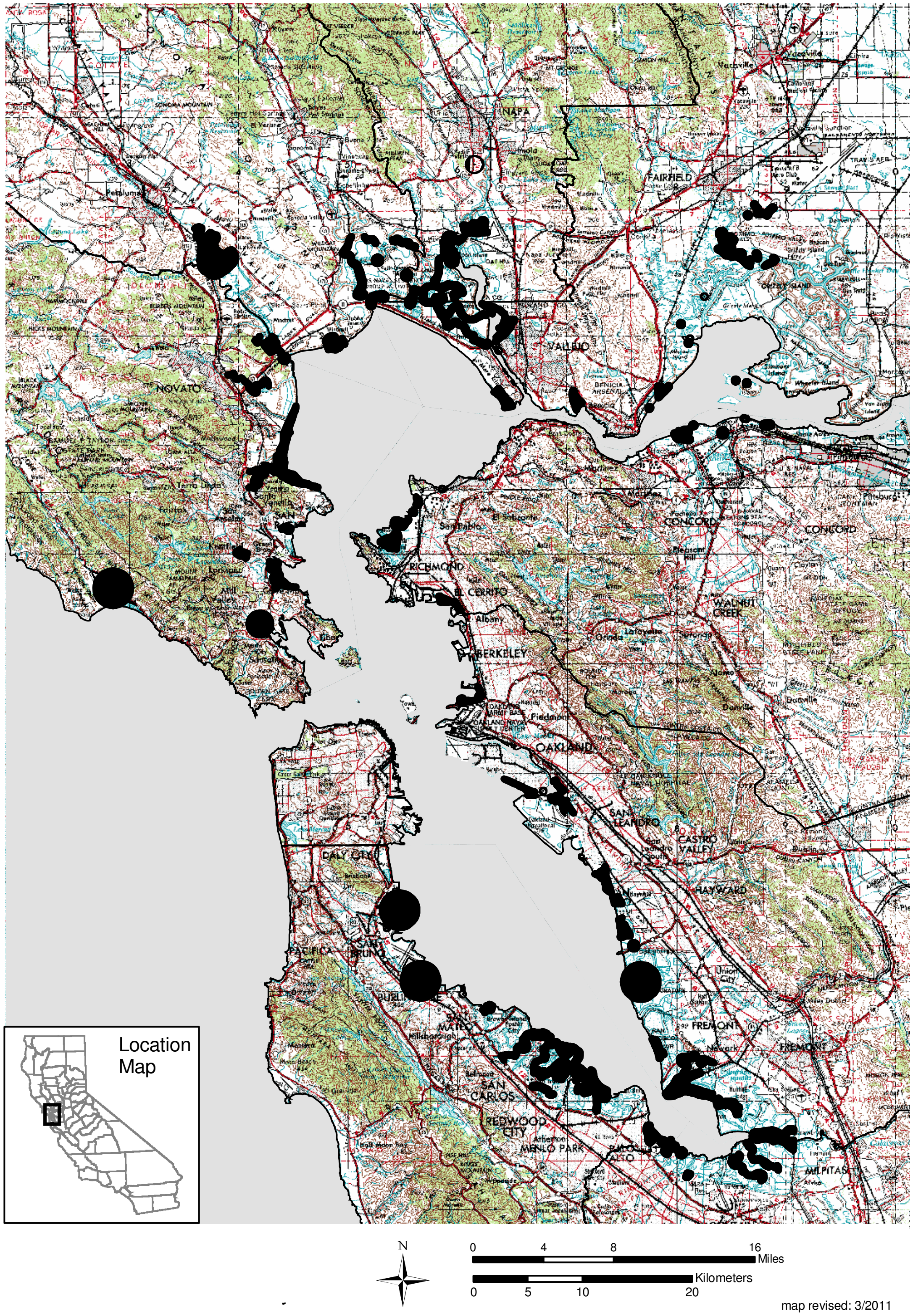

Figure 1. Known current distribution of California clapper rail

Central/South Bay. The clapper rail population in the eastern portion of the South Bay decreased substantially, from 400-500 individuals to 50-60 in 1991-92 (Harvey 1980), but then rebounded to 330 individuals in 1997-1998. In response to an increase of hybrid *Spartina*, the total South Bay rail population had rebounded since the low of the early 1990s (Harding *et al.* 1998), and was estimated to be approximately 1,040 to 1,264 by the mid to late 1990s (Albertson and Evens 2000). The largest populations currently occur in Dumbarton, Mowry, and Cogswell marshes in the East Bay, and in East Palo Alto and Greco Island in the west bay (Herzog *et al*. 2006). Likely due to invasive *Spartina* eradication efforts, rails have declined severely for the last couple years at Arrowhead, in the East Bay and appear to have been extirpated at Colma Marsh. In Alameda County, rails are known to occur in the Emeryville Crescent, Hayward, Old Alameda Creek, Ideal, La Riviere, and Coyote Creek marshes. In San Mateo County, rails currently occur in marshes along Faber/Laumeister, Ravenswood, Seal Slough, and the Colma Creek area. In Santa Clara County, rails occur along Alviso and Charleston Sloughs, and in outboard marshes of Moffett Field and Guadalupe Slough. Clapper rails can also be found in salt marshes fringing the South Bay outboard of salt evaporation pond dikes and along major tidal sloughs.

In 2006, the central San Francisco Bay experienced highest numbers of clapper rails in Corte Madera (Heerdt) and Muzzi Marshes in Marin County (Herzog *et al*. 2006). Other occupied areas include Wildcat Marsh and Oakland Inner Harbor in southern Contra Costa County and Richardson Bay and Creekside Marsh in Marin County (Albertson and Evens 2000).

San Pablo Bay. Small populations of clapper rails are patchy and discontinuously distributed throughout San Pablo Bay in small isolated tidal marsh habitat fragments (Collins *et al.* 1994). In 2004 there were between 84 and a few hundred pairs in the San Pablo Bay region (Avocet Research Associates 2004). Highest numbers of clapper rails in San Pablo Bay currently occur along Gallinas Creek and Hamilton Army Airfield marshes (Herzog *et al*. 2006). Clapper rails also occasionally occur along the Petaluma River as far north as Schultz Creek, Lower Tubbs Island, Sonoma Creek area, and along most major tidal sloughs that empty into the Napa River (Collins and Evens 1992, Evens 2000*a*, 2000*b*). California clapper rails are present near the Bahia residential development in Novato. In 2006, at least four pairs of clapper rails were detected in tidal marsh along San Antonio Creek, just to the north of the Marin Audubon Society's tidal marsh restoration site near Neils Island (Marin County; Evens *in litt*. 2007).

Clapper rails also occur on Bull Island and, as documented in November 2010, north to the Napa Flood Control Marsh, upstream along the Napa River from the Highway 121 bridge (Stenzel *in litt*. 2010). Rails are sparse in the linear strip marsh between Highway 37 and San Pablo Bay, most likely due to the lack of dendritic tidal creeks.

Surveys conducted in the early 1990s (Evens and Collins 1992, Collins *et al.* 1994) indicated a temporary decline in San Pablo Bay clapper rail populations. Surveys conducted in the late 1990s indicate that the White Slough area continues to support a moderate number of clapper rails (Evens 2000*b*). In contrast, rail numbers detected in the Sonoma Creek/Napa Slough area have declined since the early 1990s, from estimates of 13 pairs in 1992 (Evens and Stallcup 1994) to 2 birds detected in 2000 (Evens 2000*a*).

Suisun Marsh Area. Clapper rails are present sporadically and in low numbers at various locations throughout the Suisun Marsh area (Carquinez Strait to Browns Island, including tidal marshes adjacent to Suisun, Honker, and Grizzly bays). Areas where rails have been found recurrently since 1978 include the shoreline marshes from Martinez east to Port Chicago, marshes near the mouth of Goodyear Slough (Bahia), Suisun and Hill Sloughs, and the western reaches of Cutoff Slough (Harvey 1980). Rails have even been detected in Suisun Marsh during the breeding season (Foin *et al*. 1997). Surveys in 2005 found no clapper rails in Suisun Marsh or Point Edith (Herzog *et al.* 2006) and, in 2006, only two clapper rails each were observed at Rush Ranch (Suisun Marsh) and Point Edith (Herzog *et al.* 2006). California clapper rails were present in marshes of Pacheco Creek and Point Edith marshes in Contra Costa County in 2006 (Liu *et al*. 2009). Herzog *et al*. (2006) also identified only two clapper rails at Benicia State Recreation Area (Solano County) and at least two rails were detected during a survey of the same location in January 2011 (Evens *in litt*. 2011). Similar sporadic results were found during a multi-year survey by California Department of Fish and Game, in which they detected: no California clapper rails in 2002, eight in 2003, one in 2004, none in 2005, five in 2006, none in 2007, one in 2008, and none in 2009 (California Department of Fish and Game 2010).

Coastal Areas outside San Francisco Bay. Records of California clapper rails beyond San Francisco Bay are sparse, making population status in these areas difficult to track. Few records of clapper rails exist for Humboldt Bay; the last record is from 1947 (Wilbur and Tomlinson 1976). It is unknown whether clapper rails ever bred in Humboldt Bay, and clapper rails observed in that area are widely considered vagrants. Clapper rails had been presumed extirpated from Tomales Bay as of 1973, until sightings of single birds were reported there in 1998-2000 (Evens *in litt.* 2007). It is unknown whether clapper rails are currently breeding in Tomales Bay, but suitable habitat now exists.

No records of clapper rails have been reported for Morro Bay, San Luis Obispo County, in over 20 years. Clapper rails have not been reported in Elkhorn Slough, Monterey County, since 1980 (Roberson 1993). These three populations (Humboldt Bay, Morro Bay, and Elkhorn Slough) are now considered extirpated, leaving San Francisco Bay as the last stronghold and breeding population of this subspecies.

Habitat/Ecosystem

Throughout their distribution, California clapper rails occur within a range of salt and brackish marshes (Harvey *et al.* 1977). In south and central San Francisco Bay, and along the perimeter of San Pablo Bay, rails typically inhabit salt marshes dominated by *Sarcocornia pacifica* and *Spartina foliosa*. *Spartina* ssp. dominates the lower marsh zone (marsh plain) throughout the south and Central Bay (DeGroot 1927, Hinde 1954, Harvey 1988). *Sarcocornia pacifica* dominates the middle and sometimes upper marsh zone throughout the South and Central Bay, with *Distichlis spicata*, *Jaumea carnosa* (fleshy jaumea), *Frankenia salinia* (alkali-heath), and others mixing with occasional *Sarcocornia pacifica* in the high marsh zone. *Grindelia stricta* var. *angustifolia* occurs along the upper edge of tidal sloughs throughout the entire San Francisco Bay Estuary. The marshes of Humboldt Bay, Morro Bay, and Elkhorn Slough historically have not supported *Spartina*. Vegetation at these locations has been dominated by *Sarcocornia pacifica* and *Distichilis spicata*.

In the North Bay, clapper rails also occur in tidal brackish marshes that vary significantly in vegetation structure and composition, ranging from salt-brackish marsh to fresh-brackish marsh transitions. *Bolboschoenus maritimus* (alkali bulrush), an indicator of salt-brackish marsh transitions, is sub-dominant to dominant in low marsh and lower middle marsh plains. *Schoenoplectus acutus* and *Schoenoplectus californicus* (tules), *Schoenoplectus americanus* (Olney's bulrush), and *Typha* spp. dominate the low marsh zone of fresh-brackish marsh transitions, while fresh-brackish marsh plain vegetation is a diverse, patchy mixture of dominant *Distichlis spicata, Jaumea carnosa*, salt rush (*Juncus arcticus* ssp. *balticus, Juncus lesueurii*), and numerous native and non-native herbs, grasses, and sedges. *Grindelia stricta* var. *angustifolia* (and its hybrid *Grindelia x paludosum* in Suisun Marsh) is the widespread dominant of high marsh vegetation in brackish marshes today, but it occurs with other tall, dense sub-shrubby or herbaceous native vegetation along marsh edges and creek banks, such as *Baccharis douglasii* (salt marsh baccharis), *Euthamia occidentalis* (goldenrod), *Achillea millefolium* (yarrow), *Scrophularia californica* (bee-plant), and asters (*Symphyotrichum lentum, Symphyotrichum chilensis*, and intermediates, *Symphyotrichum sublantus* var. *ligulatus*; now uncommon). The historically diverse high brackish marsh vegetation probably provided ample high tide flooding refuges for clapper rails.

Use of brackish marshes by clapper rails is largely restricted to major sloughs and rivers of San Pablo Bay and western Suisun Marsh, and along portions of Coyote Creek in south San Francisco Bay. In brackish marshes, other rail species such as Virginia rail (*Rallus limicola*) and sora (*Porzana carolina*) are typically more common than clapper rails. Clapper rails were not reported from Suisun Marsh in the 19th and early 20th centuries. However, they have persisted in Suisun Marsh even after above-average rainfall and very low channel salinity in the 1990s, when tidal marshes there developed a fresh-brackish vegetation (Estrella *in litt.* 2007). Clapper rails have rarely been recorded in nontidal marsh areas.

Rail foraging and refugial habitat encompasses the lower, middle, and high marsh zones, as well as the adjacent transitional zone. Lower and middle marsh zones provide foraging habitat at low tide. Small tidal channels (*i.e.,* first- and second-order) with dense vegetation covering the banks are particularly important habitat features (Garcia 1995, Keldsen 1997). These provide important foraging habitat and hidden routes for travel in close proximity to nesting habitat. Higher marsh areas (high marsh and transitional zones) with dense vegetation are used for nesting and high-tide refugia (DeGroot 1927, Harvey 1988, Foerster *et al.* 1990, Evens and Collins 1992, Collins *et al.* 1994). Within tidal marshland in portions of north San Francisco Bay, the abundance of California clapper rails is positively correlated with channel density (Garcia 1995, Evens and Collins 1992, Collins *et al.* 1994, Foin *et al.* 1997). Keldsen (1997) found that rails prefer locations with a greater number of tidal creeks, *Grindelia stricta* var. *angustifolia* shrubs, and higher elevations.

The quality of a marsh strongly influences the density of rail population it can support (Albertson 1995, Garcia 1995). Physical habitat characteristics critical to clapper rails include marsh size, location relative to other marshes, presence of buffers or transitional zones between marshes and upland areas with sufficient high tide refugia, marsh elevation, and hydrology (Collins *et al.*

1994, Albertson 1995). Denser rail populations exist where the habitat patch size is greater than 100 hectares (247 acres; Collins *et al.* 1994).

Changes in Taxonomic Classification or Nomenclature

There have been no changes in taxonomic classification or nomenclature for the California clapper rail since its listing in 1970.

Species-specific Research and/or Grant-supported Activities

Several studies have been undertaken since the species' listing which affect, or could affect, California clapper rail. Studies have been undertaken by USGS in regards to exposure of rails to contaminants in San Francisco Bay (Bay) and many entities, such as PRBO Conservation Science, San Francisco Bay Bird Observatory, and California Coastal Conservancy, have conducted annual or occasional surveys of California clapper rails throughout the Bay since listing. Those efforts are too numerous to elaborate on here. The details of several, more recent studies follow.

Rail Movements in Response to Invasive Spartina Control. With funding through the U.S. Fish and Wildlife Service Recovery Division, the U.S. Geological Survey (USGS) began studying the ecology of California clapper rails in January of 2007 at three marshes in South San Francisco Bay (Colma Creek, Laumeister, and Cogswell). They marked 10 rails per site with radio transmitters and tracked those birds on a daily basis. They re-marked surviving rails the following winter with new transmitters as well as marked new individuals at each site in order to maintain as close to 10 birds at each site as possible. Arrowhead Marsh was added as an additional study site in 2008. Investigations began into potential food resources with the collection of prey samples at the four marshes in 2009 with work continuing in 2010. The samples will be evaluated for mercury content. Telemetry observations have provided a significant amount of data with nearly 15,000 locations on 104 individual rails tracked through February 2010. These data are providing a clear picture on space-use and movements of clapper rails and allow detailed analysis on survival rates throughout the year. Movement patterns of California clapper rails typically show small daily movements, though two individuals migrated approximately 44 km from San Mateo to Marin County. Intra-daily movements are often greater than movements on successive days. Annual home ranges averaged just over 2 hectares, but were as small as one quarter of a hectare. Radio-telemetry has also allowed for detailed observation of rail breeding behavior. Annual survival showed strong seasonal differences in survival rates. Relatively high survival was estimated during breeding and post-breeding periods, with much lower survival over-winter. A composite annual survival rate including 3 seasonal estimates was 35% (95% CI: 20% to 49%). Potential covariates associated with reduction in survival are not statistically significant, but suggest survival is lower in association with *Spartina* spraying, during periods of high tide inundation, and according to body condition metrics.

Use of Artificial Islands at Arrowhead Marsh. In 2010 and 2011, in response to rapidly declining numbers of rails detected in habitat treated to remove invasive *Spartina* at

Arrowhead marsh, USGS and East Bay Regional Park District, in coordination with the Sacramento Fish and Wildlife Office and funded through a U.S. Fish and Wildlife Service Preventing Extinction grant, conducted a pilot study to determine the use of artificial refugia at the marsh. The goals of the study were to examine effects of invasive *Spartina* control and future sea level rise on the clapper rail and the potential for improving high tide refugia. They found that rails regularly occupied all of the artificial islands across different tide levels, and there was greater occupancy during the high tide rather than only on the highest spring king tides. Chemical control of invasive *Spartina* at Arrowhead Marsh over the past three years has resulted in reduction in plant cover. This change in habitat structure also may be related to the frequent use of the artificial islands. Until regrowth of native *Spartina* replaces the lost cover, populations of clapper rails may be at risk for predation.

Finally, the implications for future sea level rise suggests that refugia will be a key element of habitat management to save this species and others like it. Sea level rise is likely to exceed marsh accretion in many San Francisco Bay marshes, especially after the next few decades (Heberger *et al.* 2009, Kirwan *et al.* 2010). This study indicates that adaptation for sea level rise should include selection of marshes with the best habitats for the most clapper rails, and management for habitat elements including elevated islands that provide clapper rails with adequate refugia.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

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

<u>Habitat loss and fragmentation</u>

Habitat loss. The greatest historical and present threat to tidal marsh ecosystems and species such as California clapper rail is the destruction and alteration of habitat. Loss of coastal wetland habitat to urban and industrial development has been extensive in California, with 90 percent of these wetlands being lost since settlement of the region (Goals Project 1999). Roughly 90 percent of original tidal marsh habitat has been altered or destroyed in Humboldt Bay (A. Pickart, S. Harris pers. comm.). Only eight percent of the original pre-historical tidal marshes remain in the Bay Area (Goals Project 1999). By 1930, one-half of the historical tidal marsh in the South Bay had been converted to salt ponds by Leslie Salt Company (later purchased by Cargill Salt Division). Leslie Salt expanded its operations to the North Bay in 1952, where it ultimately converted 14,500 hectares (36,000 acres) of diked agricultural baylands into salt ponds (Goals Project 1999). Many of the last remaining large tracts (hundreds of contiguous acres) of undiked tidal salt marsh in the South Bay were converted to salt ponds in the early to mid-1950s (U.S. Army Corps of Engineers, San Francisco District, aerial photograph and map archives). Effectively, irreversible conversion of former tidal marsh to residential and industrial areas around Oakland, Alameda, Foster City, and Redwood City was complete by the

1960s, although some residential extension within diked baylands of Redwood City continued through the 1990s.

Habitat Fragmentation and Edge Effects. Habitat fragmentation occurs when tidal marsh habitat, once extensive and contiguous, is divided into relatively small discontiguous fragments. Fragmentation complicates the impact of habitat loss by reducing tidal marsh populations, breaking them into many isolated tiny populations on habitat fragments of varying size, shape, and condition. In addition to the difficulty of supporting a viable rail population on a habitat fragment of limited area, marsh fragments may lack the full range of habitat features needed by the rail throughout its life cycle. For example, a fragment might contain feeding and nesting habitat for the rail, but completely lack refuge from high tides or storm surges.

As remaining marsh areas are reduced in size, edge effects become increasingly severe. Smaller populations and smaller (or narrower) habitats have less ability to absorb or buffer adverse impacts from outside influences, such as predation, human disturbance, or pollution.

Local extinction rates in habitat fragments generally increase as habitat area decreases and distance from neighboring populations increases (Hanski 1999). Correspondingly, breeding populations of species with limited population densities and dispersal, such as the California clapper rail, have generally been lost from smaller and more isolated tidal marsh fragments, and are at risk in many fragments where they still persist.

Habitat Degradation and Disturbance

The quality of remaining tidal marsh habitat for rails in central and northern California has been altered and degraded by human actions, including diking, habitat conversion in buffering lands, flow and salinity alteration, contamination by pollutants, and actions causing disturbance. Habitat fragmentation may be considered a form of habitat degradation. Also, invasion by non-native species often results in habitat degradation or disturbance. Many factors cause habitat degradation or disturbance in California tidal marshes; some of the most common are summarized below.

Levees. Many hundreds of miles of levees dissect former tidal areas of the San Francisco Bay Estuary and Humboldt Bay. Most were first constructed decades ago to create salt ponds, allow agriculture, or for purposes related to flood control. Levees require periodic maintenance, typically by clamshell dredges that deposit bay spoil material on the tops and sides of the levees.

Maintenance of levee systems continues to isolate tidal marshes into areas too small to develop complex tidal drainage networks vital to the rail. Levees ordinarily hinder normal circulation of tidal flows and drainage. Vegetation and soils are altered, for example, by persistent inundation or evaporative concentration of salts. Drying of marsh sediments has resulted in subsidence of the ground surface. Groundwater pumping may also contribute to subsidence. Many leveed areas are today substantially below sea level as a result, in some areas by more than 6 meters (20 feet).

Levees are now the only upland edges of many tidal marsh remnants but are generally too steep, narrow, and weedy to be high quality high-tidal refugia for tidal marsh animals. Levees also greatly facilitate site access for both people and predators. Mammalian predators, especially non-native red foxes (*Vulpes vulpes*) and Norway rats (*Rattus norvegicus*), use levees as movement corridors and denning/nesting sites at distances out into baylands that would otherwise be naturally isolated from frequent contact with terrestrial predators. Access by people and pets also creates disturbance that may affect sensitive species.

Loss of Ecotones. Prior to settlement of the Bay Area by Europeans, tidal baylands graded landward into transitional zones (or ecotones) of low-lying moist grassland or willow thickets, including some vernal pool grasslands, and then into upland areas (Goals Project 1999). Appropriately sized and structured ecotones are a critical component of California clapper rail habitat, especially in urbanized settings. These areas provide two primary benefits to adjoining wetlands by (1) absorbing and deflecting disturbances originating in upland areas, and (2) providing upland refugia during high tide and flood events, both of which ultimately influence habitat quality and carrying capacity of tidal marshes for rails and other marsh birds. In fact, the presence of a broad marsh/upland ecotone, which may be the only escape refugia during high tide situations, is crucial to the viability of rails.

Much of the historical development around the bay has not allowed for these buffering transitional zones between urban or industrial areas and tidal marshes. Refuse dumped or blown in from adjacent urban areas also affects habitat quality by attracting predators or damaging habitat. Even in rural areas, transitional and upland vegetation has been replaced with non-native annual grasses, and livestock graze up to and sometimes into the marsh. Consequently, there has been extensive loss of high marsh-upland transition area and ecotones, and urban influences and disturbances frequently border directly on remaining tidal marsh. Shellhammer found that the adjacent upland edge (*i.e.,* the ecotone between marsh and upland) exists today in only 2.5 percent of the South Bay's edge.

Disturbance. Numerous routine human activities can cause disturbance to rails, including, for example, maintenance activities for levees, flood control, dredge locks, pipelines, and utility rights-of-way; vegetation control activities; recreational uses including hiking, biking, dog-walking, bird watching, horseback riding, and water sports such as boating and kiteboarding; human and domestic and feral animal incursion from adjoining developments; ditching or spraying for mosquito control; and use of all-terrain/off-road vehicles in baylands (Goals Project 1999). Direct human-caused disturbance to the California clapper rail occurs in various sections of the Bay Trail (Albertson *in litt*. 2009*b*). Trampling by livestock and other animal populations sometimes causes physical disturbance to the rail's tidal marsh and ecotonal habitats. Quite often trails attract predators, disturb breeding rails or fragment or otherwise degrade habitat, especially in the absence of proper management.

Salinity Changes. Both fresher and more saline conditions alter rail habitats, often with adverse consequences to the species that live there. Levees can alter salinity conditions, both in water and soils. Levees reduce salinity when they blocks entry of the tides and impound rainfall or freshwater drainage. Salinity can be controlled in some leveed habitats with flow control structures (tide gates).

Wastewater discharges, which are usually lower in salinity due to pollutant discharge requirements pursuant to Federal and State water quality laws, can alter natural salinity levels in tidal waters. For example, between 1970 and 2006, freshwater discharges from the Santa Clara Water Pollution Control Plant led to the conversion of approximately 120 hectares (300 acres) of salt marsh to fresh and brackish marsh near the southern end of San Francisco Bay (H.T. Harvey and Associates 1997), which has been detrimental to the rail and other species.

Another form of salinity alteration is occurring in Suisun Marsh. Under natural conditions, Suisun Marsh salinity would be closely linked with Delta outflows and freshwater inflows from other creeks in the Suisun Marsh watershed, with considerable seasonal variation, from nearly fresh in the spring, to brackish in the fall. During high rainfall years, lowered summer soil salinity would favor conversion of middle tidal marsh zones to *Schoenoplectus*-dominated vegetation, causing decline of *Sarcocornia-Distichlis* (pickleweed-saltgrass) vegetation. During dry years, *Sarcocornia-Distichlis* vegetation would re-establish dominance and *Schoenoplectus* vegetation would retreat (Suisun Ecological Workgroup 2001). In 1988, the California Department of Water Resources and the U.S. Bureau of Reclamation constructed and began operating the Suisun Marsh salinity control gates (SMSCG) in Montezuma Slough to mitigate for increased Suisun Marsh salinities caused by the operation of the State Water Project and Central Valley Project and other upstream diversions. Though use of the gates has been minimal since its initial set-up, when used, operation of the salinity control gates has widespread effects on water and soil salinity, raises water levels in the marsh, and reduces tidal range and circulation. Artificially stabilizing salinities at low levels during the summer and fall subdues the climate-driven pattern of vegetation fluctuations. These low salinity levels are harmful to species that favor plant communities of higher or more variable salinity, especially plants that require bare areas in salty soils for colonization. Water quality standards for salinity were modified in western Suisun Marsh to allow greater climate-driven fluctuation. However, the artificially narrow and low salinity range is still enforced in eastern Suisun Marsh.

Gradual changes in salinity in California estuaries are projected to result from sea level rise pushing saline ocean water further inland (Knowles 2002, Knowles and Cayan 2002, Wilkinson 2002). Sea level rise is an ongoing process accelerated by climate change. See the section below on climate change and sea level rise in Factor E.

<u>Invasive species and invasive species control</u>

Non-native plant species capable of living in tidal marshes have invaded and altered vegetation, or threaten to do so, over extensive areas. Non-native plant species of greatest concern are those that (1) become so abundant that native plant species are diminished significantly in population size or displaced altogether, (2) become extensively dominant or develop nearly monotypic (single-species) stands, (3) colonize habitats naturally lacking in vascular plants, such as tidal flats, or (4) are annuals that thereby provide no escape cover during winter high tides because they are simply a plant skeleton that predators can see through. Invasive species cause impacts to the structure of vegetation, species competition, and composition within communities, and the soil-building properties of the tidal marsh ecosystem. Plant invasions harm tidal marsh animal populations by altering food availability or habitat structure. Invasions by non-native animals also affect tidal marsh species. To date, most animal impacts of concern have been those of non-native predators, such as red fox and Norway rats, on native prey species.

Invasive Spartina. Of several invasive non-native *Spartina* species found in San Francisco Bay, until very recently, the most abundant was *Spartina alterniflora* (smooth cordgrass) and its hybrids with the native *Spartina foliosa* (Pacific cordgrass). *Spartina alterniflora*, native to tidal marshes of the Atlantic coast and Gulf of Mexico, threatens to alter the structure of native salt marshes and mudflats in the Bay Area. In the bay region, it is much taller and faster-growing, grows more densely, and occupies a wider tidal range than the native *Spartina foliosa* (Callaway 1990, Daehler and Strong 1996).

Spartina alterniflora was reportedly introduced to San Francisco Bay around 1976 for bank stabilization. The non-native *Spartina* hybridized with native *Spartina foliosa*, forming proliferations of hybrid plants (hybrid swarms) that spread extensively and rapidly during the 1990s (Grossinger *et al*. 1998). Hybrid plants usually exhibit the large size and high growth rate more typical of *S. alterniflora*. These hybrid swarms swamped native *S. foliosa* stigmas with hybrid pollen and crowded out *S. foliosa* plants, with the potential to threaten this recently common species with extinction by genetic assimilation (Daehler and Strong 1997, Ayres *et al.* 1999).

With high biomass production and sediment trapping, *Spartina alterniflora* and hybrids are capable of accretion at unusual rates. The sediment-trapping efficiency of *Spartina* stands is proportional to density and height (Gleason *et al.* 1979, Knutson *et al*. 1982); and the density and biomass of invasive *Spartina* stands in San Francisco Bay exceeds that of the native *Spartina foliosa* by six to seven times (Callaway 1990). The density, height, productivity, and intertidal elevational range of invasive *Spartina* enable it to convert mudflat and small creeks to marsh with relatively few small tidal creeks. Invasive *Spartina* fills in both higher and lower elevations once free of *Spartina* at Elsie Roemer Marsh (Alameda Island; Nordby *et al.* 2004). Expansion of invasive *Spartina* over mudflats and marsh plains had the potential to destroy or degrade habitat for numerous tidal marsh plants and animals, including estuarine fish, migratory shorebirds, and waterfowl. While invasive *Spartina* is potentially detrimental to many native species, California clapper rails use invasive *Spartina* stands. Invasive *Spartina* benefits the rail by providing habitat for breeding and high tide refugia.

Although it was known that invasive *Spartina* provided habitat for the rail, it was determined that those benefits were outweighed by the long-term ecosystem altering effects of invasive *Spartina* invasion. By consensus of the resource agencies, a treatment program began in 2004 to eradicate all sources of invasive *Spartina*. The California Coastal Conservancy's Invasive Spartina Project (ISP) embarked, in 2004, upon a major effort to eradicate invasive *Spartina* in the Bay Area. The project is nearly complete. The ISP has reduced the coverage of invasive *Spartina* baywide by nearly 90% (from 800 net acres to less than 100 net acres) since its peak coverage in 2005-2006 (Olofson *in litt.* 2011). However, because the effects of eradication were greater than anticipated, a substantial decrease in rail numbers has been observed since the physical breakdown of treated invasive *Spartina,* likely due to loss of its use as refugial habitat (Takekawa *et al*. 2011). Though invasive *Spartina* is considered an ecosystem threat, unfortunately, its eradication is a threat to clapper rail.

In order to achieve effective restoration while protecting remaining populations of clapper rail, future invasive *Spartina* eradication needs to be planned in a way that restores native ecosystems while protecting listed species such as the clapper rail that currently depend on invasive *Spartina*. Though the scope of this five-year review does not allow further discussion of the possible ecosystem impacts of invasive *Spartina* infestation, the issue is addressed in greater detail in the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (U.S. Fish and Wildlife Service 2010).

Other non-native species of *Spartina* have become established in California tidal marshes (*S. patens* and *S. densiflora*), although most are as yet at a lower level of invasion than *Spartina alterniflora*, and none seems likely to hybridize so readily with native *Spartina*. The Invasive Spartina Project has already targeted some of these other non-native *Spartina* infestations for control.

Lepidium latifolium (broadleaf or perennial pepperweed, also known as peppergrass, white-top, and slough mustard). *Lepidium latifolium* is native to salt marshes of the Mediterranean, where it is not reported as a dominant or aggressive species (Chapman 1964). This perennial herb in the Brassicaceae (mustard family) grows from rhizomes or adventitious root-buds that produce tall, leafy stems topped with heads of abundant small white-petalled flowers in late spring and pale tan seeds in summer. Heads release clouds of pollen when disturbed, suggesting that pollination may occur independently of insects. Seed production is extremely high; each shoot can produce thousands of seeds, and the marsh surface beneath canopies of this species can become covered with ripe seed. Above-ground stems and leaves tend to die back by early summer after the plant produces seed, but in favorable conditions a second crop of flowering stems can replace them. In tidal salt marshes of San Francisco Bay, *L. latifolium* is found along the high marsh edge, especially in disturbed areas, deposits of sand or tidal litter, or levee slopes. In brackish tidal marshes with lower salinity it invades the middle marsh plain and channel edges, often forming large swards. It can even dominate the vegetation in entire marshes. *Lepidium latifolium* colonies expand more rapidly and establish with increased frequency in years of high rainfall (Baye pers. comm. 2004).

May (1995) noted that *Lepidium latifolium* invasion is generally restricted to areas with freshwater input in the southern estuary, and is most abundant in the northern estuary, where salinity levels are lower. A survey (Grossinger *et al*. 1998) found *L. latifolium* in major areas of Suisun marsh and in sporadic portions of San Pablo and Central San Francisco Bay, and present in all marshes the South San Francisco Bay. *Lepidium latifolium* is also a widespread weed of the Sacramento-San Joaquin delta, and alkaline or subsaline grazing land and cropland in interior California (M. Renz pers. comm. 1999). It has not yet been recorded in abundance in tidal marshes outside of the Golden Gate, but a few individuals have been detected along tidal marsh edges of southern Tomales Bay, Marin County (P. Baye pers. observ. 1998).

Lepidium latifolium appears to be a major threat to rare plant species of the estuary (Howald 2000, Spautz and Nur 2004, Baye pers. comm. 2004; Grewell pers. comm. 1997-2000). In California tidal marshes, *L. latifolium* is actively displacing several endangered plant populations, including *Chloropyron molle* ssp. *molle* and *Cirsium hydrophilum* var. *hydrophilum,* and reducing biomass and stature of perennial pickleweed habitat that supports other native wetland dependent species such as the clapper rail

(Grewell *et al.* 2007). Also, *L. latifolium* displaces other tall, native tidal marsh plants that serve as important refugia for clapper rails. Researchers are concerned that as the invasion progresses, growing populations of *L. latifolium* will exclude grasses and native vegetation which may reduce food resources for wildlife (Howald 2000, Spautz and Nur 2004). Without control, *L. latifolium* can be expected to spread and increase in abundance.

Manual removal, mowing, discing, and burning of *Lepidium latifolium* have failed to suppress populations, and may even stimulate them (M. Renz pers. comm. 1999, Grossinger *et al*. 1998). *Lepidium latifolium* mortality is high in response to applications of glyphosate in the pre-flowering stage (M. Renz pers. comm 1999), particularly in the early stages of shoot elongation (P. Baye pers. observ. 1999-2000). Glyphosate was used in the 1990s in San Francisco Bay to control the species (Grossinger *et al*. 1998). Imazapyr is also registered for use in wetlands and has resulted in higher control levels. However, it has soil residual activity. California Department of Fish and Game (Estrella *in litt*. 2008) had success using chlorsulfuron to control *L. latifolium* in stands away from water. In 2007 and 2008, San Pablo Bay National Wildlife Refuge preliminarily had most success by using a mixture of imazapyr and glyphosate (U.S. Fish and Wildlife Service 2007, Downard *in litt*. 2009*a*). California Department of Parks and Recreation showed preliminary success in 2011 in controlling *L. latifolium* in Benicia State Recreation Area (Southampton marsh) while successfully balancing protection of *Chlorpyron molle* ssp. *molle* and California clapper rail.

Additional non-native plants have presented an invasion threat to native plant communties of the Bay Area to varying degrees, such as, but not limited to, *Salsola soda* (Mediterranean saltwort), *Carpobrotus edulis* (iceplant, hottentot-fig, sea-marigold) and its hybrids with *Carpobrotus chilense*, *Lotus corniculatus* (birdsfoot-trefoil), *Lythrum salicaria* (purple loosestrife), *Polypogon monspeliensis* (annual beard grass), and *Atriplex semibaccata* (Australian saltbush). The primary threat from each of these is also that the native plant community, along with its function as refugial or nesting habitat for the rail, is displaced. Also, some are annuals that thereby provide no escape cover for the rail during winter high tides because they are simply a plant skeleton that predators can see through.

Invertebrates. The role of non-native tidal invertebrates in California tidal marsh ecosystems is just beginning to be studied (*e.g.,* Grosholz *et al.* 2004). Feeding, tunneling, and other invertebrate activities have the potential to significantly affect the ecosystem and species. Many non-native invertebrates, such as the mitten crab (*Eriocheir sinensis)*, were likely introduced through discharged ship ballast water.

Conservation. Tidal marshes in California today are the focus of numerous diverse conservation efforts. Many significant preservation, restoration, management, education, monitoring, and research projects are being planned or are underway, and new initiatives are emerging continuously. Any attempt to catalog these efforts here is certain to be dated by the time of publication, and to neglect many important participants and projects. It must be noted, however, that the San Francisco Estuary Institute's Bay Area Wetland Project Tracker, San Francisco Bay Joint Venture, Bay Conservation and Development Commission, San Francisco Bay Wetlands Restoration Program, Invasive Spartina Project, South Bay Salt Pond Restoration Project, and

Suisun Marsh Program websites contain extensive information and maps about tidal marsh conservation and projects around the Bay Area.

Following increased public awareness of tidal marsh destruction in the 1960s, public agencies (primarily the California Department of Fish and Game and the U.S. Fish and Wildlife Service, but including regional conservation districts, state and regional parks, and the State Lands Commission) acquired title to and protected many remaining tidal marshes throughout the Bay Area. Tidal marshes in public ownership at Greco Island, Mowry and Dumbarton Marshes, Petaluma Marsh, Fagan Slough Marsh, Rush Ranch, China Camp, Point Pinole, Southampton Marsh, and Hill Slough contain irreplaceable pre-historical tidal marshes. These agencies also acquired many diked baylands under threat of development to reserve them for future restoration to tidal marsh (*e.g.,* Cullinan Ranch, Vallejo; Bair Island, Redwood City; Baumberg Tract, Hayward; Bel Marin Keys, Novato; Hamilton Field, Skaggs Island, etc.). Currently, restorations totaling more than 4,000 hectares (10,000 acres) have been completed and over 4,000 hectares (10,000 acres) more are in the planning phase (www.wetlandtracker.org). During the 1990s, the scale of proposed restoration projects generally increased from tens of acres typically in a mitigation context, to hundreds and thousands of acres in a restoration context. Current projects range from simple levee breaching to the use of dredge spoil to raise subsided historic baylands to elevations suitable for marsh establishment.

Combined Factors. Few of the above causes of habitat degradation are independent of one another; rather, they interact. For example, construction and subsequent maintenance of a levee may restrict tidal circulation, focus the impacts of any fresh wastewater discharges, provide predator corridors and nest/den sites, compress high-tidal refugial vegetation to a narrow strip, and promote weed growth. It may also mobilize contaminants buried in marsh sediments. The presence of the levee may provide recreational access for people and their pets, potentially causing increased disturbance and litter attractive to animal pests.

In summary, habitat loss accounts for the largest historical and present threat to the California clapper rail. This loss has mainly been through filling, levees, subsidence, changes in water salinity, non-native species invasions, and pollution. However, sea level rise associated with global climate change has also begun to contribute to habitat loss and promises to do so substantially into the future. Though restoration occurring now may eventually increase the total acreage of suitable habitat significantly, it is not likely to ever reach the level or quality present prior to listing.

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

Though the commercial hunting of California clapper rail at the turn of the 20^{th} century had a significant negative effect on its population numbers, by the time of listing this threat had been eliminated. Currently, overutilization of this species is not known to be occurring for any purpose.

Factor C: Disease or Predation

Disease
Disease is not known to currently be a threat to the California clapper rail.

Predation
Throughout the bay, the remaining clapper rail population is threatened by a suite of mammalian and avian predators known to take individuals and eggs of California clapper rail. Mammalian species, such as red fox (*Vulpes vulpes*), Norway rats (*Rattus norvegicus*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), and cats (*Felis catus*), are common terrestrial predators. Avian predators such as ravens (*Corvus corax*), gulls (*Larus* spp.), and red-tailed hawks (*Buteo jamaicensis*) may be native to the general area, yet their abundance or impact in tidal marshes is aggravated by human modifications of the environment, such as levees providing dryland access, landfills providing an attractive nuisance, or poles or towers providing perches. Other species, such as gray fox and opossums, are also considered potential predators due to their foraging habits, but their impacts to tidal marsh species are less well documented.

Precipitous declines in South Bay rail populations during the mid to late 1980s are attributed largely to intensive predation by the arrival of the non-native red fox (Foerster *et al.* 1990, Albertson 1995). Rail carcasses and egg remains have been found outside of active red fox dens (Foerster and Takekawa 1991). Between 1991 and 1996, a significant negative correlation existed between breeding densities of rails and average fox abundance, such that sites with the highest densities of foxes had no rails. In addition, there was a significant positive relationship between the growth rate of clapper rail populations and red fox trapping success in the preceding year. Albertson (1995) suggested that in the South Bay, predation by red foxes posed the most serious threat to adult clapper rails.

Non-native red foxes are present in the North Bay as well as the South Bay (Lewis *et al.* 1999). Recent preliminary evidence suggests that red foxes in the North Bay (Petaluma, Santa Rosa, and Sebastopol) are non-native; however, red foxes from the Montezuma Hills area near the Suisun Bay are genetically more similar to the native Sierra Nevada red fox (*Vulpes vulpes necator*) (Sacks *in litt.* 2009). To date, no quantitative data are available on rail mortality due to non-native red fox in the North Bay or near Suisun. Non-native red fox have been observed since 1988, however, and anecdotal evidence suggests that foxes have been a factor in declines in rail detections at the mouth of Sonoma Creek (Evens 2000*a*).

Predation consistently takes a high toll on both nest success and hatching success although the impact of predators on clapper rails varies with marsh. Chicks and eggs are vulnerable to predation by the entire suite of predators. Norway rats appear to take the majority of eggs lost to predators (Harvey 1988, Foerster *et al.* 1990, Striplen 1992). Foerster *et al.* (1990) found the majority of documented nest losses were due to rats and raccoons. Of 54 active clapper rail nests that contained 348 eggs, predators were responsible for the loss of 115, rodents destroyed 108, foxes destroyed 4, and snakes destroyed 3 (Striplen 1992). An additional 43 eggs failed to hatch due to nest abandonment or inundation, and 38 disappeared during incubation. Estimates of nest predation may be underestimated, however, because certain predators, particularly red fox, are known to carry eggs away from nests prior to consumption. Red fox-depredated rail eggs (n = 4) were recovered an average of 5.8 meters (19 feet) from the nest in the South Bay (Striplen 1992). Such displaced eggs may be overlooked by observers, and nest failure mistakenly attributed to other causes, such as adult abandonment or nest inundation. Gopher snakes (*Pituophis melaoleucus*) have taken several clapper rail nests at Laumeister Marsh, and it is possible that ground squirrels and long-tailed weasels (*Mustela frenata*) may take clapper rail nests while foraging in marshes (Albertson *in litt.* 2006).

Avian species are also important predators of tidal marsh birds and mammals, including clapper rails. Populations of many native avian species (common ravens, American crows, California gulls) are artificially increased above historical population levels due to the increased availability of food resources and nesting opportunities associated with human activities. Clapper rail predation from these species has correspondingly been elevated above historical levels. Other species, such as the northern harrier, have been pushed from much of their nearby upland habitat by urban development, and their foraging activities are locally concentrated in the wetland areas. Common ravens and red-tailed hawks are known to nest in electrical towers, boardwalks, and buildings and forage in various nearby marshes of South San Francisco Bay which have otherwise limited hunting perches (Albertson *in litt.* 2009*a*). The peregrine falcon is also a likely predator of the clapper rail, and populations of this species have increased locally in recent years as a result of peregrine falcon recovery actions.

Landfills and urban areas provide food resources that would otherwise not be available, while buildings, towers, and other human-made structures provide nesting and roosting opportunities. There are four landfills directly adjacent to the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge): Sunnyvale, Palo Alto, Newby Island, and Tri City. Predators of California clapper rail eggs, such as California gulls and common ravens are attracted by these facilities. California gull populations in the South Bay have increased from fewer than 200 breeding birds in 1982 to over 46,800 in 2008 (Ackerman *et al.* 2009), due to the availability of food resources, largely from landfills, coupled with the availability of nesting habitat on dry salt ponds and levees. It is estimated that gulls spend 20 percent of their foraging time at landfills in the South Bay. In a study by Ackerman *et al*. (2009) of gull movement in relation to landfills, it was determined that California gulls from a breeding colony at pond A6 in the Alviso area of the South Bay arrived at landfills at 6:00 in the morning and left at 6:00 in the evening when the landfills were closed and the exposed refuse was covered.

Landfills have also been identified as a major source of feral and otherwise free-roaming cats on the Refuge, and steps are currently being taken to limit the numbers of cats entering the Refuge from these sites (Albertson *in litt.* 2006). In addition, the numerous Bay Area levees and trails allow cats easy access to clapper rails, as well as other rare tidal marsh species (American Bird Conservancy 2006). For instance, many sections of the Bay Trail and other public trails have large populations of cats, many of which are fed daily by members of the public or organized cat advocate groups. Five general areas were identified as sites where cat predation is considered a threat to sensitive bird species in northern and central California: Don Edwards San Francisco Bay National Wildlife Refuge, San Pablo Bay wetlands, Benicia State Recreation Area, Eastshore wetlands (Alameda County), and Elkhorn Slough (Monterey County) (American Bird Conservancy 2006).

Encroaching development not only displaces lower order predators from their natural habitat, but also adversely affects higher order predators, such as coyotes, which would normally limit population levels of native and non-native predators, especially red foxes (Albertson 1995). This is exacerbated by predator release programs, which relocate nuisance animals from adjacent urban areas. Proximity of marshes to urban areas and placement of shoreline riprap favor rat populations, and result in greater predation pressure on clapper rails in certain marshes. These predation impacts are greatly aggravated by a reduction in high marsh and natural high tide cover in marshes (Sibley 1955, Evens and Page 1986).

Factor D: Inadequacy of Existing Regulatory Mechanisms

There are several State and Federal laws and regulations that are pertinent to Federally listed species, each of which may contribute in varying degrees to the conservation of Federally listed and non-listed species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced or eliminated the threat of wholesale habitat destruction.

Federal Protections*:*

Endangered Species Act of 1973, as amended: The Endangered Species Act (Act) is the primary Federal law that provides protection for the California clapper rail. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. The Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project.

Section 9 prohibits the taking of any federally listed endangered or threatened species. Section 3(18) defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harassment is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that result from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). For projects without a Federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take permits to non-Federal applicants pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved Habitat Conservation Plan (HCP) that details measures to minimize and mitigate the project's adverse impacts to listed species. Regional HCPs in some areas now provide an additional layer of regulatory protection for covered species, and many of these HCPs are coordinated with California's related Natural Community Conservation Planning program.

California clapper rails occur with the geographic scope of three separate Habitat Conservation Plans (HCPs) currently in preparation: Pacific Gas and Electric's Bay Area HCP, the Yolo County HCP, and the Solano County HCP. All of these planning efforts are in the early planning phase. Specific locations of potential California clapper rail habitat disturbance or protection have not yet been identified.

National Environmental Policy Act: The National Environmental Policy Act (NEPA) [42 U.S.C. 4321 *et seq*.] was signed into law on January 1, 1970. The NEPA establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within the Federal agencies. The NEPA also establishes the Council on Environmental Quality (CEQ). Title I of NEPA contains a Declaration of National Environmental Policy which requires the Federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. Section 102 requires Federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all Federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major Federal actions significantly affecting the environment. These statements are commonly referred to as environmental impact statements (EIS). Section 102 also requires Federal agencies to lend appropriate support to initiatives and programs designed to anticipate and prevent a decline in the quality of mankind's world environment. All Federally-listed species that may be affected by a Federal project must be addressed by an environmental assessment (EA) and/or EIS. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 CFR 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

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

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

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

The Federal Migratory Bird Treaty Act (MBTA) (16 USC 703 *et seq.*) and its implementing regulations (50 CFR Parts 20 and 21) directly protect the California clapper rail, its eggs, and nests from being killed, taken, captured, or pursued. However, it does not protect habitat, except to the extent that habitat alterations would directly kill birds.

<u>State and Local Protections</u>:

California Endangered Species Act: The California Endangered Species Act (CESA) (California Fish and Game Code, section 2080 *et seq.*), is a State law that provides protection for the California clapper rail since the designation of this species as endangered on June 27, 1971. The CESA prohibits the unauthorized take of State-listed threatened or endangered species. The California clapper rail was listed as endangered under CESA. The CESA requires State agencies to consult with the California Department of Fish and Game (CDFG) on activities that may affect a State-listed species and mitigate for any adverse impacts to the species or its habitat. Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. However, permits for take cannot be authorized due to the “Fully Protected” status of California clapper rails and CDFG cannot require mitigation because no take is allowed.

The classification of Fully Protected was the State's initial effort to identify and provide additional protection to those animals that were rare or faced possible extinction. Lists were created for fish, amphibians and reptiles, birds and mammals. Most of the species on these lists have subsequently been listed under the California and/or Federal Endangered Species Acts; white-tailed kite, golden eagle, trumpeter swan, northern elephant seal and ring-tailed cat are the exceptions. The Fish and Game Code sections dealing with Fully Protected species state that these species "....may not be taken or possessed at any time and no provision of this code or any other law shall be construed to authorize the issuance of permits or licenses to take any fully protected" species, although take may be authorized for necessary scientific research. This language arguably makes the "Fully Protected" designation the strongest and most restrictive regarding the "take" of these species. In 2003 the code sections dealing with fully protected species were amended to allow CDFG to authorize take resulting from recovery activities for state-listed species. More information on Fully Protected species and the take provisions can be found in the Fish and Game Code, (birds at §3511, mammals at §4700, reptiles and amphibians at §5050, and fish at §5515). Additional information on Fully Protected fish can be found in the California Code of Regulations, Title 14, Division 1, Subdivision 1, Chapter 2, Article 4, §5.93.

California Environmental Quality Act: The California Environmental Quality Act (CEQA) requires full public disclosure of the potential environmental impact of proposed projects. The public agency with primary authority or jurisdiction over the project is designated as the lead agency and is responsible for conducting a review of the project and consulting with other agencies concerned with resources affected by the project. Section 15065 of CEQA guidelines requires a finding of significance if a project has the potential to “reduce the number or restrict the range of a rare or endangered plant or animal.” Species that are eligible for listing as rare, threatened or endangered but are not so listed are given the same protection as those species that are officially listed with the State. Once significant impacts are identified, the lead agency has the option to require mitigation for effects through changes in the project or to decide that overriding considerations make mitigation infeasible; however, this is not the case for California clapper rail due to its “Fully Protected” species status. In the latter case, projects may be approved that cause significant environmental damage, such as destruction of endangered species habitat. Protection of listed species through CEQA is, therefore, at the discretion of the lead agency. The CEQA provides that, when overriding social and economic considerations can be demonstrated, project proposals may go forward, even in cases where the continued existence of the species may be jeopardized, or where adverse impacts are not mitigated to the point of insignificance.

California Coastal Act: The California Coastal Commission considers the presence of listed species in determining environmentally sensitive habitat lands subject to section 30240 of the California Coastal Act of 1976, which requires their protection. In particular the spirit of this act has two important precepts:

1. To promote the public safety, health, and welfare, and to protect public and private property, wildlife, marine fisheries, and other ocean resources, and the natural environment, it is necessary to protect the ecological balance of the coastal zone and prevent its deterioration and destruction.

2. That existing developed uses, and future developments that are carefully planned and developed consistent with the policies of this division, are essential to the economic and social well-being of the people of this state and especially to working persons employed within the coastal zone.

The California Coastal Act protects the habitat of the California clapper rail because of two requirements presented in the legislation:

1. Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on those resources shall be allowed within those areas.

2. Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.

Certain local jurisdictions have developed their own Local Coastal Programs or Land Use Plans that have been approved by the Coastal Commission. Some of the major accomplishments of this act include reduction in overall development, the acquisition of prime habitat along the coast, restoration of coastal streams and rivers, and a reduction in the rate of wetland loss.

Summary of Regulatory Mechanisms

In summary, the Endangered Species Act is the primary Federal Law that provides protection for this species since its listing as endangered in 1970; and the Fully Protected Status is the primary State Law that provides protection for this species since its listing by California as endangered in 1971.

Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Federal and State Acts. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act and California Endangered Species Act. Various protections are afforded by these Acts including:

Endangered Species Act: Regulates activities that may result in take (hunt, harm, harass, capture, kill, shoot, trap, wound, or collect) of the California clapper rail.

California Endangered Species Act: Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any California clapper rail or part or product of any species listed as endangered or threatened.

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

Global warming and climate change

The most central threat to the long-term survival of the California clapper rail is also the most difficult to ameliorate at a local level- sea level rise associated with global climate change. California tidal marshes are expected to be subject to the effects of global sea level rise and climate change due to global warming (Knowles and Cayan 2002). According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007*a*), estimates show that during the 20th century, global average sea level rose at a rate of about 1.7 millimeters (0.07 inch) per year.

Satellite observations available since the early 1990s provide more accurate sea level data with nearly global coverage. This satellite altimetry data set shows that since 1993, sea level has been rising at a rate of approximately 3 mm (0.12 in) per year, significantly higher than the average during the previous half century (IPCC 2007*a*). It has been suggested that the climate system, particularly sea levels, may be responding to climate changes more quickly than the models predict (Heberger *et al.* 2009). Additionally, most climate models fail to include ice-melt contributions from the Greenland and Antarctic ice sheets and may underestimate the change in volume of the world's oceans.

According to a 2009 study conducted by the Pacific Institute, under medium to medium-high emissions scenarios, mean sea level along the California coast will rise from 1.0 to 1.4 meters (3.3 to 4.6 feet) by the year 2100 (Figure 2). Other key findings of the study report that a 1.4 meter sea level rise would flood approximately 150 square miles of land in California immediately adjacent to current wetlands and would result in accelerated erosion resulting in a loss of an additional 41 square miles of California's coast by 2100 (Heberger *et al.* 2009). The U.S. Fish and Wildlife Service has chosen to adopt this medium to medium-high emissions scenario for recovery planning purposes, as have most other government regulatory and land and resource management entities. However, other studies have indicated more drastic estimates- that sea level rise could increase by 2.0 meters (6.6 feet) by 2100. These estimates include 0.75 to 1.90 meter (2.5 to 6.2 feet; Vermeer and Rahmstorf 2009), 0.8 to 2.0 meter (2.6 to 6.6 feet; Pfeffer *et al*. 2008), 0.8 to 1.3 meter (2.6 to 4.3 feet) under the A1B scenario (Grinsted *et al*. 2010), and 0.6 to 1.6 meter (2.0 to 5.2 feet; Jevrejeca *et al*. 2010).

In addition, sixteen California state agencies worked collaboratively with the Ocean Protection Council's Science Advisory Team and the Ocean Science Trust to develop recommendations based on the best available science for incorporating sea level rise projections into decision-making in the face of future uncertainty (California Ocean Protection Council 2010). That document, dated October 2010, was required under Governor's Executive Order S-13-08 to serve as interim guidance prior to the release of the final report from the National Academy of Sciences, expected in 2012. The guidance recommends the use of ranges of sea level rise presented in the December 2009 Proceedings of National Academy of Sciences publication by

Vermeer and Rahmsdorf (2009) as a starting place and selection of sea level rise values based on agency and context-specific considerations of risk tolerance and adaptive capacity. Adjusting to use 2000 as a baseline year, the guidance document projects sea level rise to be in the range of 1.0 to 1.4 meter (3.3 to 4.6 feet) by 2100, depending on greenhouse gas emissions scenarios. Due to strong agreement among the various climate models, the range of values for sea level rise prior to 2050 tightens to 0.26 to 0.43 meter (0.9 to 1.4 feet).

Other effects associated with warmer climate and higher sea level include more extreme storm events and greater extremes of wave height and energy (Wilkinson 2002, Bromirski *et al.* 2004) and lower amounts and altered timing of freshwater inflow (Knowles and Cayan 2002). Storm surges will be riding on a higher sea surface which will push water further inland and upland (Scavia *et al*. 2002). When storm surges coincide with high tides, the chances for coastal damage are greatly heightened (Cayan *et al*. 2008). In fact, in most cases, more extreme storm events present a far greater near-term threat to local populations than sea level rise (Downard *in litt*. 2009*b*). The effects of past subsidence of leveed marsh areas (Atwater *et al.* 1979) are likely to be amplified by rising sea level, making it harder to restore some subsided areas to tidal marsh.

Effects of climate change are time-delayed, long-lasting and largely irreversible. Due to the thermal inertia in the climate system, there is a time lag between the emission of greenhouse gases and the full physical climate response to those emissions (IPCC 2007*a, b*). Sea level rise will continue for centuries due to continuing thermal expansion of the oceans and melting of the Greenland ice sheets (Meehl *et al*. 2007). Also, climate changes that result from increases in CO_2 concentrations are largely irreversible for 1,000 years after emissions cease (Archer and Brovkin 2008, Solomon *et al*. 2009).

The effects of rising sea levels on tidal marshes are dependent upon the relative rate of sea level rise versus rates of sedimentation and accretion of the marsh surface. Unless a balance between sedimentation/accretion and erosion/subsidence is met that equals or exceeds the rate of sea level rise, there will be a net loss of salt marsh habitat. According to Orr *et al*. (2003), it remains uncertain whether accretion will keep pace with accelerated sea level rise and other climate-related effects; California’s tidal marshes may either rise with rising sea level, or erode or drown. Callaway *et al*. (2007) goes one step further in concluding that sea level rise rates on the order of 10-15 millimeters/year will likely lead to marsh loss for well-established marshes, while lower rates will cause shifts from marsh-plain to low-marsh vegetation. Heberger *et al*.’s (2009) conservative end estimate of 1.0 meter (3.3 feet) sea level rise by 2100 would equate to an average 11 millimeters/year, making marsh loss the more likely scenario. Finally, as stated by Kirwan *et al*. 2010, much depends on the contribution of melting sea ice. They state that if global temperature warming follows conservative IPCC projections and ice sheets contribute little water to the oceans, model experiments indicate that many marshes will accrete vertically and maintain their position within the intertidal zone.

The maintenance of tidal marsh habitat area during sea level rise requires (1) space for tidal marshes to expand upward into adjacent habitats as sea and tide levels increase; (2) available sediment adequate to support marsh accretion rates equal to or greater than the rate of sea level rise; and (3) stable erosion rates, or at least rates that do not defeat marsh accretion. The first of these requirements—room for marshes to "move up" in elevation—is especially problematic in the many areas of the Bay Area where tidal marsh abuts a levee, seawall, or other human barrier at its landward edge. The requirement for moderate erosion rates is also of concern, given that climate change and sea level rise in California are expected to be accompanied by increased storm severity and maximum wave heights; trends that are already suggested by available data (Wilkinson 2002, Bromirski *et al.* 2004). Sediment supply for marsh accretion is not yet well understood.

As reviewed in Callaway *et al*. (2007), the salinity of California tidal marshes will be altered by climate change-related shifts in regional precipitation, changes in the timing of precipitation and snowmelt runoff, and increases in sea level. Rising temperatures have already been linked to lower snowfall, more rain, and earlier snowmelt throughout California, which is leading to significantly earlier runoff within California watersheds. Higher pulses of freshwater in winter will result in lower marsh salinities while lower freshwater delivery in summer and fall will result in higher marsh salinities. Also, sea level rise will cause salinity levels overall to increase up the estuary as tides push higher up bays, rivers, and sloughs. For example, Suisun Bay and the Delta may become saltier.

Callaway *et al*. (2007) noted that the initial impacts of climate change are likely to stem from these salinity changes, and that even relatively small salinity changes can cause shifts in dominant vegetation. Higher salinities in the summer and fall are expected to produce increased stress on tidal marsh plants, potentially leading to reduced productivity and mortality (Callaway *et al*. 2007). Furthermore, as overall salinity in the Bay Area increases and more salts accumulate in tidal marsh soils, larger pulses of freshwater of greater duration will be required to reduce soil salinities in the marsh and promote germination and recruitment (Callaway *et al.* 2007). Ultimately, species that prefer brackish conditions over salt marshes would presumably suffer reduction in habitat, while salt marsh species, such as the clapper rail, might expand into Suisun Bay and even the Delta. Closer study is needed of the potential amount and extent of salinity and habitat change, and the species-level effects of these changes.

In addition, direct loss of clapper rail nests by inundation is likely to be higher than normal in the future, due to rising sea levels. As mentioned above, nests must be built at an elevation that protects the bowl from complete inundation during high tides (Evens and Collins 1992, Collins *et al.* 1994). This will be increasingly difficult for the species to achieve, especially for nests built directly on the ground, as opposed to on vegetation. Inundated nests result in abandonment and failure (U.S. Fish and Wildlife Service unpubl. data 1990).

Overall, threats from global climate change to clapper rails and tidal marsh habitats include: (1) habitat loss where landward migration of tidal marsh plant communities is prevented by artificial or geographic barriers, or where sea level rise or erosion exceeds sedimentation; (2) salinity gradients migrating up-estuary as tidal inundation increases; (3) greater extremes of heat and desiccation stress on wetland plants that support the rail; (4) the loss and/or decreased fecundity of rare populations and species (Reid and Trexler 1991, Boorman 1992, Keldsen 1997); and (5) high mortality rates associated with extreme weather events (Downard *in litt.* 2009*b*). Simply put, since climate change threatens to disrupt annual weather patterns, it may result in a loss of habitat and/or food, and/or increased numbers of rail predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat.

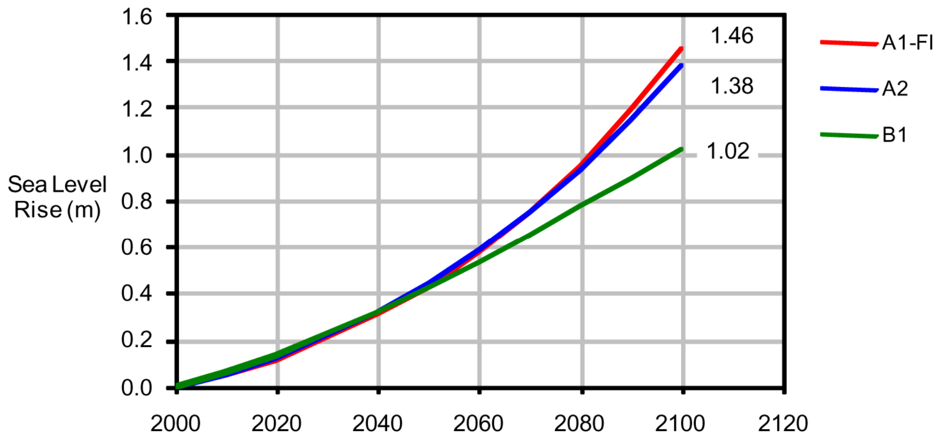

FIGURE 2. **Scenarios of sea-level rise to 2100** (Cayan *et al.* 2009). Estimated overall projected rise in mean sea level along the California coast for the B1 and A2 scenarios of 1.0 meter and 1.4 meters, respectively, by 2100. The A1FI scenario assumes a continued high level use of fossil fuels. (Source: Dan Cayan, Scripps Institution of Oceanography, NCAR CCSM3 simulations, Rahmstorf method.)

Contaminants

Environmental contaminants may adversely affect the survival, growth, reproduction, health, or behavior of species. Some contaminants may affect a narrow range of organisms while others, like petroleum products, can impact a broader range of organisms. Known contaminants of concern in the Bay Area include mercury, selenium, polychlorinated biphenyls, organochlorine and organophosphate pesticides, dioxins/furans, polycyclic aromatic hydrocarbons, and tributyltin from anti-fouling boat paints (see SWRCB 303d list, Region 2; Oros and Hunt 2005; Schwarzbach *et al*. 2006; Adelsbach and Maurer 2007). Ammonia and pyrethroid insecticides have become a recent concern. In addition, newly emerging contaminants which may act to disrupt endocrine systems, such as polybrominated diphenyl ethers and phthalates, are being detected in the estuary's water, sediments, and biota (Oros *et al*. 2005, Oros and Hunt 2005) and are poorly understood. Unmonitored contaminants in San Francisco Bay include such chemicals as pharmaceuticals, plasticizers, flame retardants, and detergent additives (San Francisco Estuary Institute 2000). Toxic effects of many of these chemicals to rails and other estuary biota are not known. In other species, some of these chemicals have caused endocrine disruption and altered gender development through *in ovo* exposures (Colburn and Clement 1992). While the full impact of these emerging contaminants on species in the estuary remains to be determined, the increasing frequency at which they are being detected is cause for concern. All of the contaminants mentioned above have the potential to adversely impact biota in the estuary, depending on the extent and degree of contamination (Phillips 1987). Three of the primary known threats are described in further detail below.

The estuary's aquatic and aquatic-dependent wildlife species are the most at risk from contamination by bioaccumulative pollutants such as mercury and selenium. Historically, the major source of mercury contamination in the San Francisco Bay-Delta was mine waste and drainage from Coast Range mercury mines and Sierra Nevada Range gold mines (San Francisco Estuary Regional Monitoring Program 1996). Substantial reservoirs of this toxic metal left over from mining activities remain in estuary sediments, as well as in sediments and soils associated with upstream tributary water bodies. Even today, mercury from these upstream sources continues to wash downstream into the estuary (California Regional Water Quality Control Board 2004). However, other significant sources of mercury have been identified as being of concern. Mercury released into the atmosphere through oil and coal combustion and through waste incineration can be re-deposited into aquatic ecosystems through precipitation, contaminating water bodies with no other known mercury inputs (Wiener *et al*. 2002). Once in the aquatic realm, certain conditions (*e.g.*, anoxia and sulfate-reducing bacteria) may allow for the transformation of inorganic mercury into methylmercury, an organic form that is highly toxic and much more bioavailable than the inorganic precursor. Under continuous exposure in a contaminated ecosystem, methylmercury is introduced into the body at a much faster rate than the body can eliminate it, and aquatic and aquatic-dependent organisms bioaccumulate it into various tissues. Methylmercury concentrations in aquatic ecosystems biomagnify in each successive trophic level, from primary producers to the top predators (Wiener *et al*. 2002). Tidal marshes often exhibit the conditions that promote methylation of mercury, and high mercury concentrations have been found in a variety of fish from the Bay Area (Greenfield *et al*. 2003).

Based on egg injection work on mallards and assessments of the rail's current reproductive status, it has been estimated that observed adverse effects, in the form of developmental abnormalities and reproductive harm are seen above 0.2 ppm fresh wet weight (fww) methlymercury in rail eggs (U.S. Fish and Wildlife Service 2003). Mercury was detected in all 64 fail-to-hatch eggs collected from six Bay Area marshes in 1992. Though piscivorous birds are generally considered to have the greatest rates of mercury bioaccumulation and herbivorous birds the least, the California clapper rail appears to be the exception. The greatest range in mercury concentrations among any species observed from San Francisco Bay was in the fail-to-hatch eggs of California clapper rails from south San Francisco Bay where, concentrations in a 1992 investigation were between 0.19 and 2.52 ppm (Schwarzbach *et. al*. 2006). Davis *et. al*. states that "Mercury toxicity to clapper rail embryos appears to be one of the primary causes of mortality in the population of this endangered species" (Davis *et. al*. 2003).

Selenium, another bioaccumulative element, can contaminate aquatic ecosystems through a variety of human activities. Selenium is a potential threat to rails because it is known to accumulate in avian eggs in proportion to the maternal dose, and to adversely impact birds by directly reducing the hatchability of eggs, as well as reducing growth and post-hatch survival of juveniles exposed in the egg. The *in ovo* threshold for selenium exposure that causes toxic effects on embryos of California clapper rails is unknown. The *in ovo* embryo toxicity threshold for selenium in black-necked stilts (*Himantopus mexicanus*), another benthic forager, is 6 µg/g (dry weight; dw) (Skorupa 1998). Clapper rail eggs collected from the North Bay in 1987 contained up to 7.4 µg/g selenium (dw) (Lonzarich *et al.* 1992). Investigations of fail-to-hatch clapper rail eggs in the South Bay in 1992, and in the North Bay in 1998, have not duplicated the elevated selenium results of Lonzarich *et al.* (1992). Maximum egg selenium concentrations in more than 60 eggs were less than 3.2 µg/g (dw). It seems unlikely that current selenium concentrations in the bay are having a significant impact on clapper rail reproduction, but that could change if selenium loadings to the estuary increase. Currently, selenium appears to primarily pose a threat to bottom-feeding animals like white sturgeon (*Acipenser transmontanus*) and Sacramento splittail (*Pogonichthys macrolepidotus*) via their bivalve prey items (Maier and Knight 1994, Presser and Luoma 2007, Linville *et al*. 2002, Stewart *et al*. 2004, Teh *et al*. 2004).

The Bay Area has many potential sources of petroleum and petroleum-byproduct (*e.g.,* PAHs) releases, due to a high degree of urbanization, with six oil refinery complexes, substantial ship and oil tanker traffic, and a large number of gasoline, diesel, or fuel oil-powered vehicles. PAHs are commonly detected in bay waters and sediments where tidal marsh species may be exposed to them (Ross and Oros 2004). Exposure of tidal marsh species to free petroleum products generally occurs as a result of vessel- or pipeline-related oil spills. As is known from numerous spill events, even relatively small exposures to oil can harm or kill birds and other wildlife (Gilardi and Mazet 1999).

Oil spills in San Francisco Bay have potential to cause serious consequences to California clapper rails. As a consequence of the catastrophic oil spills of 1989, the Oil Pollution Act of 1990 required contingency plans be completed by both State and Federal Governments. The U.S. Coast Guard and California Department of Fish and Game – Office of Spill Prevention and Response agreed to joint preparation of contingency plans. The Area Committee planning process is a proactive effort to deal with potential oil releases inherent in California's petroleum dependant economy and culture. This planning process is open to all stakeholders and has involved representatives from over 50 agencies, including environmental groups, city and county planners, California State agencies, the Federal government, and industry. These organizations have come together to produce a landmark comprehensive planning document that serves as a "one stop" marine pollution response plan for the three port areas and the included six geographical sections of the California Coast (North Coast, San Francisco Bay and Delta, and Central Coast/Monterey) (U.S. Coast Guard *in litt*. 2009). The three Area Contingency Plans provide guidance for the first 24 hours of response and are living documents, the respective area committees meeting regularly to update, review, and revise the documents as needs become apparent.

Risk of extirpation due to small populations

Small populations are typically at greater risk of extinction than larger ones (Terborgh and Winter 1980, Diamond 1984, Pimm *et al.* 1988, Morris and Doak 2003). Because California clapper rails have lost so much habitat, their populations are much reduced in size. There are many causes of the increased risk of extinction characteristic of small populations. For example, small populations have increased vulnerability to extinction due to catastrophic events like severe droughts, storms, fires, pollution spills, non-native species invasion, or epidemics (Schonewald-Cox *et al.* 1983). Another factor is natural variability in birth and death rates: a chance cluster of years of high death rates or low birth rates is likely to result in the extirpation of small populations. At low population sizes, genetic and evolutionary effects become important, including loss of genetic diversity due to founder effects, genetic drift, inbreeding, and inbreeding depression.

In general, Factor E threats- loss/reduction of habitat due to rising sea level and other climate extremes such as increased storm intensity; contaminants, and risk of extirpation due to small population size- pose some of the most significant threats to California clapper rails.

In summary, the above overarching and categorized threats of habitat loss and fragmentation, habitat degradation and disturbance, invasive non-native species, predation, sea level rise associated with climate change, and risk of small populations affect the tidal marsh ecosystem upon which the California clapper rail depends. Many of these threats are severe and immediate.

III. RECOVERY CRITERIA

The *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* was published in February 2010 and includes the California clapper rail among other endangered tidal marsh species. Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and the threats to its survival are neutralized, so its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of the species. Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species. Because we cannot envision the exact course that recovery may take and because our understanding of the vulnerability of a species to threats is very likely to change as more is learned about the species (*e.g*., habitat, demography, genetics) and its threats, it is possible that a status review may indicate that downlisting or delisting is warranted although not all recovery criteria are met. Conversely, it is possible that the recovery criteria could be met and a status review may indicate that downlisting or delisting is not warranted (*e.g*., a new threat may emerge that is not addressed by the recovery criteria below and that causes the species to remain threatened or endangered). Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

I. Downlisting criteria- California clapper rail

Factor A: The present destruction, modification or curtailment of its habitat or range. To reclassify the California clapper rail to threatened status, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

A/1. Protection and management of the following marsh complexes where core populations exist:

***Central/Southern San Francisco Bay Recovery Unit*:**

- San Rafael Creek-Richardsons Bay, including Corte Madera Creek,
- Bair-Greco-Ravenswood,
- East Palo Alto-Guadalupe Slough,
- Guadalupe Slough-Warm Springs,
- Mowry-Dumbarton,
- Hwy 84 to Hwy 92 (Coyote Hills/Eden Landing), and
- Hwy 92-Arrowhead Marsh

Habitat Area: The habitat for each Central/South Bay core population (except San Rafael Creek to Richardsons Bay) must have a minimum area of 1,250 acres (450 ha) of contiguous high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, at the high marsh/upland transition zone and/or inner-marsh. Due to constraints on restorable land, habitat in the San Rafael Creek to Richardsons Bay complex must be a minimum of 400 acres (162 ha), and have the same critical characteristics, as stated previously.

The criteria for A/1 are still valid as described in the 2010 Draft Recovery Plan. To date, the target acreages for the Central/Southern San Francisco Bay Recovery Unit have not been met. Recovery actions in this unit are either underway or have not yet been planned or initiated. The Service is not aware of adequate surveys and monitoring of California clapper rail populations in this recovery unit to make determinations regarding the amount of high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, connected by suitable habitat corridors to allow for successful reproduction, dispersal and recolonization.

A/2. Protection and management of marsh complexes where core populations exist, as follows:

***San Pablo Bay Recovery Unit*:**

- China Camp to Petaluma River,
- Petaluma River marshes,
- Petaluma River to Sonoma Creek,
- Napa marshes (Sonoma Creek to southern tip of Mare Island), and
- Point Pinole marsh

Habitat Area: The habitat area for each San Pablo Bay core population, except that at Point Pinole marsh, must have a minimum of 2,500 acres (1,012 ha) of contiguous high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, at the high marsh/upland transition zone and/or inner-marsh. Due to constraints on restorable land, habitat at Point Pinole marsh must be a minimum of 400 acres (162 ha), and have the same critical characteristics, as stated previously.

The criteria for A/2 are still valid as described in the 2010 Draft Recovery Plan. To date, the target acreages for the San Pablo Bay Recovery Unit have not been met. Recovery actions in this unit are either underway or have not yet been planned or initiated. The Service is not aware of adequate surveys and monitoring of California clapper rail populations in this recovery unit to make determinations regarding the amount of high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, connected by suitable habitat corridors to allow for successful reproduction, dispersal and recolonization.

A/3. Protection and management of marsh complexes where core populations exist, as follows:

***Suisun Bay Area Recovery Unit*:**

- Western Grizzly and Suisun Bays and marshes of Suisun, Hill and Cutoff Sloughs.

Habitat Area: The habitat area for the Suisun Bay Area population must have a minimum of 5,000 acres (2,023 ha) of contiguous high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, at the high marsh/upland transition zone and/or inner-marsh.

The criteria for A/3 are still valid as described in the 2010 Draft Recovery Plan. To date, the target acreages for the Suisun Bay Area Recovery Unit have not been met. Recovery actions in this unit are either underway or have not yet been planned or initiated. The Service is not aware of adequate surveys and monitoring of California clapper rail populations in this recovery unit to make determinations regarding the amount of high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, connected by suitable habitat corridors to allow for successful reproduction, dispersal and recolonization.

A/4. **Protection and management of 800 acres (324 ha) of habitat at Tomales Bay**, Marin County, to provide proximate, outercoast habitat for California clapper rail in the event of a catastrophic event within San Francisco Bay. The habitat must be contiguous high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, at the high marsh/upland transition zone and/or inner-marsh.

The criteria for A/4 are still valid as described in the 2010 Draft Recovery Plan. To date, the target acreages for Tomales Bay have not been met. Recovery actions in this unit are either underway or have not yet been planned or initiated. The Service is not aware of adequate surveys and monitoring of California clapper rail populations in this recovery unit to make determinations regarding the amount of high-quality tidal marsh habitat with well-developed channel systems and high-tide refugia/escape cover, connected by suitable habitat corridors to allow for successful reproduction, dispersal and recolonization.

A/5. **Control of future invasive *Spartina* infestations and implementation of a system for its early detection**.

Criterion A/5 is inappropriate, as currently worded. It would be more appropriate to call for "Control of future invasive plant infestations, while minimizing effects to clapper rails, and implementation of a system for early detection of infestations". Though there still may be a need to control remaining or re-appearing invasive *Spartina*, it is important to state that control must be conducted in a manner to minimize effects to the California clapper rail. Also, it is important to recovery of the California clapper rail that other plant infestations be controlled in the future, as well.

A/6. **Reduction in extant *Lepidium latifolium* populations to less than ten percent cover (in and down-gradient of the high marsh-upland ecotone) for five years in each marsh complex described above.**

The criterion for A/6 is still valid as described in the 2010 Draft Recovery Plan, however, it has not been met. The Service is not aware of adequate surveys and monitoring of *Lepidium latifolium* populations in this recovery unit to make a determination that less than 10 percent cover remains in each marsh complex described above.

A/7. **Implementation of site-specific management plans on lands owned by U.S. Fish and Wildlife Service, California Department of Fish and Game, East Bay Regional Park District, and Mid-Peninsula Open Space District to reduce recreation-based (human-caused) disturbance to rails, both by reduction of physical disturbance and predation to rails from domestic animals and humans and by elimination of litter and feeding stations which serve to attract predators, thereby degrading habitat quality.**

The criterion for A/7 is still valid as described in the 2010 Draft Recovery Plan. There has been progress toward this criterion in that the San Pablo National Wildlife Refuge has nearly completed its Comprehensive Conservation Plan (CCP) and the development of a CCP for Don Edwards National Wildlife Refuge is in the preliminary stages. These management plans will incorporate actions to control recreation-based disturbance.

Factor B: Overutilization for commercial, scientific or educational purposes. Though overutilization was a major factor for this species at the turn of the 20th century and set the stage for low population levels which existed at the time of the original listing, it has been eliminated and is not currently known to be a threat. Therefore, no recovery criteria were developed for this factor.

Factor C: Disease or predation. Disease is not known to be a major threat to California clapper rails at this time. To downlist California clapper rail to threatened status, predation pressures need to be reduced. This will have been accomplished if the following have occurred:

C/1. A predator management plan is developed and implemented at all sites with significant predation issues.

The criterion for C/1 is still valid as described in the 2010 Draft Recovery Plan. Several refuges within the San Francisco Bay National Wildlife Refuge Complex are implementing predator management as part of their Comprehensive Conservation Plans. There is not sufficient data to determine whether other landowners with predation issues are implementing predator management.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, no recovery criteria were developed under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To downlist California clapper rail to threatened status, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient resilience to stochastic events, criteria under Factors A-C have been met and have resulted in at least the following average number of rails over a 10 year period, spread over a large geographic area:

i. Central/Southern San Francisco Bay: 1,062
ii. San Pablo Bay: 936
iii. Suisun Bay: 100

The average number of rails required for downlisting was calculated from the minimum required acreage above, derived itself from a population viability analysis conducted for California clapper rail. The minimum acreage was multiplied by the rail density corresponding to the 60^{th} percentile of observed winter populations for that particular region. Respectively, those are 0.15 bird/ac, 0.09 bird/ac, and 0.02 bird/ac for the regions above.

Rather than specify a minimum number of rails that must be supported per marsh complex, it is assumed that a natural distribution over a large geographic area would result if the other minimum acreage protection and management criteria are met.

For downlisting of the California clapper rail to occur, habitat protection need not have resulted in the occupation of Tomales Bay marshes by the species.

The criterion for E/1 is still valid as described in the 2010 Draft Recovery Plan. California clapper rail numbers reflected in recent studies sum to a total far less than the targets identified above, therefore we can confidently state that the criterion has not been met.

The delisting criterion for preservation of high marsh/upland transition lands should be added as a criterion for downlisting as well.

Delisting criteria- California clapper rail

Factor A: The present destruction, modification or curtailment of its habitat or range. To delist the California clapper rail, threats to the species habitat must be reduced or removed. This will have been accomplished:

A/1. When all *downlisting* criteria under A/1 have been achieved.

This criterion is still valid. See downlisting criteria number A/1 above for status.

A/2. When all *downlisting* criteria under A/2 have been achieved.

This criterion is still valid. See downlisting criteria number A/2 above for status.

A/3. When all *downlisting* criteria under A/3 have been achieved.

This criterion is still valid. See downlisting criteria number A/3 above for status.

A/4. When all *downlisting* criteria under A/4 have been achieved.

This criterion is still valid. See downlisting criteria number A/4 above for status.

A/5. When all *downlisting* criteria under A/5 have been achieved.

This criterion is still valid. See downlisting criteria number A/5 above for status.

A/6. When all *downlisting* criteria under A/6 have been achieved. **In addition,** a plan must be developed and implemented for early detection and control of *Lepidium latifolium* (in and down-gradient of the high marsh-upland ecotone) following any future increase beyond ten percent cover. Also, a funding source must be secured to fund such actions in perpetuity.

This criterion is still valid. See downlisting criteria number A/6 above for status.

A/7. When *downlisting* criteria under A/7 have been achieved **at all sites**.

This criterion is still valid. See downlisting criteria number A/7 above for status.

A/8. Implementation of the *Habitat Management, Preservation, and Restoration Plan for Suisun Marsh* (in preparation by the Suisun Marsh Charter Group), San Pablo Bay National Wildlife Refuge Comprehensive Conservation Plan (in preparation by San Pablo

Bay National Wildlife Refuge), and the *South Bay Salt Pond Restoration Plan* (U.S. Fish and Wildlife Service 2009).

This criterion is still valid. The *Habitat Management, Preservation, and Restoration Plan for Suisun Marsh* is still in preparation and the San Pablo Bay National Wildlife Refuge's Comprehensive Conservation Plan is nearly complete and will begin implementation soon. The *South Bay Salt Pond Restoration Plan* is currently being implemented. The SBSP Restoration Project published the Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) in March of 2007 and the Final EIS/EIR in December 2007. Habitat restoration and enhancement was initiated in 2010 in 11 South Bay ponds, comprising 3,081 acres (Island Ponds, SF2, A6, A5/7/8, E8A/9/8X) plus 1,400 acres in the North Bay at the Napa Plant site. The restoration design is near completion for the restoration and enhancement of another 3 ponds comprising 472 acres (E12/13, A16). Phase 1 construction is scheduled to be complete in 2012. In addition, a number of studies are underway that will help us understand how the Bay and its fish and wildlife resources are responding to the restoration, resulting in more targeted future restoration actions.

Factor B: Overutilization for commercial, scientific or educational purposes. Though overutilization was a major factor for this species at the turn of the 20th century and set the stage for low population levels which existed at the time of the original listing, it has been eliminated and is not currently known to be a threat. Therefore, no recovery criteria were developed for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat to California clapper rails at this time. To delist California clapper rail, predation pressures need to be reduced or removed. This will have been accomplished if the following have occurred:

C/1. All *downlisting* criteria under C/1 have been achieved. In addition, predator monitoring indicates that for 5 consecutive years, predation pressure on California clapper rails falls below a level at which it negatively affects long-term population persistence.

This criterion is still valid. See downlisting criteria number C/1 above for status.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, no recovery criteria were developed under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To delist California clapper rail, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient resilience to stochastic events, criteria under Factors A-C have been met and have resulted in at least the following average number of rails over a 10 year period, spread over a large geographic area:

i. Central/So SF Bay: 3,180
ii. San Pablo Bay: 2,048
iii. Suisun Bay: 200
iv. Tomales Bay: 32

The average number of rails required for delisting was calculated from a population viability analysis conducted for California clapper rail. For more information on the calculation of carrying capacity, see **Appendix F** of the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (U.S. Fish and Wildlife Service 2010). The minimum acreage was multiplied by the rail density cooresponding to the 90th percentile of observed winter populations for that particular region. Those are 0.45 bird/ac and 0.20 bird/ac for Central/So SF Bay and San Pablo Bay, respectively. Species experts agreed on a realistic density of 0.04 bird/ac for the Suisun and Tomales Bay metapopulations.

Rather than specify a minimum number of rails that must be supported per marsh complex, it is assumed that a natural distribution over a large geographic area would result if the other minimum acreage protection and management criteria are met.

Criterion E/1 is still valid. See downlisting criteria number E/1 above for status.

E/2. To minimize impacts sustained after oil spills occurring at or near core populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of California clapper rails.

Criterion E/2 is still valid. The Contingency plan above has not yet been revised accordingly.

E/3. A map must be developed which identifies sources and extents of mercury exposure in rails and a plan must be in place to remediate the most significant point sources of mercury. In addition, exposure of rails to mercury must be reduced such that mercury concentrations in every rail egg sampled throughout its range must fall below 0.2 ppm (fresh wet weight), the point above which it is believed developmental abnormalities and reproductive harm occur.

Criterion E/3 is still valid and the map described above has not yet been created. The Service is not aware of studies indicating mercury has been reduced such that concentrations in rail eggs fall below 0.2 ppm (fww).

E/4. High marsh/upland transition lands, when and wherever possible, must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. In addition, there must be a partnership developed, involving resource agencies, public landowners/managers and private landowners, to implement Strategic Habitat Conservation (SHC), specifically to guide future habitat acquisition and management goals given the challenge of local sea level rise.

Criterion E/4 is still valid. Although the Service is not aware of high marsh/upland transition lands being created and/or preserved since the 2010 Draft Recovery Plan, there has been increasing focus on this particular habitat element in several regional restoration plans in development. In addition, partnerships to specifically guide tidal marsh habitat acquisition and management in the face of sea level rise have not yet been created.

IV. SYNTHESIS

Habitat loss due to human actions continues to be the greatest threat to the California clapper rail. Habitat loss and degradation that threatens California clapper rail is due to filling, levees, subsidence, changes in water salinity, non-native species invasions, non-native species control, sea level rise associated with global climate change and contamination. In addition, habitat suitability of many marshes is further limited by small size, fragmentation, and lack of other vital features such as sufficient escape habitat. California clapper rail populations have been declining since 2000 and fewer individuals exist today than when the species was listed. Larger tracts of high quality habitat are needed to maintain stable populations over time. Several projects such as the *Habitat Management, Preservation, and Restoration Plan* for Suisun Marsh, the *San Pablo Bay National Wildlife Refuge Comprehensive Conservation Plan*, and the *South Bay Salt Pond Restoration Plan*, which target restoration of California clapper rail habitat, are either in preparation or in early implementation. Though these plans will move the species toward recovery, the Service is not aware of any significant recovery efforts for California clapper rail within this species' range that would achieve the criteria identified in the Draft Recovery Plan and discussed in Section III of this review. Therefore, we believe the California clapper rail (*Rallus longirostris obsoletus*) still meets the definition of endangered, and recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
  ____ *Extinction*
  ____ *Recovery*
  ____ *Original data for classification in error*
_X__ No Change

New Recovery Priority Number and Brief Rationale: No change in recovery priority number.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

The basic strategy for recovery of the California clapper rail is the protection, enhancement, and restoration of extensive, well-distributed tidal marsh habitat suitable for the species. The 2010 Draft Recovery Plan identifies short- and long-term components of the general recovery strategy; neither alone is sufficient to recover the California clapper rail. Below is a list of recommendations for actions over the next five years.

1.) **Acquire/protect or restore/protect tidal marsh habitat according to Figures III-8 through III-26 in the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California*.** First priority for acquisition/restoration of baylands is those areas with the best quality habitat and the most rapid restoration potential relative to anticipated sea level rise. Habitat acquisition/restoration efforts should first build large blocks of suitable habitat around existing populations under least pressure from non-native predators, either the least subsided or with the highest natural sedimentation rates. In addition, links must be maintained throughout the bay to facilitate dispersal and gene flow among subpopulations. However, restoration planning should assume all lands below 140 cm elevation will be inundated by 2100. Importantly, high ground adjoining or near marshes should be acquired and protected. Existing steep-sided outboard dikes should be redesigned such that when they need to be replaced/heightened in response to flooding threats from sea level rise, they have more gradual slopes on their bay sides (*i.e.*, slopes of 10 to 1 or more). More acquisitions and easements of high, undeveloped ground adjacent to marshes should be made so that marshes can migrate landward as sea levels rise. Such planning and acquisition will help protect future marshes from losing their high marsh zones altogether.

    In marshes where control of invasive *Spartina* has been accomplished, revegetation with the native plant community should occur without delay. Though the physical structure of some invasive *Spartina* remains, eradication is nearly complete baywide. Revegetation with native *Spartina foliosa* should now be the focus to provide refugial habitat for the rail.

Expanding salt marsh at the mouths of Chorro and Los Osos creeks in Morro Bay contains tidal creek networks which may be, or may become, structurally suitable for clapper rails. If California clapper rail populations in San Francisco Bay increase to sizes and densities that promote significant emigration of vagrants, they may recolonize Morro Bay and other sites outside the San Francisco Bay, such as Tomales Bay. Tidal marsh and tidal creek networks there should be conserved to allow for such range re-expansion.

2.) **Implement site-specific management plans on lands adjacent to the Bay to reduce human-caused disturbance to rails.** This includes reducing impact to tidal marsh species from recreation-based activities (*i.e*., by preventing illicit off-road vehicle use, limiting watercraft access), domestic animal disturbance (*i.e*., by enforcing leash laws, prohibiting the feeding of feral or otherwise free-roaming cats, eliminating predator-attracting litter), and management actions such as invasive plant species control, biological monitoring, vegetation clearing, mosquito abatement, and dredging activities (*i.e*., by restricting activities to after the breeding season of the rail). Also, management plans should include the control or elimination of important invasive plant competitors such as *Lepidium latifolium* (perennial pepperweed) to avoid development of monoculture that excludes important refugial habitat for the rail. This should be done in coordination with the U.S. Fish and Wildlife Service to minimize impacts to clapper rails.

3.) **Conduct a population viability analysis on the California clapper rail.** Assess population status, study turnover of subpopulations (local extinction and new establishment of subpopulations), conduct other research on population dynamics to predict recolonization rate of restored marshes, with an emphasis on necessary connectivity. Develop California clapper rail population models that incorporate metapopulation dynamics. Specifically, this should be an age-structured population model and should project the likelihood of population expansion or contraction, including the possibility of extinction or decline in number below specified levels.

4.) **Study the effects of the Invasive Spartina Project on California clapper rail movement.** Marked individuals should be used to determine the extent of displacement and redistribution of the species throughout its habitat within marshes treated to eliminate invasive *Spartina*. These studies should build upon applied studies currently being conducted by USGS on survival rates, factors that limit survival, movement patterns, and dispersal. The USGS and East Bay Regional Park District should continue critical research into the use of artificial islands by California clapper rails displaced by decreasing amounts of invasive *Spartina* at Arrowhead Marsh, in an effort to provide important refugial habitat while native vegetation is re-established. Results of this study should be applied to habitat restoration efforts range-wide.

5.) **Conduct research into toxicity of mercury to rails, mercury exposure pathways and potential means to interrupt those pathways.** Research should be conducted into what proportion of the rail population can sustain developmental abnormalities due to mercury exposure, while retaining a self-sustaining population. This research should build upon mercury analyses recently conducted by the USGS and those currently ongoing by the South Bay Salt Pond Restoration Project relative to the opening of Pond A8. Results of research on toxicity of mercury to rails should be used to revisit Delisting Criteria E/3 for the rail, which requires that mercury concentrations in every rail egg sampled throughout its range must fall below 0.2 ppm (fresh wet weight).

In the long term, research on wetland restoration techniques and design efficacy, and contaminant concentrations in wetland sediments (especially methylmercury production) is necessary. A map must be developed which identifies sources and extents of mercury exposure in rails and a plan must be in place to remediate the most significant point sources of mercury.

VII. REFERENCES CITED

Ackerman, J., C. Eagles-Smith, J. Takekawa, J. Bluso-Demers, D. Tsao, and D. Le Fer. 2009. California Gull Movements in Relation to Nesting Waterbirds and Landfills: Implications for the South Bay Salt Pond Restoration Project. U.S. Geological Survey and San Francisco Bay Bird Observatory.

Adams, E. 1900. Notes on the California clapper rail. Condor 2(2):31-32.

Adelsbach, T., and T. Maurer. 2007. Dioxin toxic equivalents, PCBs, and PBDEs in eggs of avian wildlife of San Francisco Bay. U.S. Fish and Wildlife Service, Environmental Contaminants Program On-refuge Investigations.

Albertson, J.D. 1995. Ecology of the California clapper rail in south San Francisco Bay. M.A. Thesis, San Francisco State University. 200 pp.

Albertson, J.D., and J. Evens. 2000. California clapper rail *in:* Olofson, P.R. (ed.). Baylands Ecosystem Species and Community Profiles: life histories and environmental requirements of key plants, fish, and wildlife. Goals Project (Baylands Ecosystem Habitat Goals), San Francisco Bay Regional Water Quality Control Board, Oakland, California.

American Bird Conservancy. 2006. Impacts of Feral and Free-Ranging Cats on Bird Species of Conservation Concern. A five-state review of New York, New Jersey, Flroida, California, and Hawaii. May 2006.

Applegarth, J.H. 1938. The ecology of the California clapper rail in the south arm of the San Francisco Bay. M.Sci. Thesis, Stanford University, Palo Alto, CA. 153 pp.

Archer D. and V. Brovkin. 2008. The millennial atmospheric lifetime of anthropogenic CO_2. Climate Change 90:283-297.

Atwater, B.F., S.G. Conard, J.N. Dowden, C.H. Hedel, R.L. MacDonald, and W. Savage. 1979. History, landforms and vegetation of the estuary's tidal marshes *in*: Conomos, T.J. (ed.) San Francisco Bay: The Urbanized Estuary. Proc. 58th Ann. Mtg. Pacific Division of the American Association of the Advancement of Science. California Academy of Sciences.

Avocet Research Associates. 2004. California Clapper Rail (*Rallus longirostris obsoletus*) breeding season survey, San Pablo Bay and tributaries, 2004: Final Report to Marin Audubon Society. Point Reyes Station, California. 17 pp. plus tables and appendices.

Ayres, D.R., D. Garcia-Rossi, H.G. Davis, and D.R. Strong. 1999. Extent and degree of hybridization between exotic (*Spartina alterniflora*) and native (*S. foliosa*) cordgrass (Poaceae) in California, USA determined by random amplified polymorphic DNA (RAPDs). Molecular Ecology 8: 1179-1186.

Boorman, L.A. 1992. The environmental consequences of climatic change on British salt marsh vegetation. Wetlands Ecology and Management 2:11-21.

Bromirski, P.D., Flick, R.E., Cayan, D.R., Graham, N. 2004. Coastal sea level and wind wave variations during the historical record. Presentation at California Climate Change Conference, June 9, 2004, Sacramento, CA. Available:

http://www.climatechange.ca.gov/events/2004_conference/presentations/2004-06-09_BROMIRSKI.PDF (accessed Dec. 2005)

Brooks, A. 1940. The clapper rail of Morro Bay. Condor 42(2):126-127.

Bryant, W.E. 1888. Birds and eggs from the Farallon Islands. Proc. Calif. Acad. Sci., 2nd Ser. 1:25-50.

Bryant, D.A. 1931. August field notes. Cull 13 (9): 3-4.

California Department of Fish and Game. 2010. California clapper rail and California black rail Suisun Marsh Survey 2009. Monitoring Report for the Suisun Marsh by California Department of Fish and Game Bay-Delta Region to California Department of Water Resources. Contract #4600008033.

California Natural Diversity Database (CNDDB). 2011. California Department of Fish and Game.

California Ocean Protection Council. 2010. State of California Sea Level Rise Interim Guidance Document. Developed by the Sea Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT), with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust. October 2010.

California Regional Water Quality Control Board. 2004. Annual report of the San Francisco Bay Region.

Callaway, J.C. 1990. The introduction of *Spartina alterniflora* in South San Francisco Bay. M.A. Thesis, San Francisco State University. San Francisco, CA. 50 pages.

Callaway, J.C., V.T. Parker, M.C. Vasey, and L.M. Schile. 2007. Emerging issues for the restoration of tidal mash ecosystems in the context of predicted climate change. Madrono. 54:234-248.

Cayan, D. R., P. D. Bromirski, K. Hayhoe, M. Tyree, M. D. Dettinger, and R. E. Flick. 2008. Climate change projections of sea level extremes along the California coast. Climatic Change 87:857-873.

Cayan, D., M. Tyree, M. Dettinger, H. Hidalgo, T. Das, E. Maurer, P. Bromirski, N. Graham, and R. Flick. 2009. Climate change scenarios and sea level rise estimates for California 2008 Climate Change Scenarios Assessment. California Climate Change Center. *In prep.*

Chapman, V.J. 1964. Coastal Vegetation. Oxford, Pergamon Press.

Cohen, D.A. 1895. The California clapper rail. Oologist 12(11):171-173.

Colburn, T., and C. Clement. 1992. Chemically-induced alterations in sexual and functional development: the wildlife/human connection. Princeton Science Publishers. Princeton, New Jersey.

Collins, J.N., and J.G. Evens. 1992. Evaluation of impacts of naval riverine forces training operations on nesting habitat of the California clapper rail at Napa River, California. Navy Western Division, Naval Facilities Engineering Command, San Bruno, CA. 19pp.

Collins, J., J. Evens, and B. Grewell. 1994. A synoptic survey of the distribution and abundance of the California clapper rail (*Rallus longirostris obsoletus*) in the northern reaches of the San Francisco Estuary during the 1992 and 1993 breeding season. Draft Technical Report to California Department of Fish and Game, Yountville, CA. 36 pp.

Daehler, C.C., and D.R. Strong. 1996. Status, prediction and prevention of introduced cordgrass, *Spartina* spp. invasions in Pacific Estuaries. Biological Conservation 78: 51-58.

Daehler, C.C., and D.R. Strong. 1997. Hybridization between introduced smooth cordgrass (*Spartina alterniflora*; Poaceae) and native California cordgrass (*S. foliosa*) in San Francisco Bay. American Journal of Botany 84(5):607-611.

Davis, J., D. Yee, J. Collins, S. Schwarzbach, and S. Luoma. 2003. Potential for Increased Mercury Accumulation in the Estuary Food Web. San Francisco Estuary and Watershed Science, John Muir Institute of the Environment, UC Davis.

DeGroot, D.S. 1927. The California clapper rail: its nesting habitats, enemies, and habitat. Condor 29:259-270.

Diamond, J.M. 1984. "Normal" extinctions of isolated populations. Pp. 191-246. *in:* Nitecki, M.U. (ed.). Extinctions. University of Chicago Press, Chicago, Illinois.

Evens, J. 2000*a*. California clapper rail and California black rail: 2000 breeding season surveys. Sonoma Creek Bridge seismic retrofit and barrier placement project: Sonoma and Solano counties, California. Report by Avocet Research Associates, Point Reyes Station, CA. Prepared for California Department of Transportation and Parsons Brinckerhoff. 7 pp.

Evens, J. 2000*b*. California clapper rail and California black rail: Napa-Sonoma Wildlife Area, White Slough Unit, year 2000 breeding season. Report by Avocet Research Associates, Point Reyes Station, CA. Prepared for California Department of Transportation and Wetlands Research Associates. 7 pp. + appendices.

Evens J., and J.N. Collins. 1992. Distribution, abundance, and habitat affinities of the California clapper rail (*Rallus longirostris obsoletus*) in the northern reaches of the San Francisco Estuary during the 1992 breeding season. Final report to California Department of Fish and Game, Yountville, CA. Avocet Research Associates, Point Reyes, CA. 26 pp.

Evens, J., and G.W. Page. 1983. The ecology of rail populations at Corte Madera Ecological Reserve: with recommendations for management. Report by the Point Reyes Bird Observatory. Stinson Beach, CA. 62 pp.

Evens, J., and G.W. Page. 1986. Predation on black rails during high tides in salt marshes. The Condor 88:107-109.

Evens, J.G. and R.W. Stallcup. 1994. Coastal Riparian Marsh. Breeding Bird Census **65**(2): 105-106.

Foerster, K.S. 1989. Summary of California clapper rail winter populations in the San Francisco Bay National Wildlife Refuge, November 1988 to January 1989. U.S. Fish and Wildlife Service Report, Newark, CA. 17 pp.

Foerster, K.S., and J.E. Takekawa. 1991. San Francisco Bay National Wildlife Refuge predator management plan and final environmental assessment. San Francisco Bay NWR, Newark, CA. 54 pp.

Foerster, K.S., J.E. Takekawa, and J.D. Albertson. 1990. Breeding density, nesting habitat, and predators of the California clapper rail. Unpubl. Rpt. No. SFBNWR-116400-90-1, prep. for San Francisco Bay NWR, Newark, CA. 46 pp.

Foin, T.C., E. J. Garcia, R.E. Gill, S.D. Culberson, and J. N. Collins. 1997. Recovery strategies for the California clapper rail (*Rallus longirostris obsoletus*) in the heavily-urbanized San Francisco estuarine ecosystem. Landscape and Urban Planing 38:229-243.

Garcia, E.J. 1995. Conservation of the California clapper rail: An analysis of survey methods and habitat use in Marin County, California. M.Sci. Thesis, University of California, Davis. 135 pp.

Gilardi, K.V.K., and J.A.K. Mazet. 1999. Oiled wildlife response in California: A summary of current knowledge of populations at risk and response techniques. Oiled Wildlife Care Network and Wildlife Health Center School of Veterinary Medicine University of California, Davis, CA. 124 pp.

Gill, R., Jr. 1972. South San Francisco Bay breeding bird survey, 1971. Calif. Dept. Fish and Game, Wildlife Management Branch Administrative Report 72-6. Sacramento, CA. 69 pp.

Gill, R. 1979. Status and distribution of the California clapper rail (*Rallus longirostris obsoletus*). Calif. Fish and Game 65:36-49.

Gleason, M.L., D.A. Elmer, N.C. Pien, and J.S. Fisher. 1979. Effects of stem density upon sediment retention by salt marsh cord grass, *Spartina alterniflora* Loisel. Estuaries 2:271-273.

Goals Project. 1999. Baylands Ecosystem Habitat Goals: A report of habitat recommendations. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. First Reprint. U.S. Environmental Protection Agency, San Francisco, California and San Francisco Bay Regional Water Quality Control Board, Oakland, California.

Gould, G.I., Jr. 1973. California clapper rail survey, 1973. Calif. Dep. of Fish and Game, Special Wildl. Investigations rep., Proj. W-54-R-5, Job II-10. 10pp.

Greenfield, B.K., J.A. Davis, R. Fairey, C. Roberts, D.B. Crane, G. Ichikawa, and M. Petreas. 2003. Contaminant concentrations in fish from San Francisco Bay, 2000. RMP Technical Report: SFEI Contribution 77. San Francisco Estuary Institute, Oakland, CA. Available: http://www.sfei.org/rmp/reports/fish_contamination/2000/FishStudy_finalv2.pdf (accessed Dec. 2005).

Grewell, B. J. , J. C. Callaway, and W. R. Ferren, Jr. 2007. Estuarine Wetlands. Pp. 124-154 *in*: M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr (eds.). Terrestrial Vegetation of California, 3rd edition. Univeristy of California Press, Berkeley, California.

Grinnell, J. 1915. A distributional list of the birds of California. Pacific Coast Avifauna 11.

Grinnell, J.H. and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27:1-608.

Grinnell, J., H.C. Bryant, and T.I. Storer. 1918. California clapper rail. Gamebirds of California: 283-291. U.C. Press, Berkeley.

Grinsted, A., J. C. Moore, and S. Jevrejeca. 2010. Reconstructing sea level from paleo and projected temperatures 200 to 2100 A. D. Climate Dynamics 34:461-472.

Grosholz, E., J. Black, P. Rosso, N. Christiansen, and R. Blake. 2004. Consequences of *Spartina* invasion for migratory shorebirds and Canada geese. Abstract. Third International Conference on Invasive Spartina, San Francisco Estuary Invasive Spartina Project, San Francisco, California.

Grossinger, R., J. Alexander, A.N. Cohen, and J.N. Collins. 1998. Introduced tidal marsh plants in the San Francisco Estuary: Regional distribution and priorities for control. San Francisco Estuary Institute, Richmond, CA.

Hanski, I. 1999. Metapopulation Ecology. Oxnard University Press, Oxford.

Harding, E.K., D.F. Doak, J. Albertson, and J.E. Takekawa. 1998. Predator management in San Francisco Bay wetlands: past trends and future strategies. Final Report prepared for U.S. Fish and Wildlife Service, Sacramento, CA.

Harvey, H.T., H.L. Mason, R. Gill, and T.W. Wooster. 1977. The marshes of San Francisco Bay: their attributes and values. Report to San Francisco Bay Conservation and Development Commission.

Harvey, T.E. 1980. A breeding season study of the California clapper rail in south San Francisco Bay, California. Unpubl. Final Report prepared for San Francisco Bay NWR, Newark, CA. 45 pp.

Harvey, T.E. 1988. Breeding biology of the California clapper rail in south San Francisco Bay. Transactions of the Western Section of the Wildlife Society 24:98-104.

Heard, R.W. 1982. Observations on the foods and food habits of clapper rails from tidal marshes along the east and gulf coasts of the United States. Gulf Resource Report 7:125-135.

Heberger, M., H. Cooley, P. Herrera, P.H. Gleick, and E. Moore. 2009. The impacts of sea-level rise on the California coast. A Draft Paper from the California Climate Change Center. Pacific Institute. CEC-500-2009-024-D.

Herzog, M., L. Liu, J. Evens, and N. Warnock. 2006. Temporal and spatial patterns in population trends in California clapper rails (*Rallus longirostris obsoletus*) 2006 Report. PRBO Conservation Science, Petaluma, California. Avocet Research Associates, Point Reyes Station, California.

H.T. Harvey and Associates. 1997. Marsh plant associations of South San Francisco Bay: 1996 comparative study including Alviso Slough. Unpubl. report, 22 January, 1997. Project No. 477-18. Prepared for the City of San Jose, California**:** 117.

Hinde, H. 1954. The vertical distribution of salt marsh phanaerogams in relation to tide levels. Ecol. Monogr. 24:209-225.

Howald, A. 2000. *Lepidium latifolium*. Invasive Plants of California Wildlands. Carla C. Bossard, John M. Randall, and Marc C. Hoshovsky, Editors. University of California Press. 222-227.

IPCC. 2007*a*. Climate change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P. R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Found at http://www.ipcc.ch/ipccreports/ar4-wg3.htm.

IPCC. 2007*b*. Summary for Policymakers. *in* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, editors. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA. Available on the internet at <http://www.ipcc.ch/>. Accessed October 8, 2009.

Jevrejeva, S., J. C. Moore, and A. Grinsted. 2010. How will sea level respond to changes in natural and anthropogenic forcing by 2100. Geophysical Research Letters 37:L07703, doi:07710.01029/02010GL042947.

Johnson, R.W. 1973. Observations on the ecology and management of the northern clapper rail, *Rallus longirostris crepitans* Gmelin in Nassau County, New York. Ph.D. Thesis, Cornell Univ., NY. 223 pp.

Johnston, R.F. 1956. Predation by short-eared owls on a *Salicornia* salt marsh. Wilson Bull. 68:91-102.

Jorgensen, P.D. 1975. Habitat preference of the light-footed clapper rail in Tijuana Marsh, California. M.Sci. Thesis, San Diego State University, San Diego, CA. 84 pp.

Jorgenson, P.D., and H.L. Ferguson. 1982. Clapper rail preys on savannah sparrow. Wilson Bulletin 94:215.

Keldsen, T.J. 1997. Potential impacts of climate change on California clapper rail habitat of south San Francisco Bay. M.S. Thesis, Colorado State University.

Kimball, H.H. 1922. Bird records from California, Arizona and Guadalupe Island. Condor 24(3):96-97.

Kirwan, M., G. R. Guntenspergen, A. D'Alpaos, J.T. Morris, S. M. Mudd, and S. Temmerman. 2010. Limits on the Adaptability of Coastal Marshes to Rising Sea Level. Geophysical Research Letters. Vol. 37, L23401, doi: 10.1029/2010GLO45489.

Knowles, N. 2002. Natural and management influences on freshwater inflows and salinity in the San Francisco Estuary at monthly to interannual scales. Water Resour. Res., 38, 25-1 to 25-11.

Knowles, N., and D. Cayan. 2002. Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco Estuary. Geophysical Research Letters, 29, 38-1 to 38-4. Available:

http://tenaya.ucsd.edu/~knowles/papers/knowles_grl_2002.pdf#search='knowles%20francisco%20salinity%202002' (Accessed Dec. 2005).

Knutson, P.L., R.A. Brochu, W.N. Seelig, and M. Inskeep. 1982. Wave damping in *Spartina alterniflora* marshes. Wetlands 2:87-104.

Kozicky, E.L., and F.V. Schmidt. 1949. Nesting habits of the clapper rail in New Jersey. Auk 66:355-364.

Lewis, J., K.L. Sallee, and R.T. Golightly. 1999. Introduction and Range Expansion of Nonnative Red Foxes (*Vulpes vulpes*) in California. The American Midland Naturalist. 142:372-381.

Lindsdale, J.M. 1936. Occurrence of the California clapper rail away from marshes. Condor 38:216.

Linville R.G., S.N. Luoma, L. Cutter, G.A. Cutter. 2002. Increased selenium threat as a result of invasion of the exotic bivalve *Potamocorbula amurensis* into the San Francisco Bay-Delta. Aquatic Toxicology 57:51-64.

Liu, L., and J. Wood. 2011. 2010 Annual Report: California Clapper Rail (*Rallus longirostris obsoletus*). TE-807078-12.

Liu, L., J. Wood, N. Nur, D. Stralberg, and M. Herzog. 2009. California Clapper Rail (*Rallus longirostris obsoletus*) Population Monitoring: 2005-2008. Prepared for California Department of Fish and Game by PRBO Conservation Science. Sept. 29, 2009.

Maier, K.J., and A.W. Knight. 1994. Ecotoxicology of selenium in freshwater systems. Reu. Environ. Contam. Toxicol. 134(3):l-48.

May, M. 1995. *Lepidium latifolium* L. in the San Francisco Estuary. Department of Geography, University of California at Berkeley. Unpublished report.

Meanley, B. 1985. The marsh hen: A natural history of the clapper rail of the Atlantic coast salt marsh. Tidewater Publications, Centreville, Maryland.

Meehl G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J. M. Gregory, A. Kitoh, R. Knutti, J. M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A. J. Weaver, and Z.-C. Zhao. 2007. 2007: Global Climate Projections. *in* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and G.H. Miller, editors. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report to the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, New York, NY, USA.

Moffitt, J. 1941. Notes on the food of the California clapper rail. Condor 43(6):270-273.

Morris, W.F., and D.F. Doak. 2003. Quantitative conservation biology: theory and practice of population viability analysis. Sinauer Associates, Sunderland, Massachusetts.

Newberry, J.S. 1857. Report of explorations and surveys to ascertain the most practical and economical route for a railroad from the Mississippi River to the Pacific Ocean. N o. 6, part 4. Pp. 73-110. Report on the zoology of the route. Washington, DC.

Nordby, J.C., A.N. Cohen, and S.R. Beissinger. 2004. The impact of invasive *Spartina alterniflora* on song sparrow populations in San Francisco Bay salt marshes. Presentation at the Third International Conference on Invasive Spartina, November 10, 2004, San Francisco, CA.

Oros, D.R., and J. Hunt. 2005. Emerging contaminants: Endocrine disrupting chemicals (EDCs). Regional Monitoring News 10, 10-12.

Oros, D.R., D. Hoover, F. Rodigari, D. Crane, and J. Sericano. 2005. Levels and distribution of polybrominated diphenyl ethers in water, surface sediments, and bivalves from the San Francisco Estuary. Environmental Science and Technology 39: 33-41.

Orr, R.T. 1939. Fall wanderings of clapper rails. Condor 41:151-152.

Orr, R. 1942. A study of the birds of the Big Basin region of California. American Midland Naturalist 27(2):273-337.

Orr, M., S. Crooks, and P.B. Williams. 2003. Will restored tidal marshes be sustainable? *in:* Larry R. Brown (ed.). Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science 1(1) (October 2003), Article 5. (http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art5)

Pfeffer, W. T., J. T. Harper, and S. O'Neel. 2008. Kinematic constraints on glacier contributions to 21st century sea level rise. Science 321.

Phillips, D.J.H. 1987. Toxic contaminants in the San Francisco Bay-Delta and their possible biological effects: Richmond, San Francisco Estuary Institute. 413 pp.

Pimm, S.L., H.L. Jones, and J.M. Diamond. 1988. On the risk of extinction. American Naturalist 132: 757-785.

Presser T.S., and S. N. Luoma. 2007. Forecasting selenium discharges to the San Francisco Bay-Delta Estuary: Ecological effects of a proposed San Luis drain extension. USGS Professional Paper 1646. 209 pp.

Reid, W.V., and M.C. Trexler. 1991. Drowning the national heritage: climate change and U.S. coastal biodiversity. World Resources Institute, Washington, DC. 48 pp.

Roberson, D. 1985. Monterey Birds. Monterey Pen. Audubon Society, Carmel, Ca.

Roberson, D. 1993. Clapper Rail (*Rallus longirostris*). Pp. 413-414 *in*: D. Roberson, and C. Tenney (eds.). Atlas of the breeding birds of Monterey County California. Monterey Peninsula Audubon Society.

Ross, J.R., and D.R. Oros. 2004. Polycyclic aromatic hydrocarbons in the San Francisco Estuary water column: sources, spatial distributions, and temporal trends. Chemosphere 57(8):909-920.

San Francisco Bay Conservation and Development Commission. 2009. Suisun Marsh Protection Plan. Available on the internet at <http://www.bcdc.ca.gov/laws_plans/plans/suisun_marsh.shtml>. Accessed September 8, 2009.

San Francisco Estuary Institute. 2000. Contaminant loads from stormwater to coastal waters in the San Francisco Bay region: comparison to other pathways and recommended approach for future evaluation. Available on the internet at <http://www.sfei.org/rmp/reports/AB1429/ab14.html>. Accessed September 8, 2009.

San Francisco Estuary Regional Monitoring Program. 1996. Annual monitoring report.

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G. Titus. 2002. Climate change impacts on U.S. coastal and marine ecosystems. Estuaries 25:149-164.

Schonewald-Cox, C.M., S.M. Chambers, B. Macbryde, and W.L. Thomas (eds.). 1983. Genetics and conservation, a reference for managing wild animal and plant populations. Benjamin/Cummings, Menlo Park, California.

Schwarzbach, S.E., J.D. Albertson, and C.M. Thomas. 2006. Effects of predation, flooding, and contamination on reproductive success of California clapper rails (*Rallus longirostris obsoletus*) in San Francisco Bay. The Auk 123(1): 1-16

Sibley, C.G. 1955. The responses of salt-marsh birds to extremely high tides. Condor 57(4): 241-242.

Silliman, O.P. 1915. Range of the California clapper rail. Condor 17:201.

Solomon S., G.-K. Plattner, R. Knutti, and P. Friedlingstein. 2009. Irreversible climate change due to carbon dioxide emissions. Proceedings of the National Academy of Sciences of the United States of America 106:1704-1709.

Spautz, H., and N. Nur. 2004. Impacts of non-native perennial pepperweed (*Lepidium latifolium*) on abundance, distribution, and reproductive success of San Francisco Bay tidal marsh birds. PRBO Conservation Science.

Spendelow, J.A., and H.R. Spendelow, Jr. 1980. Clapper rail kills birds in a net. J. field Ornithol. 51(2):175-176.

State Coastal Conservancy, 2011. California Clapper Rail Surveys for the San Francisco Estuary Invasive Spartina Project 2010. Prepared by Olofson Enviromental, Inc., Berkeley, California. February 2011.

Stewart, A.R., S.N. Luoma, C.E. Schlekat, M.A. Doblin, and K.A. Hieb. 2004. Food web pathway determines how selenium affects aquatic ecosystems: A San Francisco Bay case study. Environ. Sci. Technol. 38(17):4519-4526.

Storer, T. 1915. Additional records of California clapper rail and red phalarope in California. Condor 17: 98.

Striplen, C.J. 1992. Effects of predation on hatching success of the California clapper rail (*Rallus longirostris obsoletus*) in the south San Francisco Bay and characterization of nest predation through use of artificial nests and captive animals. Prepared for the U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge, Newark, CA. 24 pp.

Suisun Ecological Workgroup. 2001. Final Report to the State Water Resources Control Board. Available on the internet at <http://www.iep.ca.gov/suisun_eco_workgroup/final_report/SEWFinalReport.pdf>. Accessed on October 10, 2009.

Takekawa, J.Y., M. Casazza, C. Overton, T. Bui, and J. Hull. 2011. Refugia habitats for California Clapper Rail: use of artificial islands in Arrowhead Marsh. Unpubl. Data Summary Report. USGS Western Ecological Research Center. Vallejo and Dixon, CA. February 9, 2011. 5 pp.

Taylor, H.R. 1894. Among the California clapper rail. Nidiologist 1(10-11):153-155.

Taylor, P.B. 1996. Clapper Rail *in:* Hoyo et al. (eds.). Handbook of the birds of the world. Vol. 3. Lynx Edicions. Barcelona.

Teh, S.J., X. Deng, D.F. Deng, F.C. Teh, S.S.O. Hung, T.W.M. Fan, J. Liu, and R. Higashi. 2004. Chronic effects of dietary selenium on juvenile Sacramento splittail (*Pogonichthys macrolepidotus*). Environmental Science and Technology 38:6085-6093.

Terborgh, J., and B. Winter. 1980. Some causes of extinction. *in*: M.S. Soule, and B.A. Wilcox (eds.). Conservation biology: an evolutionary-ecological perspective. Siquer Associates, Sunderland, Massachusetts.

Test, F.H., and A.R. Test. 1942. Food of the California clapper rail. Condor 44:228.

Todd, R.L. 1986. A saltwater marsh hen in Arizona: A history of the Yuma clapper rail (*Rallus longirostris yumanensis*). Final Rept. Arizona Game and Fish Dept., Fed. Aid Proj. W-95-R, Phoenix, AZ.

U.S. Fish and Wildlife Service. 1983. Endangered and threatened species; listing and recovery priority guidelines. Federal Register 48: 43098-43105.

U.S. Fish and Wildlife Service. 1984. Salt marsh harvest mouse and California clapper rail recovery plan. Portland, Oregon.

U.S. Fish and Wildlife Service. 2003. Evaluation of the Clean Water Act Section 304(a) human health criterion for methylmercury: protectiveness for threatened and endangered wildlife in California. US Fish and Wildlife Service, Sacramento Fish and Widlife Office, Environmental Contaminants Division. Sacramento, Califormnia. 96 pp+ appendix.

U.S. Fish and Wildlife Service. 2007. Endangered and threatened wildlife and plants; Designation of critical habitat for *Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle) and *Chloropyron mollis* ssp. *mollis* (soft bird's-beak); Final Rule. Federal Register 72(70):18517-18553.

U.S. Fish and Wildlife Service. 2009. Monitoring Plan for *Castilleja ambigua* ssp. *humboldtiensis* (Humboldt Bay owl's clover) at the Lanphere Dunes Unit, Humboldt Bay National Wildlife Refuge. May 6, 2009.

U.S. Fish and Wildlife Service. 2010. Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California. Xviii + 636 pp.

Varoujean, D.H. 1972. A study of the California clapper rail in Elkhorn Slough, 1972. Report for Calif. Dept. of Fish and Game. 9 pp.

Vermeer M. and S. Rahmsdorf. 2009. Global sea level linked to global temperature. Proceedings of the National Academy of Sciences of the United States of America 106:21527-21532.

Wiener, J.G., D.P. Krabbenhoft, G.H. Heinz, and A.M. Scheuhammer. 2002. Ecotoxicology of mercury. Chapter 16 *in:* Hoffman, D.J., B.A. Rattner, G.A. Burton, Jr., and J. Cairns, Jr. (eds.). Handbook of ecotoxicology, 2nd edition. CRC Press.

Wilbur, S.R., and R.E. Tomlinson. 1976. The literature of the western clapper rails. Wildl. Res. Rpt. No. 194, U.S. Fish and Wildlife Service, Washington, DC.

Wilkinson, R. (ed.). 2002. Preparing for a changing climate: the potential consequences of climate variability and change - California. Report of the California Regional Assessment Group, for the U.S. Global Change Research Program, September 2002. Draft, 430 pp. Available: http://www.ncgia.ucsb.edu/pubs/CA_Report.pdf (accessed Dec. 2005).

Williams, L. 1929. Notes on the feeding habits and behavior of the California clapper rail. Condor 31:52-56.

Williams, L. 1957. Middle Pacific Coast Regional Audubon field notes 11:427.

Winter, J., and S.A. Laymon. 1979. Middle Pacific Coast Region. American Birds. 33:309-310.

Zembal, R., and J. M. Fancher. 1988. Foraging behavior and foods of the light-footed clapper rail. Condor 90:959-962.

Zembal, R., and B.W. Massey. 1983. The light-footed clapper rail: Distribution, nesting strategies, and management. Cal-Neva Wildl. Trans. 1983:97-103.

Zembal, R., B.W. Massey, and J.M. Fancher. 1989. Movements and activity patterns of the light-footed clapper rail. J. Wildl. Manage. 53:39-42.

Zucca, J.J. 1954. A study of the California clapper rail. Wasmann Journal of Biology 12(2):135-153.

***In Litt*. References**

Albertson, Joy. 2006. Biologist. Don Edwards National Wildlife Refuge. Electronic mail from Joy Albertson to Valary Bloom. October 17, 2006.

Albertson, Joy. 2009*a*. Biologist. Don Edwards National Wildlife Refuge. Electronic comments on administrative draft tidal marsh recovery plan sent from Joy Albertson to Valary Bloom on May 6, 2009.

Albertson, Joy. 2009*b*. Biologist. Don Edwards National Wildlife Refuge. Electronic mail from Joy Albertson to Valary Bloom on February 13, 2009.

Downard, Giselle. Biologist. 2009*a*. San Pablo Bay National Wildlife Refuge. Electronic mail from Giselle Downard to Valary Bloom. February 9, 2009.

Downard, Giselle. Biologist. 2009*b*. San Pablo Bay National Wildlife Refuge. Electronic mail from Giselle Downard to Valary Bloom. June 3, 2009.

Estrella, Sarah. 2007. Biologist. California Department of Fish and Game. Electronic mail sent from Sarah Estrella to Valary Bloom on December 13, 2007.

Estrella, Sarah. 2008. Bay Area Lepidium Science and Management Series (Day 2), October 29, 2008, Oakland, CA "Control of Perennial Pepperweed in Tidal Marshes and Plant Community Effects in Suisun Marsh". Presentation by Sarah Estrella, California Department of Fish and Game.

Evens, Jules. 2007. Avocet Research Associates, Point Reyes Station, California. Electronic mail sent from Jules Evens to Jim Browning on September 25, 2007.

Evens, Jules. 2011. Avocet Research Associates, Point Reyes Station, California. Electronic mail sent from Jules Evens to Valary Bloom on January 10, 2011.

Grewell, Brenda. 2006. USDA Agricultural Research Service, Plant Sciences Department, University of California, Davis, CA. Electronic mail sent to Valary Bloom on February 15, 2006.

Olofson, P. 2011. Electronic mail from Peggy Olofson to Valary Bloom dated March 2, 2011, regarding 2010 California clapper rail monitoring report for the Invasive Spartina Program.

Sacks, B. 2009. University of California, Davis. Electronic mail from Ben Sacks to Valary Bloom dated April 21, 2009, regarding ancestry of North Bay and Suisun Bay red foxes.

Stenzel, Lynne. 2010. PRBO Conservation Science. Electronic mail from Lynne Stenzel to James Browning dated December 1, 2010, regarding location of California clapper rail in a previously undocumented location- Napa Flood Control Marsh along Napa River.

U.S. Coast Guard. 2009. Memorandum, dated December 3, 2008, from U.S. Coast Guard stating availability of revision to Sector San Francisco Area Contingency Plan. Effective January 1, 2009. Made available to the public via Internet at www.dfg.ca.gov/ospr/.

Personal Communications and Observations

Baye, Peter. 2004. Marsh ecologist. Annapolis, California. Telephone conversations.

Grewell, Brenda. 1997-2000. Research Ecologist. USDA. Davis, California. Telephone conversations.

Pickart, Andrea and S. Harris. 1999. Humboldt National Wildlife Refuge. Telephone conversation.

Renz, M. 1999. Telephone conversation.

Smith, D. 1998, 2000. Telephone conversations.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

California clapper rail (*Rallus longirostris obsoletus*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Review Conducted By: Valary Bloom, Sacramento Fish and Wildlife Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Sacramento Fish and Wildlife Office

Acting

Approve [signature] Date 3/28/13

Cooperating Field Supervisor, Bay Delta Fish and Wildlife Office

Approve [signature] Date 4/29/13