

Other Birds of the Baylands Ecosystem

Eared Grebe

Podiceps nigricollis

Howard L. Cogswell

Introduction

The eared grebe is a small, stocky-bodied bird that may be found in a variety of habitats within the San Francisco Estuary, and particularly in the salt ponds of the South Bay. The eared grebe acquires its name from the golden tufts of feathers that fan out behind the eyes of the adult in breeding plumage.

Description

Breeding Biology - Eared grebes nest primarily on medium-sized to large lakes with marshy borders. They build a floating nest attached to underwater or emergent vegetation, as is typical of grebes. Where successful, they typically nest in colonies from a few pairs to many hundreds. In California, most breeding occurs at lakes east of the Sierra Nevada-Cascade mountain ranges. However, at least in wet years, nesting colonies have been found in the Sacramento and San Joaquin valleys, inland valleys of coast-slope southern California, and at such mountain lakes as Lake Tahoe and the Big Bear-Baldwin lakes in San Bernardino County (Grinnell and Miller 1944; miscell. records).



S. H. Hinshaw

In the Bay Area, a colony of 70 or more eared grebes nested in 1983 in northwest Pleasanton on out-of-use sewage ponds with marsh at one corner. There were at least 65 young produced at this site that were still flightless when the pond was drained in July, and the adults all left. Most of the young that survived in the remaining border ditch were captured, banded, and released at Coyote Hills or Lake Chabot (personal field notes and Amer. Birds 37:1022). An apparently larger colony (101 nests in use or being built on July 15) the same year was successful in Crittenden Marsh near Moffett Field, 39 juveniles being seen there on August 19 (Bousman, pers. comm.). At least 12 adults and 15 "immatures" were noted in the same marsh in August 1986, and 10 nests (seven with eggs) were also there in June 1992, but these disappeared by July 25. On May 11-24, 1993, Peter Metropulos found 12+ nests, many with eggs, in a pond east of Crittenden Marsh¹. Nests were constructed of emergent vegetation in 2-3 feet of water over *Salicornia*, about 10-15 feet from shore. On July 5, there was no eared grebe activity on the pond, although five pairs and six nearly-fledging young were on Crittenden Marsh. In 1994, as many as 10 adults were seen in the same area, at least six of them obviously paired, but no nesting evidence was obtained². Irregular, but at least sometimes successful nesting is thus demonstrated in a bay-related habitat in our area of interest. Bousman (pers. comm.) also reported that Gloria Heller discovered at the Western Foundation of Vertebrate Zoology (Camarillo, California) a "nest card for eared grebe on an unnamed lake on Stanford University on May 14, 1908 with seven eggs (not collected)." This was apparently the earliest record of breeding anywhere near the Bay. Neither Grinnell and Wythe (1927) nor Grinnell and Miller (1944) mentioned this early record, although they indicated summer occurrence on Lake Merced, San Francisco, as indicative of possible nesting there.

¹ This was an out-of-use salt pond, and so may have contained brackish rainwater.

² These records were summarized from the Santa Clara County breeding season records of eared grebes, supplied by William Bousman.

Migration Ecology - The Great Salt Lake, Utah, and Mono Lake in central-eastern California are well-known major concentration points for post-breeding migrant eared grebes. Adults engage in a “molt-migration” to reach such areas and begin to put on weight from the abundant food (brine shrimp, etc.) before beginning their annual molt, which involves loss of all flight feathers at the same time. The birds are thus flightless for more than a month. Many aspects of the Mono Lake populations - the weight changes, progress of the molt, mortality, arrival, departure, and distribution on the surface of the lake - are detailed by Jehl (1988). Total eared grebe populations on Mono Lake, per Jehl’s extensive sampling and careful analysis, reached peaks of 500,000 to 800,000 in September through October. He also showed a summary map of sizes of populations at this and other (all lesser) migration stopover points for August through October 1985. However, Jehl’s work did not include San Francisco Bay salt ponds, despite the fact that they undoubtedly held far more than the median number of grebes (6,000) among his sites from Saskatchewan to southeastern California.

Wintering Ecology - According to Jehl (1988) the only truly major concentrations during mid-winter are on the Salton Sea in southeastern California, and the Gulf of California, Mexico; but small numbers persist through some winters even at Mono Lake and other inland waters not subject to freezing. At Salton Sea, estimates of the total population in February and March have been as high as 205,000 to 700,000 (1977 and 1953 aerial counts; AOU 1998 and *Audubon Field Notes*). Christmas Bird Counts in 1981-82 through 1985-86 for only the south end of the Sea ranged from 3,510 to 24,140 (Jehl 1988).

Distribution and Abundance

North America - The regular breeding range of the eared grebe extends from southwestern Canada to western Minnesota and eastern Illinois south to northwestern Mexico and south-central Texas, with local populations south to central Mexico. In winter, numbers are found regularly along the Pacific Coast from southern British Columbia to Central America, and inland from central California, Utah, and central Texas south. Non-breeding birds of this species occur casually in the eastern United States. In the Old World, the eared or “black-necked” grebe is found locally across central and southern Eurasia and parts of Africa (AOU 1998, map in Palmer 1962). Several closely related species (classified as subspecies of the eared grebe by some authors) are resident in the Andes, high plateaus, or southern part of South America (Sibley and Monroe 1990).

San Francisco Bay Area - Eared grebes occur rather widely as migrants and more narrowly through the winter on waters of many sorts in the Bay Area. They

have been seen on lakes, ponds, marsh sloughs, the open bay, and (especially during spring migration) even the ocean as far offshore as the Farallon Islands.

The larger counts or estimates of numbers of eared grebes tallied from published reports or field notes pertaining to San Francisco Bay or vicinity by Cogswell (1977) range from 10 to 170 on freshwater lakes (September through January), five to 50 on brackish lakes (Lake Merritt in Oakland and Berkeley Aquatic Park, October through January), 13 to 90 on eastern mid-San Francisco Bay or harbors connected to it (October through January), and 25 to 600 on the ocean near South Farallon Island (October through May, but mostly Christmas Bird Counts). By comparison, the peak numbers reached on medium-salinity salt evaporators from October through April regularly range in the hundreds or thousands per one to several large ponds. Counts in the southwestern Hayward evaporators were from 113 to 751 in September through December 1965-69, 490 on February 14, 1965, and 7,500 on April 17, 1965 - but only 83 on May 4, 1965 (H. Cogswell, field notes). The 7.5-mile radius Hayward-Fremont Christmas Bird Count circle (centered at Hwy. 880 and Whipple Rd.) includes all of the same salt ponds and others to the south as far as Dumbarton Point. Over 1,000 eared grebes are tallied in many years of that count, nearly all of which are on salt evaporators. The same is probably true for the occasional thousands (max. 13,615 in 1973) on the San Jose Christmas Bird Count, although a smaller area of salt ponds is in that circle.

Habitat Use and Behavior

Eared grebes may occasionally be seen in a variety of habitats within the San Francisco Estuary, but they most frequently are found in medium to high-salinity salt evaporator ponds, where they rest and forage. The decidedly preferred habitat from late August through April or early May is the medium or medium-high salinity ponds, where counts may range up to several thousand birds per pond. These ponds show high concentrations of brine shrimp (*Artemia salina*) and/or water boatmen (Hemiptera: *Corixidae*), which are prime prey for these small grebes. When on fresh water, they also take many kinds of aquatic insects and crustaceans but apparently few fish (Palmer 1962).

Two special studies of the use of salt-pond habitats by birds deserve mention. Anderson (1970) studied the series of ponds lying north of Mowry Slough, which then ranged from low-salinity (intake pond M1) through medium-high salinity. He found a maximum of 6,330 eared grebes in November on his “ponds of high salinity³.” In a

³ These ponds were actually of lower salinity than two or three other ponds that lay between his study area and the final crystallizers.

more thorough, two-year study of the 11 ponds lying west of Coyote Hills and north of the Dumbarton Bridge approach, Swarth, et al. (1982) reported a maximum count of 5,565 eared grebes in April 1980, but numbers the following spring were below 3,200. They had average counts of 500 and about 1,950 in November of the two successive years, and a very few were found through the summer. The November through April eared grebe numbers per 10 hectares in each of the 11 ponds in the same study were strongly correlated (at $p < 0.02$ level) with the grams dry weight of invertebrate biomass in the same ponds. That biomass was calculated from samples obtained by hundreds of plankton hauls thru the upper ¼ meter of water within three meters of a canoe. Brine shrimp (*Artemia salina*) and water-boatmen (Hemiptera: *Corixidae*) constituted nearly all of these samples. The grebes may, however, also have been eating brine-fly (Diptera: *Ephydra* sp.) larvae and pupae which spend most of the time below the ¼-meter depth, or even adult brine flies on the water surface which are quite able to escape the hauled net.

In the baylands of the San Francisco Estuary, eared grebes will also use subtidal and tidal habitats (including large marsh channels) for foraging and resting, although this is more common on offshore islands during migration than on the Bay proper. A relatively few birds use freshwater marsh for breeding and foraging. Seasonal wetlands are used for foraging and less commonly for breeding, particularly when water ponds for long periods and there is at least some emergent or near-surface vegetation. For the purposes of the Goals Project (and the Project's Habitat Matrix), it should be considered that eared grebes do not significantly use those areas classified by the Project as tidal flats, tidal marsh, riparian woodland, adjacent uplands, unvegetated supratidal shores, rocky islands or cliffs, and towers or other human-built structures.

Conservation and Management

On the South Bay, each set of medium- to medium-high saline salt evaporators presumably hosts numbers of eared grebes similar to those cited above for the Mowry Slough, Coyote Hills, and southwest Hayward areas. Peaks appear to be in October or November on some ponds (at which time Mono Lake still harbors about a half-million or more grebes), while on other ponds the peak does not occur until spring migration in April. For example, during the April migration period in 1980, over 5,000 birds were reported west of Coyote Hills (Swarth et al. 1982), and on April 14, 1996, 2,000 birds were counted on one salt pond (H9) in Hayward (J. & F. Delfino, pers. comm.). There are at least seven sets of such medium-salinity ponds in the South Bay system. If it were estimated that each set of ponds harbors just 3,500 birds (the mean of the two figures cited) during the spring

migration and in the fall, then it could be hypothesized that the South Bay salt ponds may support as many as 24,500 eared grebes. This would constitute an additional migration stop for this species that is well above the median for the entire range shown by Jehl. While mid-winter numbers here are somewhat lower, there are still thousands of eared grebes to be found on the salt ponds, and the area as a whole may well serve as wintering or migration habitat for 50,000 to 100,000 birds—a significant portion of the total species population, even though far below the major magnets of Mono Lake and Salton Sea.

This species is the most partial to use of the salt-pond habitat of any of the birds found there. It should be recognized in all plans for future habitat management that this species would thus suffer a marked impairment of its total available high-quality habitat if the saline ponds were eliminated or sharply reduced in extent. Nearly the same dependence on saline lakes or salt ponds for migration stopovers is also likely true of the Wilson's and red-necked phalaropes, even though their wintering area is far to the south of that of the eared grebe.

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Western and Clark's Grebes

Aechmophorus occidentalis and *A. clarkii*

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Introduction

The western and Clark's grebes are very closely related; until recently, the Clark's grebe was thought to be a light morph of the western grebe. Still more recent work indicates that the two soon may be re-merged taxonomically. In the San Francisco Bay region, the western grebe outnumbered the Clark's grebe by at least 9 to 1 (Shuford et al. 1989). The biology of the two species is virtually identical. Unless indicated otherwise, the information elsewhere in this account applies to both species and is from Storer and Nuechterlein (1992).

The western/Clark's grebe is the largest grebe in North America and one of the largest in the world; they are the size of a medium-sized duck (weighing about 1,430 g). These species are basically piscivores and the stiletto-shaped beak is well-suited for spearing fish. The bill also is used like a forceps to grasp fish (and occasionally crustaceans).

Distribution and Abundance

Western/Clark's grebe is found throughout the western portion of North America, except in the deserts and tundra. These grebes frequent lakes, large rivers, tidal sloughs, bays, and coastal marine waters (greater than 15 m deep). They breed on inland bodies of fresh and

saline waters or protected tidal waters, from the Pacific Coast east to Colorado and from Saskatchewan south to Colorado. The breeding season extends from February to September (Cogswell 1977), and they vacate inland breeding areas, flying to the west coast, before freeze-up. Wintering birds occur in Pacific Coast waters from British Columbia south to Mexico.

These species do not breed in habitats that are directly part of San Francisco Bay. Around the Bay Area, these grebes breed among the tall emergent vegetation on a number of isolated reservoirs (e.g., Calaveras Reservoir, Santa Clara County; Bousman, pers. comm.; Lake Merced, San Francisco County; Grinnell and Miller 1944). The largest breeding population close to San Francisco Bay is at Clear Lake, Lake County, and at Lake San Antonio, Monterey County.

No area-wide counts for western/Clark's grebes are available either historically or in recent years. The longest records of local censuses come from various Christmas Bird Counts. Counts that have provided data from the late 1960s at localities reporting few grebes (circa five or fewer grebes reported per party-hour) — Crystal Springs Reservoir, Benicia, Oakland, Hayward-Fremont, and Palo Alto — have shown no trends in numbers. The southern Marin County count, however, began at levels of 30-70 grebes/party-hour in the early 1970s, but declined gradually to vary around 10 grebes/party-hour by the late 1980s or early 1990s.

Most of the grebes of these species seen on San Francisco Bay are non-breeding individuals. In the Bay Area, peak numbers occur October through April (Ainley and DeSante 1980, Briggs et al. 1987, Shuford et al. 1989), the non-breeding period. The majority of such wintering birds come from breeding sites well inland (Great Basin, etc.). A few individuals, perhaps including local breeders, can be seen on San Francisco Bay in any month of the year, however.

Habitat Use and Behavior

Within the San Francisco Estuary, western/Clark's grebes can be found in the waters of sheltered coves, and sparsely in sloughs. Rarely are they found in the open Bay, except along tidal rips in the vicinity of Raccoon Straits and Angel Island.

Western/Clark's grebes are entirely aquatic and never come to land, unless ill. Their nests float, but are attached to emergent reeds. When foraging, these grebes dive by jumping up and forward. They use their feet for propulsion. Many of the fish consumed are near-bottom dwellers. Herring (*Clupea harengus*) are an important component of the diet of these grebes in bays of the Pacific Coast, such as Puget Sound (Palmer 1962). This fish is likely an important part of the grebe diet in San Francisco Bay.



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Conservation and Management

The presence of these species in San Francisco Bay is contingent upon the availability of forage fish, such as herring. The decline in grebe numbers in southern Marin may be due to changes in the herring population size or distribution. Herring, which occur most densely in the central and outer part of San Francisco Bay (waters of Marin and San Francisco counties), declined in spawning biomass from the 1960s through the mid-1980s, and during the 1990s, they have shifted somewhat from spawning in waters off Marin to waters off San Francisco (CDFG 1995).

The western/Clark's grebes and other grebe species typically seek sheltered waters, where in San Francisco Bay they are constantly displaced by the boats of human fishers, which also seek these localities. The prohibition of boats in the inner part of Richardson's Bay provides sanctuary. In fact, very large numbers of these grebes occur in Richardson's Bay, which is also in proximity to herring spawning areas.

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American White Pelican

Pelecanus erythrorhynchus

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Introduction

The American white pelican is one of the larger birds of North America, and certainly the largest piscivore (22-35 kg). The species is very gregarious, being both a colonial breeder and a group-forager.

Distribution and Abundance

The species nests exclusively on islands within large saline lakes in western North America, from just south of the tundra in central Canada to Texas, and from the Pacific Coast to the Mississippi River Valley. During winter, breeding populations move to traditionally established sites in California and Mexico as well as areas along the Gulf of Mexico (Palmer 1962).

Occurrence in the San Francisco Bay Area is very localized and is confined to the non-breeding season, generally from June through December (Shuford et al. 1989, Bousman 1993). The American white pelican frequents very shallow water and is seen (rarely) in the open parts of the Bay only in transit. They are almost exclusively gregarious and roost in flocks on dikes. One wintering population can be found at White's Slough, Contra Costa County (pers. obs.), another in the Hayward area, and another frequents salt evaporation ponds of the South Bay (Bousman 1993).

A few thousand likely spend their non-breeding season in the San Francisco Bay Area. No trend in numbers has been apparent during recent decades (Bousman 1993).



Peter Weber

Habitat Use and Behavior

American white pelicans feed on small, rough fish; in San Francisco Bay this would include sticklebacks (*Gasterosteus lineatus*) (Palmer 1962). They capture prey by swimming in large groups, corralling them, and then scooping them up with their large beaks.

Conservation and Management

The presence of this species in San Francisco Bay results from its well-being at inland breeding sites and the presence of quiet waters, such as salt evaporation ponds.

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Brown Pelican

Pelecanus occidentalis

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Introduction

The brown pelican is one of the largest piscivorous birds of coastal and estuarine waters of North America (weighing about 17 kg). The species breeds colonially, constructing its stick nests on the ground or, more commonly, in trees or shrubs. Pelicans lay two eggs per nesting attempt.

Distribution and Abundance

In western North America, the brown pelican breeds on islands in marine waters on either side of Baja Califor-



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nia, Mexico, north to the Channel Islands of southern California and to Florida. In the West, following the breeding season, many thousands move north to “winter” from central California north to the Columbia River. Peak numbers in central California, including the San Francisco Bay and surrounding area, occur from July through November (Shuford et al. 1989, Bousman 1993, Jacques 1994). During years when pelicans do not breed, such as during El Niño years, large numbers (in the thousands) occur throughout the year in northern California, including San Francisco Bay (Anderson and Anderson 1976). The highest counts in central and northern California occur during those warm-water periods (Ainley and DeSante 1980, Jacques 1994). Choice of wintering areas has to do with the availability of food and to tradition (Jacques 1994).

There are no current or historical Bay-wide censuses of brown pelican. The number of birds found over the waters of San Francisco Bay in a given year varies according to the well being of this species at its breeding grounds and the numbers in coastal waters of central California. In years of high breeding productivity or years of non-breeding, more pelicans can be found here. The fall peak in brown pelican numbers in central California has ranged from about 7,000 (in 1987) to 21,000 (in 1981; Jacques 1994). Currently, on average, several hundred occur within the Bay each summer and fall. As the species recovers from effects of DDT on its breeding productivity in the 1950s and 1960s (Anderson and Gress 1983), numbers seen in the Bay Area have slowly increased (e.g., Ainley 1972, Baldrige 1973).

Habitat Use and Behavior

In San Francisco Bay, brown pelicans frequent all the deeper waters, including some salt evaporation ponds and the mouths of the larger creeks (e.g., Corte Madera Creek, Marin County). Significant numbers are not found much farther inland than San Pablo Bay. They roost in numbers on small islands (e.g., Red Rocks) and breakwaters (e.g., Alameda Naval Air Station).

Brown pelicans feed on schooling fish. In waters of the San Francisco Bay, their diet includes such species as anchovies (*Engraulis mordax*) and smelt (e.g., *Hypomesus* spp.; Pers. obs. and Palmer 1962). Their technique of feeding—plunging beak first from altitude into the water to grasp fish up to a meter or so deep—requires deep water.

Conservation and Management

Except on nesting grounds, brown pelicans are not intimidated by the presence of humans. The species occurs in close proximity to humans and forages very close to human fishers. As long as forage fish are available, the population of brown pelicans will do well. When forage

fish are not available, brown pelicans scavenge fish offal discarded by humans.

Because this species is a higher order consumer, populations suffered considerably due to the effects of DDT on breeding productivity in the 1950s and 1960s (Anderson and Gress 1983).

Currently, the California population of this species is listed as endangered on the Federal Endangered Species List, but may (or should) be down-listed or delisted soon (e.g., CEQ 1986, Ainley and Hunt 1990).

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Double-Crested Cormorant

Phalacrocorax auritus

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Introduction

Cormorants are found the world over from the Arctic to the Antarctic. The family is large, and its members are mostly confined, with exception, to coastal marine waters. Cormorants are foot propelled divers and feed mostly on fish, although they take mid-water swimming crustaceans (such as shrimp) as well (Ainley 1984).

Cormorants construct their nests in colonies. Most nest on the ground, although some colonies occur in trees or on man-made structures. Among marine birds, cormorants are the most prolific, with their clutches averaging three to four eggs per nest. The capacity to lay so many eggs (most marine birds lay one egg only) allows their populations to respond positively to periodic conditions of food abundance. On the other hand, having so many chicks to feed often leads to food stress among parents when food is sparse and, consequently, to high mortality of chicks (Ainley 1984).

Distribution and Abundance

In North America, the double-crested cormorant is the only cormorant species associated with inland bodies of fresh, brackish, and saline water. They also occur close to ocean shores in protected waters. All other North American cormorant species are strictly marine, and in San Francisco Bay, except for vagrants, these other species occur only in the vicinity of the Golden Gate and Angel Island.



Don DesJardin

In the early part of the 20th century, almost all double-crested cormorants that occurred in San Francisco Bay likely nested on the offshore Farallon Islands, but commuted to the Bay for foraging. Since the late 1970s, they began to nest in small numbers around the Bay, especially on power transmission towers, bridges and, rarely, trees.

This species now is widespread in San Francisco Bay and the Delta. Since the species is a colonial breeder, breeding birds are concentrated in only a few locations - one major concentration is in the North Bay salt evaporators near Napa, two are in the Central Bay at the Richmond and Oakland-Bay bridges, and another is in the South Bay at the Dumbarton Bridge. The birds radiate outward from these colonies to forage at distances of 20 or more miles away. Double-crested cormorants often forage in flocks (see Barlow 1942, 1943), but also do so singularly.

In the 1800s through the 1940s, many thousands of these birds occurred in San Francisco Bay and were associated with schools of sardines (*Sardinops coerulea*), upon which they fed (Barlow 1942, 1943; Ainley and Lewis 1974). Owing to persecution by humans and perhaps the decline of sardine populations, the numbers of double-crested cormorants in San Francisco Bay declined rapidly, reaching a low during the 1960s and early 1970s (Ainley and Lewis 1974, Carter et al. 1995). Since then populations have been recovering. As of 1991, about 2,800 birds nested around San Francisco Bay in 12 colonies: Russ, Knight, Wheeler, and Donlon islands; San Pablo Bay radar station and beacon; the Richmond, Bay, and San Mateo bridges (and associated electric towers); and electric towers along the very southern shore of the Bay (Carter et al. 1995; SF Bay Bird Observatory, unpubl. data). The largest colonies in the Bay are on the Oakland-San Francisco Bay Bridge and Richmond-San Rafael Bridge (846 and 1,116 birds, respectively, in the mid-1990s; Carter et al. 1995). On the basis of sightings of banded birds, as well as a decline at the Farallones and simultaneous increase on the Richmond Bridge, the Farallon colony has supplied many recruits to these populations (Stenzel et al. 1995). A few pairs also nest at several localities in counties bordering San Francisco Bay; for example, several pairs nest on transmission towers near the mouth of Stevens' Creek, Santa Clara County (Bousman 1993).

This species is most prevalent in waters of the San Francisco Bay and Delta during winter - November through March. The increasing summer breeding population is the result of the arrivals of yearlings from the previous breeding season and birds from the colder, interior parts of North America. Although no Bay-wide census has been conducted during winter, their numbers likely reach 10,000 or more.

Habitat Use and Behavior

Breeding cormorants typically are very sensitive to disturbance from the intrusion of humans. Double-crested cormorants are among the least sensitive among all cormorants, which is not to say, however, that the species is oblivious to the presence of humans. They will flee their nests, leaving the contents to scavenging gulls or corvids when people approach within a couple hundred feet.

The double-crested cormorant forages in shallow waters overlying bottoms of flat relief. Such foraging areas may include rivers and sloughs tributary to San Francisco Bay, as well as salt evaporation ponds and areas such as San Pablo Bay. Large numbers are found in the tidal rips associated with Angel Island and Raccoon Straits. Double-crested cormorants feed mainly on fish. Herring (*Clupea harengus*) is an important prey in many coastal areas, and likely also in San Francisco Bay during winter. Midshipmen (*Porichthys notatus*) are an important food item during spring and summer (Palmer 1962, Ainley et al. 1981, Ainley, pers. obs. for San Francisco Bay).

Conservation and Management

For many years, the species was eradicated throughout North America because it was accused of foraging on favorite sport fishes. Protection from persecution and disturbance, and the increased availability of man-made structures on which to nest, has contributed greatly to the increase in numbers during recent decades. Even today there is pressure to control numbers, especially in cases where they forage on stupid, hatchery raised trout introduced to urban reservoirs (e.g., Lagunitas Reservoir, Marin County). Another factor that may have "allowed" the recent increases has been control of pesticides. This species is particularly sensitive to these compounds (Gress et al. 1973, Fry 1994).

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Snowy Egret

Egretta thula

William G. Bousman

Introduction

The snowy egret is a member of the family of herons and egrets (Ardeidae) that occur in wetlands throughout the world's avifaunal regions. Within the New World, the snowy egret is widespread in its distribution and is a counterpart of the little egret (*Egretta garzetta*) of the Old World. Two subspecies are recognized (Palmer 1962), *E. t. thula*, that breeds in the eastern United States



Don Desjardin

through Mexico and into South America as far south as Chile and Argentina, and *E. t. brewsteri*, that breeds in the western United States including California south to Baja California and western Mexico. Within its breeding range it is generally common, although strongly dependent upon wetlands for foraging both during and outside of the breeding season. In the San Francisco Bay, it is a resident species.

Snowy egrets are generalists in their feeding habits, foraging on small fishes, frogs, lizards, snakes, crustaceans, worms, snails, and insects. As with most generalists, they are opportunistic in their feeding and benefit from drying periods in seasonal wetlands and fish blooms that occur in salt ponds or other impoundments. Males establish breeding territories, and then, after pair formation, the pair normally defends a smaller nesting territory (Palmer 1962). Foraging territories are also defended. Breeding is normally colonial with one brood per year. Snowy egrets normally lay three to five eggs, but the young hatch asynchronously, and the smallest young survive only when food is plentiful. Nests are constructed on the ground, in trees, or marsh vegetation. On West Marin Island, they nest on the ground, in coastal scrub, in buckeye, and in live oaks. Birds that occasionally nest at Audubon Canyon Ranch use redwood trees and nest 60 to 70 feet above the ground (Shuford 1993). In Alviso, they nest in tules along Artesian Slough just barely above the surface of the water.

Distribution and Abundance

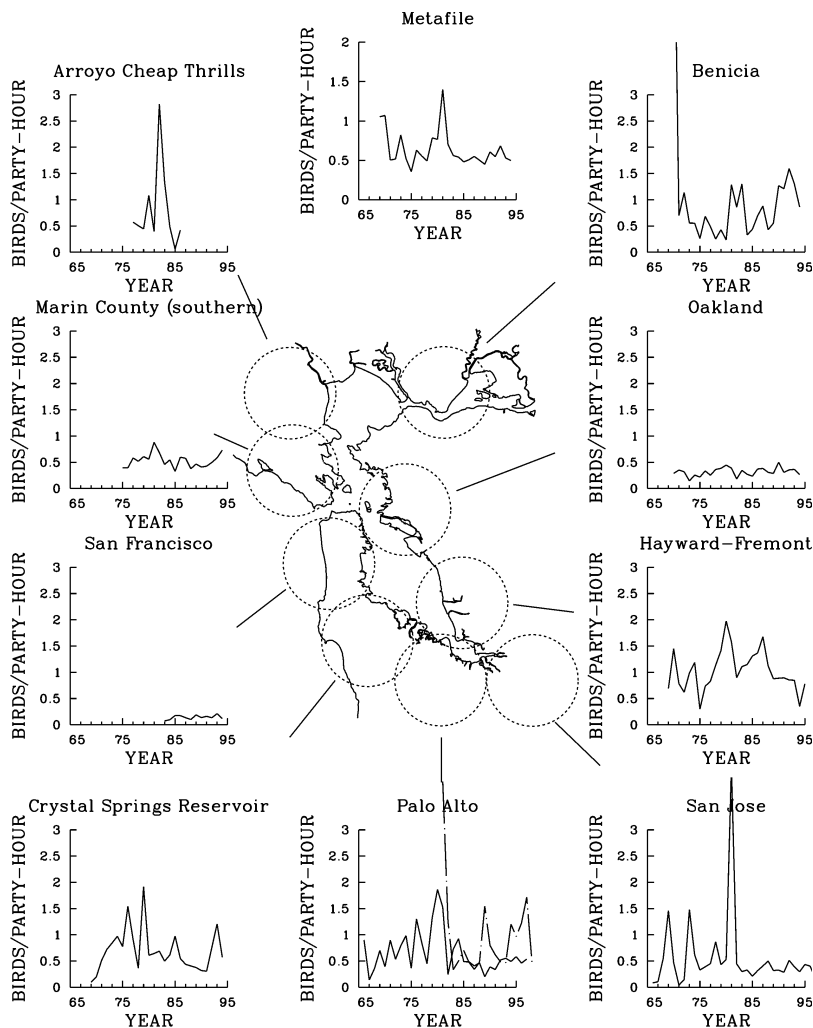
Modern Distribution - McCaskie et al. (1979) described the snowy egret as common to abundant in the seashore, coastal, interior, and Great Basin districts in northern California, although they noted that it is much less common inland, as well as on the coast north of Sonoma County. They considered beaches, mudflats, and marshes to be the primary habitat for this egret.

In Southern California, Garrett and Dunn (1981) considered snowy egrets to be common residents at the Salton Sea and along the Colorado River Valley, but only common as a winter visitor along the coastal slope where some birds are found uncommonly in the summer. It has occurred as an uncommon transient anywhere in the region. This species has nested along the Salton Sea, but has declined because of competition with cattle egrets. Along the coastal slope, recent nesting records included Sandyland Slough in Santa Barbara County and Buena Vista Lagoon and the Tijuana River Valley in San Diego County.

Today this species is a common, year-around resident in the San Francisco Bay. Christmas Bird Count (CBC) data from the late 1960s to the present, shown in **Figure 7.1**, indicate that this species is found regularly on the CBCs in Benicia, Oakland, Hayward-Fremont, San Jose, Palo Alto, Crystal Springs Reservoir,

Figure 7.1 Christmas Bird Count data for Snowy Egret - Approximate geographic location of Count circles indicated by dashed lines

National Audubon Society's *Audubon Field Notes*, and its successor publications, *American Birds*, and *Field Notes*, Volumes 24-51.



Marin County (southern), and Arroyo Cheap Thrills. For all of these counts, the numbers are comparable and show no substantial changes in the last 25 years. The aggregate number of birds counted in the nine CBC circles shown in **Figure 7.1** can be approximated by summing the mean number recorded on each count. This aggregate mean, 1,112 birds, represents a lower bound of the birds present in San Francisco Bay, as not all estuarine habitats are sampled within these circles, and it is likely that some birds were missed during these counts. Comparisons of Palo Alto CBC and Summer Bird Count (SBC) data obtained in the same count circle allow a comparison of summer and winter numbers using identical census protocols. These data show essentially the same population in both the summer and winter seasons, and it appears that this species is permanently resident in this portion of the Bay.

Historical Distribution - Within California, Grinnell and Miller (1944) considered the snowy egret to be a year-round resident below the 1,000-foot elevation level in the southern three-fourths of the State, which includes the San Francisco Bay Area. Elsewhere it was found only in the summer or as a vagrant. They

described the Sacramento, San Joaquin, and Colorado River valleys as the chief location for this egret, but noted that it was found coastally from Marin County south to San Diego County.

Prior to 1880, this species was considered locally common in the State (Grinnell and Miller 1944). Plume hunting, however, was as devastating to this species on the Pacific Coast as it was in the East, and starting in the 1880s, this species was nearly wiped out in the State. By the early 1900s, it was thought to be extinct within California. By the 1920s, it was considered a rare straggler to the Bay Area with only two locations noted (Grinnell and Wythe 1927). By the early 1940s, however, this species had started to recover and in favored places was locally common. Even by 1940, however, the only known breeding site was in Los Banos (Grinnell and Miller 1944).

By the early 1950s, in the South Bay, this species was considered an uncommon winter visitant (Sibley 1952). Emily Smith (*Audubon Field Notes* 9:51) considered ten birds at Alviso on 30 August 1954 to be notable, and this was the largest number reported for the Middle Pacific Coast Region in that season. A survey of South

Bay breeding birds in 1971 (Gill 1977) recorded 340 pairs on Bair Island, near Redwood City and this colony apparently was first started in 1969. This colony was still active at least through 1975 (Gill 1977), but it is no longer extant, and the reasons for its abandonment have not been described.

The species now appears to have recovered to its carrying capacity in the Bay Area, as noted above by the CBC population trends. It appears that most of this recovery occurred in the period from the mid-1950s to the late 1960s. No census data are available, however, that can accurately characterize the numbers present prior to European settlement.

Habitat Use and Behavior

From Palmer (1962), this species uses fresh, brackish, and salt-water habitats throughout its range. Within the San Francisco Estuary, it uses all of these habitats for foraging, although for breeding, it is rarely far from brackish or salt water. The densest concentrations of snowy egrets are found either where drying ponds concentrate suitable fish species or where fish blooms occur, and by inference, seasonal wetlands and impoundments are an important source of prey. Nonetheless, this species feeds widely along the tidewater margin, in nearby freshwater streams, and in lakes and reservoirs. In all cases, it depends upon healthy fish habitats for its prey base.

It uses a wide variety of substrates for nesting, and it seems clear that the actual substrate is of little importance compared to the security that the nesting locality provides from predation. Nearly 500 pairs have been noted at West Marin Island (Shuford 1993) and this is the largest concentration in the Bay Area. At Alviso, nests are built only slightly above the water in dense tules and 150 pairs were noted here in 1980 (*Am. Birds* 34: 811). Away from the Bay Area, this egret was first found breeding in Sonoma County in 1991 in the midst of an active black-crowned night heron colony in Penngrove. Seven active nests were found that year (Burridge 1995), and this shows the flexibility this species exhibits as long as a satisfactory prey base exists and there are secure nesting sites.

No quantitative data are available on the use of estuarine habitats for foraging by this species, either during the breeding season or at other times of year. In the South Bay, this species is observed in a wide range of habitats; birds leaving the Alviso heronry fan out to forage on the mudflat tidal edge, along streams flowing into the Bay, and the salt ponds. At times, unusual fish concentrations occur in seasonal wetlands or salt ponds, and, at these times, unusual concentrations of herons result. Some representative high counts from the South Bay include 390 counted by Alan M. Eisner in Charleston Slough on 3 August 1992, and 340 censused by Stephen

C. Rottenborn in the vicinity of the Sunnyvale Water Pollution Control Plant ponds on 24 July 1993 (Bousman 1994).

The two breeding population centers of this species in the North and South bays suggest the plasticity of this species in its uses of all major estuarine habitats. South Bay observations clearly indicate the importance of salt pond habitats, as well as the tidal edge of mudflats and riparian areas, whereas in the North Bay, use of salt ponds and other impoundments is less important than foraging in tidal areas.

Conservation and Management

The basic needs of this species are secure areas for nesting, adequate wetlands for foraging, and continued protection from direct persecution by man. However, this species is still vulnerable in its limited nesting colonies as indicated by the killing of snowy egrets, along with many great egrets in the West Marin Island colony in October 1955 (*Audubon Field Notes* 10: 51). The protection of the two large colonies, the one on West Marin Island in the North Bay and the other along Artesian Slough in the South Bay, is the most important need for this species within the estuarine system. As a foraging generalist tied directly to numerous habitats within the Estuary, the continued health of this population depends upon the general health of the Estuary and the various prey stocks.

Population surveys of the West Marin Island colony (Shuford 1993) are shown below in **Table 7.1**. Although these numbers demonstrate fairly wide fluctuations in breeding numbers, they do not indicate any long-term changes. Comparable data from the Alviso heronry have not been published. Both of these major Bay colonies are presently protected, but each is vulnerable to natural hazards, as well as direct and indirect acts of man.

The Bair Island colony near Redwood City was successful from 1969 into the 1980s and was then abandoned. Except for Gill's records (Gill 1977), data documenting the growth and decay of this colony have not been published, and there has been only limited discus-

Table 7.1 Estimated Breeding Pairs of Snowy Egrets on West Marin Island (Shuford 1993)

Year	No. of Birds	Year	No. of Birds
1979	262	1986	126
1980	-	1987	239
1981	325	1988	212
1982	500	1989	245
1983	400	1990	300
1984	400	1991	277
1985	161		

sion of why the colony was abandoned. San Francisco Bay Bird Observatory records indicate that the decline of the colony is probably linked to severe predation by red fox (Cogswell, pers. comm).

The Baire Island colony example of a fairly recent birth, growth, and decay of a major colony within the estuarine system, with little documentation, remains a warning for the stewards of our estuarine system. It is unclear how the Goals Project is to set goals for estuarine health without sufficient data to examine the 'pathology' of specific population failures or shifts.

It is believed that the greatest hazard now for this species is the continuing population increase of the non-native red fox in the South Bay. The Alviso heronry nests are largely in tules slightly above the tidal line, and although the water offers some protection from predators, the red fox has shown in its depredations on the clapper rail its willingness to overcome water barriers. As this population increases it appears only a matter of time before this colony is extirpated. It is possible that colony protection against this predator's burgeoning population could be obtained through a carefully designed barrier that enhances the effect of the present water barrier. It is possible that this colony could be re-established on Bair Island; however, protection of that area may be even more difficult.

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Black-Crowned Night Heron

Nycticorax nycticorax

William G. Bousman

Introduction

The black-crowned night heron is a member of the family of herons and egrets (Ardeidae) and is found worldwide. In the New World, the subspecies *N. n. hoactli* is recognized and breeds from Oregon and southern Canada, south to Chile and Argentina. In winter, the northern populations withdraw to the southern United States, although they linger on the West Coast to Oregon and the East Coast to Massachusetts (AOU 1957). Within its breeding range, it is generally common and is dependent largely on wetlands for foraging. It is a resident species in the San Francisco Bay Area.

The black-crowned night heron generally forages at the margins of lakes and streams, on brackish and on salt waters. Its chief prey items are fish, crustaceans, insects, and amphibians normally obtained by stalking or waiting for prey from a stationary position. It normally feeds at night, dawn, or dusk on individual feeding territories and roosts during the day. When trees are available it will frequently use them for roosting, otherwise it uses tules and cattails. It tends to use less open habitats than other egrets and herons (*Egretta* and *Ardea*), but is not so secretive as the bitterns (Palmer 1962, Cramp 1977).

Locally, in the South Bay, this species is nicknamed the "night raven" for its tendencies to prey on recently hatched ducklings. On 26 June 1988, Phyllis Browning (pers. comm.) watched two herons take six Class 1 gad-wall ducklings in a half-hour period in the Palo Alto



Doug Rodda

Flood Control Basin. At the same time, a western gull made 17 attempts on a gadwall family without success.

The black-crowned night heron nests in trees and shrubs, or less frequently in tules. Although a solitary feeder, this species is gregarious at roosts and is a colonial breeder. Males establish territories within the breeding colony and will bring twigs to a nesting site as part of advertising displays. Once a pair-bond is established, the male will bring sticks to the site where the female remains. A number of social behaviors are associated with nesting pairs (Palmer 1962, Cramp 1977). The species is single-brooded and will normally lay three to five eggs. The young hatch asynchronously, and the younger (smaller) nestlings will survive only when food is plentiful.

Distribution and Abundance

Modern Distribution - McCaskie et al. (1979) described the black-crowned night heron as uncommon to fairly common in Northern California within the sea-shore, coastal, interior, and Great Basin districts, but as a vagrant in the mountain district. They characterized its habitat use as beaches, mudflats, marshes, rocky shores, and riparian areas. Garrett and Dunn (1981) noted the species as fairly common in Southern California along the coastal slope, at the Salton Sea, and along the Colorado River Valley. They recorded recent breeding from Morro Bay, Santa Barbara, and San Diego.

Current Christmas Bird Count (CBC) data from the late 1960s to the present, shown in **Figure 7.2**, indicate that this species is found regularly on CBCs in Benicia, Oakland, Hayward-Fremont, San Jose, Palo Alto, Crystal Springs Reservoir, San Francisco, Marin County (southern), and Arroyo Cheap Thrills. For all of these counts, the numbers are comparable. Winter populations in terms of birds/party-hour have increased for Benicia (+6.0%, $p < 0.005$), San Jose (+3.7%, $p < 0.025$), and Arroyo Cheap Thrills (+19.5%, $p < 0.025$), while declines are noted on Crystal Springs Reservoir (-5.8%, $p < 0.005$) and Palo Alto (-3.7%, $p < 0.025$). This species is less common in the Palo Alto count circle during the summer based on Summer Bird Count (SBC) data with a mean of 0.33 birds/party-hour (std. dev. = 0.47, $n = 15$) compared to the winter average of 0.87 birds/party-hour (std. dev. = 0.61, $n = 27$). Interestingly, the Palo Alto SBC also shows a significant decline in the population (-2.6%, $p < 0.005$). The black-crowned night heron appears to be common throughout the Bay Area, and is perhaps best considered a resident species, with some augmentation in winter by non-resident northern or interior birds. The aggregate number of birds counted in the nine CBC circles, calculated by summing the means of the CBCs, is 838 birds. This represents a lower bound on the wintering population of black-crowned night heron in the San Francisco Bay estuarine system.



Doug Rodda

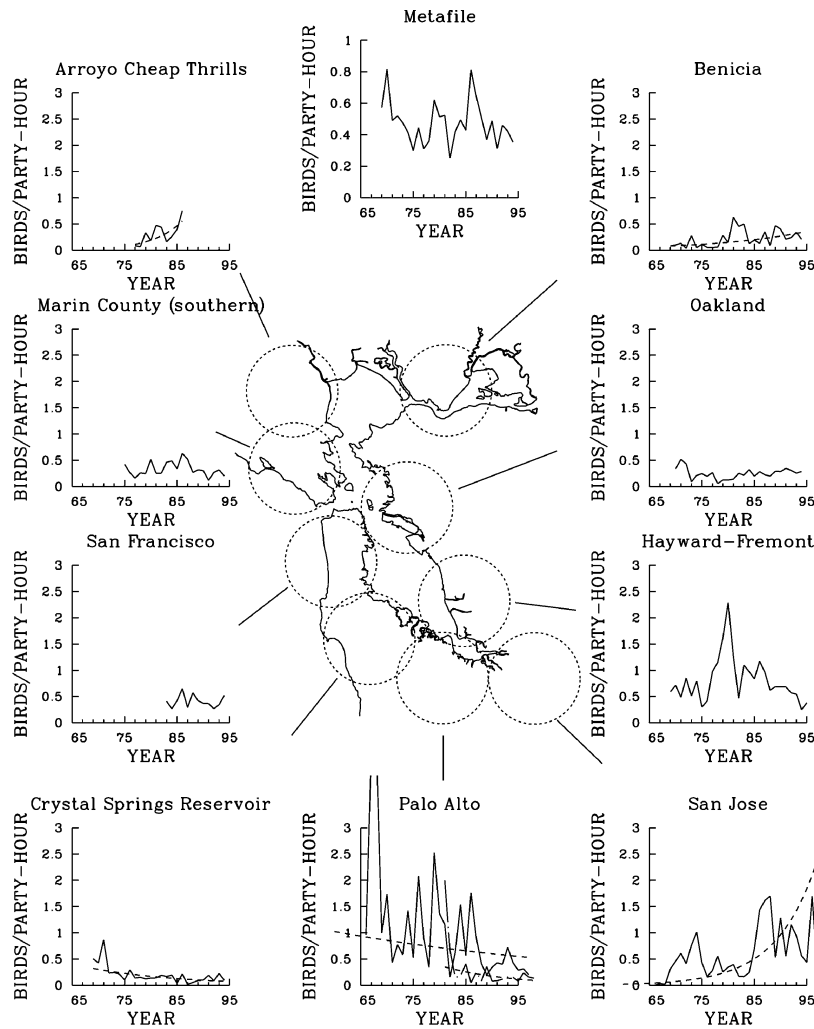
Historical Distribution - Grinnell and Miller (1944) considered the black-crowned night heron to be somewhat common throughout the State in the summer with fewer birds present in the winter. They noted that it occurred on both sides of the Sierran crest and bred from the lower Sonoran to the Transition life zones. They commented that this heron was formerly abundant in some localities, but numbers had been greatly depleted in historical times. Within San Francisco Bay, they cited breeding records from Belvedere Island in Marin County, and Alameda and a location near Alvarado in Alameda County.

Sibley (1952) noted that the Alameda County nesting colonies were no longer active by the 1920s and that there were no longer any active colonies in the South Bay. Emily Smith (*Audubon Field Notes* 8: 359) considered 27 birds counted on 11 July 1954 and 21 on 25 July 1954 at Alviso to be an unusual concentration. A nesting colony was established on Bair Island near Redwood City in 1967, and this included at least 684 nests in 1971 (Gill 1977). This colony was later abandoned because of red fox incursions (H. Cogswell, pers. comm.).

This species has clearly recovered in recent decades to where there are relatively stable populations, although it is unclear whether these are as large as existed prior to European settlement. Unlike the snowy egret, it is not apparent that this bird was hunted for its plumes at the end of the last century, and the down turn in its population must be related to other factors. Without knowing what these factors were, it is difficult to determine with any certainty why the species has recovered. It is possible, however, that the decline of duck hunting in the South Bay has benefited this species, as well as a number of other non-game species that were targets of casual hunters.

Figure 7.2 Christmas Bird Count data for Black-Crowned Night Heron - Relative geographic location of Count circles indicated by dashed lines

National Audubon Society's *Audubon Field Notes*, and its successor publications, *American Birds*, and *Field Notes*, Volumes 24-51.



Habitat Use and Behavior

The black-crowned night heron is a generalist in its foraging, as with many of the herons, and uses a variety of habitats. Unlike some of the other herons, however, it is a solitary feeder and does not normally concentrate at drying ponds and fish blooms. Suitable habitat requires numerous foraging opportunities in either fresh, brackish, or salt water. A suitable roost site for this crepuscular species is required as well.

The black-crowned night heron uses a variety of substrates for nesting. On West Marin Island, it uses coastal scrub and sometimes buckeye for their nests (Shuford 1993). At Alviso, they nest in tules along Artesian Slough. There is some evidence that introduced eucalyptus provide particularly safe nest locations because of the smooth bark (Roberson and Tenney 1993). The substrate *per se* appears to be relatively unimportant for this species, and the primary need is for a nest site that is safe from predation. Up to 300 pairs have nested on West Marin Island (Shuford 1993), and this is the densest concentration in the Bay Area. Up to 150 pairs were counted nesting in the Artesian Slough colony in

the South Bay in 1980 (Am. Birds 34: 811). Outside of the Bay Area, breeding is less common in coastal areas. A small colony exists in Monterey County at Carmel Point in eucalyptus. A maximum of 13 nests were counted in 1992 (Roberson and Tenney 1993). At least three small colonies are located in Sonoma, largely in urban areas where they create some difficulties for the local (human) residents (Burridge 1995).

Conservation and Management

The basic needs of this species are secure areas for nesting, adequate wetlands for foraging, and the continued protection from direct persecution by man. The protection of the two large colonies, one on West Marin Island in the North Bay and the other along Artesian Slough in the South Bay, is the most important need for this species within the estuarine system. As a foraging generalist tied directly to numerous habitats within the Estuary, the continued health of this population depends upon the general health of the Estuary and the various prey stocks. Population surveys of the West Marin Island colony (Shuford 1993) are shown in **Table 7.2** and,

Table 7.2 Estimated Breeding Pairs of Black-Crowned Night Herons on West Marin Island (Shuford 1993)

Year	No. of Birds	Year	No. of Birds
1979	98	1986	40
1980	-	1987	41
1981	109	1988	35
1982	80	1989	61
1983	89	1990	37
1984	54	1991	45
1985	79		

although these data demonstrate fairly wide fluctuations in breeding numbers, they do not indicate any long-term population changes. Comparable data from the Alviso heronry have not been published. Both of these major San Francisco Bay colonies are presently protected, but each is vulnerable to natural hazards, as well as direct and indirect acts of man. We have, at best, only a poor understanding of the factors that determine whether a nesting colony will succeed or fail. As an example, the Bair Island colony near Redwood City was successful from 1969 into the 1980s and was then abandoned. Except for Gill's records (Gill 1977), data that document the growth and decay of this colony have not been published, nor has there been a detailed discussion as to why the colony was abandoned. The fairly recent history of birth, growth, and decay of a major colony within the estuarine system, with little documentation, remains a warning for the stewards of our estuarine system.

It is believed that the greatest hazard now for the black-crowned night heron is the increasing population of the non-native red fox in the South Bay. The Alviso heronry nests are largely in tules, slightly above the tidal line and, although the water offers some protection from predators, the red fox has shown in its depredations on the clapper rail its willingness to overcome water barriers. As the fox population increases, it appears only a matter of time before this colony is extirpated. It is possible that colony protection against this predator's burgeoning population could be obtained through a carefully designed barrier that enhances the effect of the present water barrier. It is possible that this colony could be re-established on Bair Island; however, protection of that area may be even more difficult.

No quantitative data are available on the use of estuarine habitats for foraging by this species, either

during the breeding season or at other times of year. In the South Bay, this species is observed in a wide range of habitats, and birds leaving the Alviso heronry fan out to forage on the mudflat tidal edge, the salt ponds, and along streams flowing into the Bay. This species does not concentrate at prey resources, such as fish blooms or drying ponds as some of the other Ardeids, but it does congregate at secure day roosts. A representative day roost was of 145 birds tallied at the Palo Alto Baylands on a high tide on 22 November 1984 (pers. obs.).

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California Clapper Rail

Rallus longirostris obsoletus

Joy D. Albertson
Jules G. Evens

Introduction

Populations of clapper rails along the Pacific Coast and the Colorado River have been considered variously as races of *Rallus longirostris*, races of *Rallus elegans*, or separate species (AOU 1983). Currently, *R. longirostris* and *R. elegans* are treated as superspecies (Taylor 1996). Three subspecies of clapper rail (*Rallus longirostris*) occur in California: the 'California' clapper rail (*R. l. obsoletus*), the 'light-footed' clapper rail (*R. l. levipes*), and the 'Yuma' clapper rail (*R. l. yumanensis*) (AOU 1957). Each of the three subspecies is classified as 'endangered' by the U.S. Department of the Interior (Federal Register 50 CFR 17.11; USFWS 1973), primarily due to habitat loss. Both *obsoletus* and *levipes* are listed as 'endangered' by the State of California; *yumanensis* is listed as 'threatened' (CCR Title 14, Section 670.5).

The California clapper rail is a secretive, hen-like waterbird, indigenous to estuarine marshlands in San Francisco Bay (Grinnell and Miller 1944, Gill 1979, AOU 1983). Though *R. l. obsoletus* may still occur as a transient in outer coast marshes, its status there is precarious. No breeding populations have been detected at Morro Bay and Elkhorn Slough in recent years. Comments that *R. l. obsoletus* is "resident at Tomales Bay and Monterey Bay" (AOU 1957) are no longer accurate.

Description

The clapper rail is one of the largest species of the genus *Rallus*, measuring 31-40 cm in length and weighing approximately 250-350 grams, with the males slightly larger (Taylor 1996). It has a rusty or rufous breast, orange bill, white and black feathers on the flanks, as well as white undertail coverts, creating effective cam-



Peter LaTourrette

ouflage within the marsh vegetation (Ridgeway 1880, Grinnell et al. 1918).

Breeding Biology - Clapper rail pairs are monogamous and will fiercely defend overlapping, year-round territories (Applegarth 1938, Massey and Zembal 1987, Zembal et al. 1989, Albertson 1995). Courtship is initiated by the male and involves the male approaching the female with an uplifted tail, pointing his bill to the ground and swinging it from side to side. Courtship feeding of the female is also common. Males normally build the nest, which occurs on or near the ground, usually on a slight rise (Ehrlich et al. 1988). The nest consists of a platform of dead plant material arched over by surrounding live vegetation to form a roof. In the South Bay, nests have primarily been found in gumplant bushes (*Grindelia humilis*), pickleweed clumps (*Salicornia virginica*), cordgrass stands (*Spartina foliosa*), saltgrass patches (*Distichlis spicata*), and wrack (DeGroot 1927, Applegarth 1938, Zucca 1954, Harvey 1988, Foerster et al. 1990). In the North Bay, nests have been found in *Scirpus robustus*, *Salicornia virginica*, or *Grindelia humilis*. Nests tend to be located less than two meters from first-order channels and at least 100 meters upstream from the marshland shoreline (Evens and Page 1983, Evens and Collins 1992). The marshland beneath the nests ranges in elevation from 15 cm below Mean High Higher Water (MHHW) to about five cm above MHHW, and the nests themselves are constructed entirely above MHHW (Evens and Collins 1992, Collins et al. 1994).

Eggs are laid March through July (DeGroot 1927, Harvey 1980, Evens and Page 1983). A clapper rail can lay between five and 14 eggs, with the average being seven eggs per clutch (DeGroot 1927, Zucca 1954). Incubation is shared by both adults and is variously reported as 23 to 29 days (Applegarth 1938, Zucca 1954) and 18 to 29 days (Taylor 1996). The peak nesting period for clapper rails is April through May, and a majority of hatching occurs mid-April through early June (Applegarth 1938, Zucca 1954, Harvey 1988, Foerster et al. 1990). DeGroot (1927) states that clapper rails may "double clutch," or produce two broods per year. However, Applegarth (1938) attributes late nesting attempts to renesting, occurring when the first nest has failed, rather than to production of a second clutch after a successful hatch.

Clapper rail chicks are precocial and will leave the nest soon after hatching (Applegarth 1938). One adult will tend the newly hatched chicks, while the other parent continues incubation until all eggs have hatched (Applegarth 1938, Meanley 1985). Young rails accompany the parents for approximately eight weeks, learning to forage for food on their own (DeGroot 1927, Zembal 1991). Juveniles fledge at ten weeks (Johnson 1973) and may breed in the spring following hatch.

Survivorship is low, 0.49-0.52 (Albertson 1995), similar to that of the Yuma clapper rail (Eddleman 1989).

Much predation takes place during high winter tides and is likely due to the ease of capture by predators at this time. This increased predation is likely enhanced by the increased movement of rails within this season, similar to other clapper rail subspecies (Eddleman 1989, Zembal et al. 1989). Raptors, in particular, gain advantage during high tide in marshes that do not have sufficient high vegetation to provide aerial cover for rails. In one study, most (64%) of the rails killed were taken by raptors, primarily during the winter season (Albertson 1995). In another study, an estimated 25% of the population of rails in one 35 ha marsh was taken by raptors from April through November; circumstantial evidence indicated that the barn owl (*Tyto alba*) was the primary predator at that site (Evens and Page 1983). In that study, predation of nests and eggs was also attributed to rats, ravens, and high tides (Evens and Page 1983).

Migration Ecology - California clapper rails are considered non-migratory residents of San Francisco Bay salt marshes, but post-breeding dispersal has been documented during the fall and early winter (Orr 1939, Wilber and Tomlinson 1976). Harvey (unpubl. data) reported three of 54 banded birds moving approximately one km across a slough and one moving about 10 km, from Dumbarton Point to Alameda Creek. Most birds, however, did not move from the marsh in which they were banded: 48% were found 100 m or less from the capture sight, and 78% were less than 500 m away. Albertson (1995) reported one of 29 monitored rails moving approximately three kilometers in early breeding season and successfully establishing a breeding territory. Old records from the Farallon Islands, outer coast marshes, and a variety of extralimital locations (Grinnell and Miller 1944; Evens, unpubl. field notes; American Birds notebooks) suggest that there is a fairly regular fall dispersal period from August through November. This dispersal may be irruptive in nature, occurring in some years, not in others.

Food and Feeding - The primary diet of clapper rails consists of various invertebrate species, including mussels, clams, crabs, snails, amphipods, worms, spiders, insects, and fish (Williams 1929, Applegarth 1938, Moffitt 1941). In addition, clapper rails will opportunistically take small birds (Jorgensen and Ferguson 1982) and rodents (pers. obs.), as well as carrion (Moffitt 1941). A majority of foraging occurs during low tide when mudflats and tidal sloughs are exposed, and food is more readily available (Applegarth 1938, Foerster and Takekawa 1991).

Distribution and Abundance

Historical Distribution - The historical distribution of the California clapper rail was restricted to the tidal marshlands of coastal California from Humboldt Bay in the north to Morro Bay in the south (Grinnell

1915, Grinnell and Wythe 1927, Grinnell and Miller 1944, AOU 1957, AOU 1983, Gill 1979). It occurred formerly at Humboldt Bay (Grinnell and Miller 1944); Tomales Bay (Storer 1915, Brooks 1940, Grinnell and Miller 1944, AOU 1957); Elkhorn Slough, Monterey County (Grinnell and Miller 1944, Varoujean 1972); and Morro Bay, San Louis Obispo County (Brooks 1940, AOU 1957). Present distribution is restricted to the tidal marshes of San Francisco Bay (Evens 1985, Baron and Takekawa 1994). Recent records from coastal estuaries outside of San Francisco Bay are sporadic and represent presumed dispersants or vagrants.

The historical distribution within San Francisco Bay was apparently restricted to tidal marshlands downstream from Suisun Bay (Grinnell 1915, DeGroot 1927, Grinnell and Wythe 1927, Moffitt 1941, Grinnell and Miller 1944). The literature suggests that the populations have fluctuated widely in historic times. A decline noted in the 19th century was attributed to depredation by hunters (Taylor 1894). DeGroot (1927) implies that numbers declined around the turn of the century in the North Bay, and Grinnell and Wythe (1927) reported that although still common in the South Bay, they had become rare elsewhere around the Bay. By 1944, Grinnell and Miller stated that clapper rails had recently recolonized former habitat "in marshes on northern and eastern sides [of the Bay] in Marin, Sonoma, Napa, Contra Costa and extreme western Solano counties." This wording, along with a distribution map delimiting the range at Carquinez Strait (Grinnell and Miller 1944), suggests the North Bay population was limited to the shores of San Pablo Bay. It seems clear that, historically, clapper rails were restricted to the tidal marshes of San Francisco and San Pablo bays, but were absent from Suisun Bay and associated marshlands (Collins et al. 1994).

Modern Distribution - Data on current population levels is somewhat equivocal and may indicate fairly wide population fluctuations, or partial knowledge of abundance, among sub-regions of the Bay. Based on surveys conducted from 1971 through 1975, Gill (1979) estimated a population of 4,200-6,000 rails with 55% in the South Bay, 38% in the Napa marshes, and the remaining 8% in other North Bay and outer coast marshes. There is some indication that Gill overestimated; however, the weight of the evidence suggests that the decline in the population has been real, at least since the mid-1980s (J. Takekawa, pers. comm.). By the mid-1980s, on the basis of breeding and winter population estimates, approximately 1,200-1,500 California clapper rails remained, with greater than 80% of the population found in the South Bay (Harvey 1980, Harvey 1988, T. Harvey and P. Kelly, unpubl. data). By 1988, populations were estimated to have declined to 700 rails (Foerster and Takekawa 1991), with one of the primary causes of this decline being predation caused by the introduction of the red fox. One estimate suggested that

the South Bay supported up to 90% of the total rail population (SFEP 1992), however, the most recent update suggests a more even distribution between the South and North bays (see below).

In 1990-91, the Bay-wide population was estimated as 300-500 individuals, followed by a rebound in 1993 to over 800 individuals (USFWS unpubl. data). Increases in South Bay rail populations during this time period are largely attributable to ongoing predator management, initiated in 1991 (Harding et al. 1998). Winter surveys conducted in 1997-98 estimated the South Bay populations to be 650-700 individuals (USFWS unpubl. data). The most recent comprehensive surveys (1992-93) in the northern reaches of the Bay (San Pablo and Suisun bays) resulted in conservative estimates of 195-282 breeding pairs, or 390-564 individuals (Collins et al. 1994). Given these data (and their limitations) the most recent estimates indicate a total population of 1,040-1,264 rails in San Francisco Bay. **Figure 7.3** shows the known distribution of California clapper rails around the San Francisco Bay.

Carquinez Strait - Habitat is limited along the Strait, but a small population (estimated at one to three pairs) has persisted at least since 1948 at Southhampton Marsh (Evens and Collins 1992).

Suisun - Clapper rails are scattered at several sites around Suisun Bay and Marsh, with an indication that populations are present some years but not others. Areas where rails have been found with some regularity since 1978 include the shoreline marshes from Martinez east to Point Edith, bayshore marshes near the mouth of Goodyear Slough, the upper portions of Suisun and Hill sloughs (B. Grewell, pers. comm.), and the western reaches of Cutoff Slough and associated tributaries (Harvey 1980). Winter records appear to be more numerous in this region than breeding season records. An apparent range expansion into this area probably indicates habitat changes resulting from conversion of these marshes into more brackish condition with substantial decreases in freshwater flow from the Sacramento-San Joaquin Delta (Rozenfurt et al. 1987, Evens and Collins 1992, Leipsic-Baron 1992.)

North Bay - The marshlands along the North Bay shore and associated rivers and sloughs support clapper rails, with concentrations near the mouths of the larger tributaries (e.g., Gallinas Creek, Novato Creek, Petaluma River, Black John Slough, Sonoma Creek, and Napa River). Gill (1979) identified the Napa River as a North Bay population center which supported "40% of the entire population." Subsequent field work (Evens and Collins 1992, Collins et al. 1994) suggests a decline at that site, but concentrations still exist at White Slough (Vallejo) and Coon Island (Evens and Collins 1992).

Central Bay - A relatively small extent of appropriate habitat occurs in the Central Bay. Primary areas that support clapper rails are: Corte Madera (aka

'Heerd't') and Muzzi marshes (30 pair in 1992-93; Collins et al. 1994); San Leandro Area (Arrowhead and Elsie Romer marshes); and inner Richmond Harbor (Collins et al. 1994). Muzzi Marsh is of particular interest because it is a restored marsh that was not colonized until 1984, and the population was estimated at 15 rails in 1987 (Evens and Page 1987). Other sites include Richardson Bay and Creekside Marsh, Marin County.

South Bay - Foerster (1989) indicated that California clapper rail numbers on the western side of the Bay were stable, but the East Bay population (primarily in Ideal, Dumbarton, and Mowry marshes) had decreased substantially during the past decade, from 400-500 individuals in the early 1980s, to 50-60 in 1991-1992 (Harvey 1980, USFWS unpubl. data). Recent surveys show strong recovery of East Bay populations following implementation of a predator management program to control red foxes (Harding et al. 1998), with over 330 counted in 1997-98 winter surveys. Currently, the largest populations of rails occur in Dumbarton and Mowry marshes on the East Bay, and Palo Alto and Greco marshes on the West Bay. The most recent survey data indicate that rail populations on the east and west sides of the South Bay are approximately equal.

Habitat Use and Behavior

Habitat Requirements - The California clapper rail occurs primarily in emergent salt and brackish tidal marshlands of San Francisco Bay. Preferred habitat is subject to direct tidal circulation and is characterized by predominant coverage by pickleweed (*Salicornia virginica*) with extensive stands of Pacific cordgrass (*Spartina foliosa*), and, in the North Bay, *Scirpus robustus*, abundant high marsh cover, and an intricate network of tidal sloughs which provide abundant invertebrate populations (Grinnell et al. 1918, DeGroot 1927, Harvey 1988, Collins et al. 1994) as well as escape routes from predators (Zembal and Massey 1983, Foerster et al. 1990).

Generally, the upper marsh zone is dominated by pickleweed, with saltgrass (*Distichlis spicata*), alkali heath (*Frankenia grandifolia*), and jaumea (*Jaumea carnosa*) occurring at the highest elevations, as well as gumplant (*Grindelia* spp.) along the upper edge of some tidal sloughs. The lower marsh zone along the Bay is dominated by stands of Pacific cordgrass, which also occurs along the banks of tidal sloughs within the marsh (DeGroot 1927, Hinde 1954, Harvey 1988). Low marsh areas with sparse vegetation, mudflats, and tidal sloughs are important foraging areas for rails (Applegarth 1938, Albertson 1995). Higher marsh areas 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).

Past studies (Applegarth 1938, Zucca 1954, Jorgensen 1975, Massey et al. 1984, Harvey 1988) re-

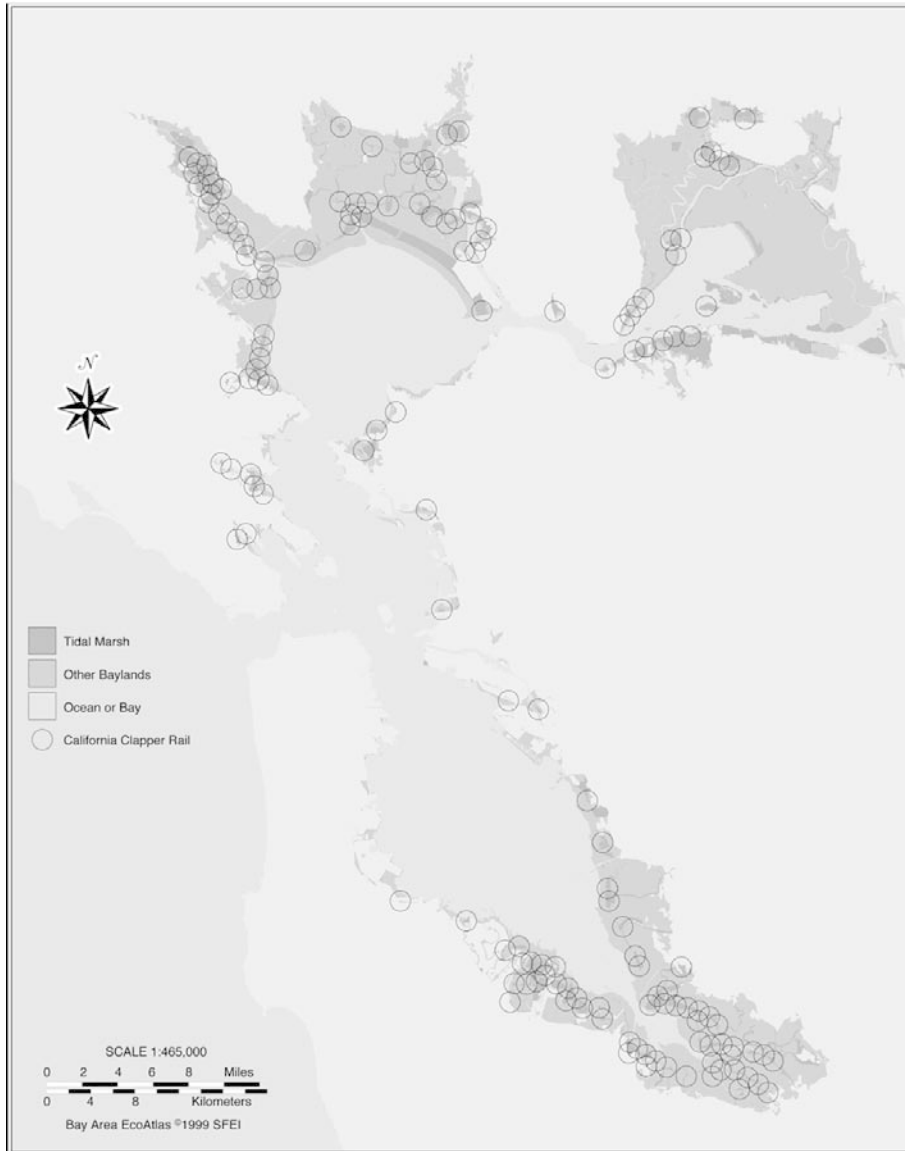


Figure 7.3 Known Distribution of the California Clapper Rail – Each circle represents one or more breeding pairs

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ported on the importance of cordgrass as a canopy and nesting material. This apparent preference for cordgrass may be tied to the fact that cordgrass grows primarily along tidal sloughs and at the marsh edge, where rails prefer to forage. Weather-influenced changes in *Spartina* biomass and productivity may account for variations in nesting habitat preference (Gill 1979).

California clapper rails also occur in brackish wetlands consisting of bulrush (*Scirpus* spp.) (Gill 1979). In these areas, rails use bulrush plant materials for nest building and cover, but nests are still associated with tidal channels, as in pickleweed dominated marshes (Evens and Collins 1992). This type of habitat occurs along the larger creeks in the South Bay, in some areas of Napa Marsh, Petaluma River, and Sonoma Creek in San Pablo Bay, and in Suisun Bay (Gill 1979).

In the North Bay, natural habitat for *obsoletus* is the saline and marginally brackish tidal marshland with

small channels that extend through or into patches of tall monocot vegetation. The ecological functions of salinity and tidal action are unknown. The tidal channels serve an important function as areas for foraging and as protected pathways. The monocot vegetation is used as nesting material. At marshland elevations near Mean High Water (MHW), the vegetation must be at least 50 cm tall to permit the construction of a nest that is low enough to be concealed by the natural plant canopy and yet high enough that it will not be inundated by the maximum high tides of the breeding season. At marshlands of higher elevation, shorter vegetation may be utilized.

Rail density seems to be positively correlated to channel density, although minimum and maximum values of channel density are not obvious from the data collected thus far. Suitable habitat is provided by most of the youthful marshlands that have evolved since the middle of the last century, as well as the remaining frag-

ments of historical, mature marshlands. Local populations of breeding California clapper rails are most dense where patches of habitat are at least 100 ha in size. Such patches typically comprise some historical and youthful marshlands together. These marshlands may support relic populations of *obsoletus*. Fewer than fifteen such patches exist within the northern Estuary. One third of these adjoin the mouths of major tributaries downstream from Carquinez Strait. Small parcels of marshland along the immediate margin of a major tributary seem more likely to support *obsoletus* than similar sized parcels that are more isolated. In general, the density of rails decreased upstream toward the headward extent of the major tributaries of the Estuary (Collins and Evens 1992, Collins et al. 1994).

Other physical attributes of a marsh that influence rail use and may contribute to creating a self sustaining population of rails include size of the marsh, location relative to other marshes, buffer areas between marsh and upland, marsh elevation, and hydrology (Collins et al. 1994, Albertson 1995). These "high quality" characteristics play an integral part in the everyday survival of the clapper rail, providing food resources, cover from predators, breeding and nesting habitat, and refuge areas at high tides. Hence, the quality of a marsh will determine how many rails can be supported in a particular marsh (Garcia 1995, Albertson 1995).

There are few records of breeding rails utilizing diked marshes or other non-tidal habitat, but one observer (K. Rambo, pers. comm., in Orton-Palmer and Takekawa 1992) documented a successful breeding pair in a sewage oxidation pond, and Orton-Palmer and Takekawa (1992) documented use of a diked marsh by a breeding pair at Moffett Field. One pair was noted breeding in a small diked marsh adjacent to a larger undiked wetland at Muzzi Marsh, Marin County in 1992, and a pair apparently bred in a sewage pond adjacent to Richardson Bay in Mill Valley in 1997. Close proximity of tidal marshes supporting other breeding rails are thought to contribute to the use of these non-tidal areas.

Movement - Results of recent radio-telemetry studies indicated that most rails showed strong site tenacity, with very little movement between seasons and small core-use area ($x=0.87$ ha) which was defended throughout the year (Albertson 1995). This same observation has been made for Yuma clapper rails (Todd 1987) which were found to vocalize only in core-use areas, demonstrating probable territorial defense areas. Home ranges sizes varied by individual bird, but significant within-season differences are apparent among marshes, particularly in core-use areas (Albertson 1995). Core-use areas are defined as the highly defended portion of the territory (*per* Hinde 1954) and contain the nest site. Although the basis for differences in rail homerange size between marshes has not been absolutely determined, differences in predation pressure, quality of

habitat, and size/orientation of the marsh may account for most of these differences (Albertson 1995).

Conservation and Management

Numerous human-related factors, including commercial and sport hunting during the late 1800s (DeGroot 1927, Wilber and Tomlinson 1976, Gill 1979), have led to rail population declines over the last 150 years (Harvey 1988, Foerster et al. 1990). The Migratory Bird Treaty Act (1913), which restricted harvest on game species including the clapper rail, is believed to have led to a substantial recovery of populations in many remaining marshes (Bryant 1915, Moffitt 1940, Grinnell and Miller 1944). During the early to mid-1900s, commercial and urban development destroyed over 85% of the primary tidal marshes of San Francisco Bay, resulting in severe rail population declines, range contraction, and fragmented distribution (Gill 1979, USFWS 1984, Nichols et al. 1986, Foerster et al. 1990, Leipsic-Baron 1992).

Presently, California clapper rail populations are restricted to fragmented salt marshes in San Francisco Bay. Remaining marshes are geographically disjunct, and characterized by lack of a significant transition zone to terrestrial habitat, relatively small size, a large edge to area ratio, and close proximity to urban and industrial development. Several factors have previously been identified as negatively affecting current rail populations, including predation by non-native red fox (Foerster et al. 1990, Albertson 1995), contaminants (Ohlendorf and Fleming 1988, Ohlendorf et al. 1989, Lonzarich et al. 1990, Leipsic-Baron 1992), and marsh conversion and degradation (Foerster and Takekawa 1991). Predation is likely their most immediate threat for survival.

Clapper rail (*Rallus* sp.) populations are subject to predation by a number of species. At least ten native and three non-native predators are known to prey on California clapper rails and their eggs (Albertson 1995). However, recent evidence suggests that the non-native red fox may pose the most serious threat to adult clapper rails (USFWS and USN 1990, Foerster et al. 1990, Foerster and Takekawa 1991, Zembal 1992, Albertson 1995).

During the late 1800s, the red fox (*Vulpes fulva*) was introduced to western California by hunters. In addition, some individuals escaped from commercial farms (Lewis et al. 1993). Red foxes are well adapted to urban environments, and thus their populations have rapidly expanded along the coast in such areas as San Francisco Bay (Albertson 1995).

In addition, free-roaming and feral cats (*Felis domesticus*) prey on rails in marshes adjacent to housing and landfill areas (Albertson 1995). The Norway rat (*Rattus norvegicus*), raccoons (*Procyon lotor*), and non-native foxes prey on eggs and may cause low annual recruitment (DeGroot 1927, Applegarth 1938, Harvey 1988, Foerster et al. 1990). Harvey (1980) found that

rats took 24% of eggs in 50 nests, and a 1992 study in the South Bay showed that rats preyed on 31% of eggs in 54 monitored nests (USFWS unpubl. data).

Extensive conversion of tidal lands resulting from historic and ongoing pressures of agricultural production, urbanization, and salt production has drastically reduced California clapper rail habitat in the San Francisco Estuary. The remnant tidal marshlands of the Estuary, the largest and last refuge of *obsoletus*, occupy only about 15% of their historic extent (Dedrick 1989), yet even in such diminished capacity comprise greater than 90% of all remaining California tidal marshlands (MacDonald 1977).

Fragmentation of habitat involves the construction of dikes and levees that serve as corridors for terrestrial predators. The devastating effect of red fox on *obsoletus* in the southern reaches of the Estuary is well-documented (Foerster et al. 1990, Burkett and Lewis 1992), and has been noted in regard to *R. l. levipes* in southern California (Zemba *in* Foerster et al. 1990). In the northern reaches of the Estuary, the distribution of red fox is disjunct. They are reported west of Benicia and east of Dixon, but not in the Suisun system (Bob Smith, pers. comm.). We observed red fox at Wildcat, Point Pinole, China Camp, Mare Island, Second Napa Slough, and Dutchman Slough. None were detected in the Suisun Marsh, where coyote (*Canis latrans*) was quite common. We also noted sign of raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), feral cat, and rats (*Rattus* spp.). Raccoon sign was noted in virtually every tidal marsh, and we suspect that, as in the southern reach (Foerster et al. 1990), raccoon populations as well as those of other mesopredators have increased dramatically over the last decade. In addition, river otter (*Lutra canadensis*) is quite common in the Suisun Marsh area and should be considered as a potential predator of birds that nest on the ground near water (Ingles 1965).

According to MacArthur (1972), colonization among isolated patches of habitat requires very high fecundity of source populations. Given the effects of fragmentation, increased predation rates, possibly lowered fecundity (Foerster et al. 1990), and a low rate of dispersal, California clapper rails probably can not colonize or survive in all fragments of their habitat. Mortality due to predation could be so severe that immigration from source populations is infrequent, and the rate of survival of pioneering individuals is low. This might explain their absence in ostensibly suitable habitat observed in this study.

As with the California black rail (*Laterallus jamaicensis coturniculus*) and other tidal marsh dependant species (Evens et al. 1991, Nur et al. 1997) subject to similar pressures, simulation models have demonstrated that populations of fewer than 10 pairs (Richter-Dyn and Goel 1972, Roth 1974), or perhaps 25 pairs (Shaffer 1981), are inherently unstable and tend toward extinc-



tion due to stochastic events. Due to these factors, the persistence of subpopulations may depend on contiguity of marsh parcels and ability of rails to disperse among sites.

In addition to habitat fragmentation and the concomitant threat of predation, other pressures that threaten to alter or degrade the habitat and impact rail populations include: continued diversion of freshwater inflow from the North Bay (Rozengurt et al. 1987, Williams and Josselyn 1987); a progressive rise in sea level (Williams 1985, Moffatt and Nichol et al. 1987); and contamination. Contamination of other species of estuarine birds has been documented in this estuary (Ohlendorf et al. 1986, Ohlendorf and Fleming 1988, Phillips and Spies 1988), and other studies have detected dangerous levels of contaminants in clapper rail eggs (Lonzarich et al. 1990). The threat of toxic contamination of the substrate is ongoing, cumulative, and poorly understood.

Recommendations

The quality of restored habitat will dictate the potential rail population density. High quality habitat should include:

- Direct tidal circulation sufficient to allow the full tidal cycle,
- A predominant pickleweed marsh with cordgrass, gumplant, and other high marsh plants,
- Abundant, dense high marsh cover, and
- An intricate network of tidal sloughs.

In addition to these qualities, other physical characteristics of marshes that should be taken into account when planning a restoration project include size of marsh, location relative to other marshes, buffer area between marsh and upland, and type/extent of interface with humans and human-made structures.

Small sites may not provide enough habitat for a viable population of breeding birds. Ideally, restored areas should be able to potentially support viable rail populations and not be subject to wide population fluctuation.

tuations. Therefore, marsh restoration sites should be at least as large as existing sites, such as Dumbarton Marsh (118 ha) or Mowry Marsh (164 ha). Marsh restoration should focus on significantly expanding marsh acreages in areas currently supporting high populations of clapper rails, such as the Dumbarton, Mowry, Greco, and Palo Alto areas in the South Bay. In the North Bay, historic wetland acreage in close proximity to rail population centers provide opportunities for restoration, for example White Slough and Coon Island on the Napa River, diked areas adjacent to Sonoma Creek and the Petaluma River, and in large diked areas associated with Suisun Slough in Suisun Bay. This would allow existing populations to increase, reducing the probability of local extinctions.

Location of marshes with respect to one another should also be taken into consideration when planning restoration. Areas to be managed for clapper rails should be in close proximity to facilitate dispersal without risk of excessive predation. Rails have been found to disperse between 1-3 km, therefore primary marshes should be within this distance from one another. Intervening marsh corridors need to be of sufficient quality and width (at least several hundred feet) to provide adequate cover and food resources for dispersing rails.

Buffer areas between marsh and upland are critically important to rails for escape cover from predators during high tides. Absence of higher transitional areas adjacent to a marsh could result in high mortality during periods of tidal inundation. In a telemetry study (Albertson 1995), much of the predation was found to occur during high tides, when cover was scarce and little refugial area was available. Buffer areas need to provide cover of sufficient height and density to protect rails during extreme high tides. Marsh restoration projects should incorporate gradual transition areas from marsh into upland whenever possible, rather than an abrupt elevation change from marsh to levee.

Human-made structures, such as power lines, poles, and buildings, provide raptor perches. If these structures are in close proximity to marshes, predation by raptors can be high (Albertson 1995). Marsh restoration projects should take this into account and plan to remove structures if possible, or plan larger restoration projects to minimize the effects of such structures. Human dwellings, landfills, and rubble piles can harbor Norway rat and feral cat populations, therefore marshes in these areas may be subject to high levels of predation from these species. Human disturbance from recreational use, utilities maintenance, and high-intensity adjacent uses can disturb rails and cause homerange abandonment with subsequent nesting failure. Proposed use of adjacent land and public access to marshes should, therefore, be carefully evaluated prior to being permitted.

Habitat restoration should include management of non-native plant species, such as smooth cordgrass (*Spar-*

tina alterniflora) and pepperweed (*Lepidium* spp.), in order to protect existing and future rail habitat from degradation. In particular, invasion of smooth cordgrass causes excessive sedimentation, which will clog tidal sloughs important to rails for foraging. A Bay-wide effort must be undertaken to control smooth cordgrass.

Continued predator management will be needed to maintain viable clapper rail populations and prevent extinction. Control efforts should target red fox, feral cats, and selected known native predators in areas of prime rail use. Structures and debris that harbor rats (riprap, decrepit buildings and vessels, etc.) should be removed from areas adjacent to rail habitat.

Predator management is not the solution to increasing future populations, however. In the long-term, only restoration of high quality tidal marsh habitat will ensure future survival and recovery of the California clapper rail. The current amount and configuration of suitable habitat is insufficient to substantially increase rail densities and population sizes. Several tidal restoration projects around the Bay are being undertaken by the San Francisco Bay National Wildlife Refuge complex and others. One 1,500 acre parcel, Cullinan Ranch, formerly farmland along the Napa River area of the North Bay is being restored to full tidal action by means of levee breaching and sedimentation. The Knapp property, a 452 acre former salt pond in Alviso and Guadalupe sloughs, will be restored to tidal marsh. Bair Island, a 1,600 acre former salt pond will be restored to tidal action. This area holds much promise for rail recovery due to its large size and close proximity to another fairly large rail population on nearby Greco Island. Additional opportunities exist in San Pablo and Suisun bays.

Recovery of California clapper rail populations will require the preservation of existing habitat and restoration of large acreages of high quality tidal marshes. In order to afford this species the best chance for recovery, restoration of former salt and brackish tidal marsh areas should be maximized in all subregions of San Francisco Bay. Restoration should focus on areas that have the greatest potential for developing into high quality salt marsh habitat.

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California Black Rail

Laterallus jamaicensis coturniculus

Lynne A. Trulio

Jules G. Evens

Introduction

Two subspecies of the black rail breed in North America, the eastern black rail (*Laterallus jamaicensis jamaicensis*) and the California black rail (*L. j. coturniculus*). The bulk of the population (>90%) is associated with the tidal marshlands of the San Francisco Estuary. The species' reliance on tidally influenced, completely vegetated, high elevation salt marsh habitat makes it a valuable indicator species of mature, upper tidal marsh habitat.

The California subspecies is a sparrow-sized bird, approximately five to six inches long. Cogswell and Christman (1977) note that this secretive bird can be positively identified by its "dark slate color, with faint white bars on the sides and chestnut nape and the prominent white spotted back." The California black rail is found primarily in three locations on the West Coast: the San Francisco Estuary and local coastal marshes, the lower Imperial Valley and the lower Colorado River at the border of California and Arizona, and northwestern Baja California (Eddleman et al. 1994).

The discovery in 1994 of a black rail population in freshwater marsh habitat in the Sierra foothills east of Marysville (Aigner et al. 1995) suggests that other unknown populations also may exist. Indeed, in 1997, systematic surveys of potential habitat in the vicinity of this 1994 site detected small populations scattered throughout the foothills, mostly between 100 and 200 meter elevations. Of more than 100 sites surveyed, approximately one quarter supported black rails in 1997 (J. Tecklin, pers. comm.). Subsequent field work detected rails at 71 sites in the lower foothills of three counties, extending from north of Chico on Butte County, south through Nevada County (J. Tecklin, *in press*).

In the San Francisco Bay Area, this rail is primarily a bird of tidally influenced marshes and is most often seen during very high tides when it is forced out of the lower elevation pickleweed marsh.



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Description

Because the California black rail is so furtive, very little is known about its ecological requirements, although recent studies have begun to reveal some of these mysteries (Flores and Eddleman 1993). Old records from San Diego Bay and more recent surveys in San Francisco Bay indicate that birds may begin the breeding season (as evidenced by calling) as early as mid-February at coastal locations, later in the interior. During breeding season, birds call primarily during twilight hours. Males and females are distinguished by their very different calls, although much remains to be learned about the vocalizations of this species.

Breeding Biology - Nesting occurs in tall grasses or marsh vegetation, and nests consist of a small, woven cup of marsh plants, reeds, or grasses constructed by the male and female. In San Francisco Bay, nests with eggs have been found in April (J. Evens, pers. obs.), in San Diego Bay (where the species no longer breeds) in May (Cogswell and Christman 1977). Limited data suggest that San Francisco Bay rails lay 6 ± 1.4 eggs (Wilbur 1974). Data from non-tidal Arizona habitat showed that both males and females may incubate, that incubation is 17 to 20 days, and that second and replacement clutches are possible (Flores and Eddleman 1993). Behavior in tidal marshes in San Francisco Bay may differ from Arizona, however.

The first known record of the species in California was of a single individual on the Farallon Islands, 48 km west of San Francisco, October 18, 1859 (Brewster 1907). There are no reliable records of birds breeding in San Francisco Bay before 1970 (Evens et al. 1991), but undoubtedly this species has been resident since before European colonization. Recent evidence confirms breeding in the North Bay at China Camp, Black John Slough and Day Island, Marin County, and Sonoma Creek, Sonoma County (J. Evens, 1986-94 unpubl. field notes), however, presence of territorial birds during the breeding season implies breeding throughout the tidal marshlands of San Pablo Bay, Carquinez Strait and Suisun Bay, and at sporadic sites in the Delta and on the outer coast.

Single nest or juvenile observations have been recorded at Alviso, Newark, Richardson Bay, Benicia, and Pinole between 1910 and 1970. Very few nests or juveniles have ever been recorded from the Central or South Bay, none in recent years and breeding status there is uncertain. Records compiled by S. Rottenborn from Santa Clara Valley Audubon Society dating back to 1927 suggest that black rails have been very rare to non-existent outside the winter months in the South Bay during this period. A recent late-season record of a black rail calling was on April 26-27, 1993 at the Palo Alto Baylands. Evens et al. (1991) also report territorial calling at the Dumbarton Bridge in April 1989.

Migration Ecology - Migration is commonly believed to be an autumn (August through October) dispersal, probably comprised mostly of birds of the year (juveniles). Extralimital records support this view. Grinnell and Wythe (1927) noted that this species was a "fairly common fall and winter visitant" in the San Francisco Bay Area. Although black rails winter in the United States, their migration pattern in California is not clear, and the extent of their winter dispersal is not known (Ehrlich et al. 1992). Based on the known distribution within San Francisco Bay, it seems likely that the post-breeding season dispersal from North Bay marshes accounts for winter numbers in the South Bay.

Although there are numerous non-breeding season (August-March) records of black rails in these Central and South Bay marshes, their numbers are apparently not sustained through the spring (Evens et al. 1991). Very little is known, however, about spring movement. Reasons for the breeding season absence in the South Bay may include several interrelated factors, including lower elevation of marshes, less peripheral high marsh or transitional habitat, and increased predation rates (Manolis 1978, Evens et al. 1991).

The recent discovery of numerous populations in freshwater marshes and seepages in the Sierra Foothills (Aigner et al. 1995; J. Tecklin, pers. comm.) indicates that the species has the ability to colonize isolated habitat patches. The Rallidae in general disperse themselves effectively and the colonization of several disparate and isolated sites in California in recent years, some of which are newly created (Evens et al. 1991, Aigner et al. 1995, Nur et al. 1997), points to the importance of any marsh habitat for black rails.

Food and Feeding - This species feeds by ground gleaning on terrestrial insects, aquatic invertebrates, and perhaps seeds. Sampling of rail habitats in North Bay marshes indicate Arachnida and Amphipoda as likely prey items, although these findings are largely speculative (Evens, pers. obs.).

Distribution and Abundance

Historically, the black rail occurred from Central California south to San Diego and Baja. Several breeding season surveys of the bird's distribution in California provide current information on the abundance, distribution, and habitat choice of this species in the San Francisco Bay (Manolis 1978, Evens et al. 1991, Nur et al. 1997). Eddleman et al. (1994) stated that in "coastal California during the breeding season, the California black rail is presently found at Bodega Bay, Tomales Bay, Bolinas Lagoon, San Francisco Estuary, and Morro Bay" Although once more widely distributed, the bulk of the population is "now restricted... to the tidal marshlands of the northern reaches of the San Francisco Estuary (San Pablo Bay). . . at relatively few sites" (Evens et al. 1991).

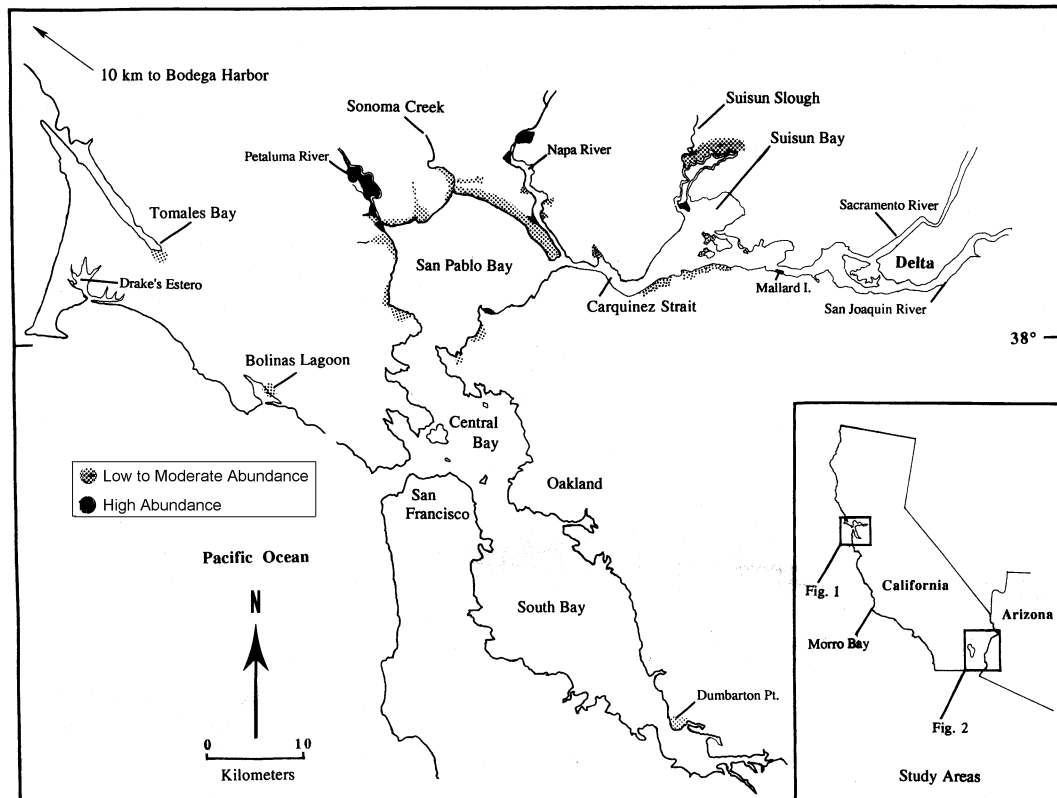


Figure 7.4 Distribution and Relative Abundance of Black Rails (*Laterallus jamaicensis coturniculus*) in the San Francisco Bay Region Point Reyes Bird Observatory breeding season surveys, Evens et al. 1991.

Figure 7.4 shows the approximate current distribution and relative abundance of black rails in the San Francisco Bay region (Evens et al. 1991), Evens et al. (1991) described the species as rare throughout most of its California range, except in those areas noted by Eddleman, where it is fairly common. Currently, the coastal Southern California breeding population is extirpated.

In his spring and summer surveys, Manolis (1978) found no birds in Central and South Bay marshes, but did find them in San Pablo Bay and Suisun marshes. The extensive breeding season survey by Evens et al. (1991) in San Francisco Bay marshes confirmed distributional patterns found by Manolis. The survey also found numbers concentrated in the northern reaches; birds were largely missing from the Central Bay (except Corte Madera marsh) and were very rare in the South Bay.

Areas of highest concentration are "Petaluma River Wildlife Management Area, along Black John and Fagan sloughs and Coon Island in Napa Marsh, and in some bayshore marshes of San Pablo Bay" (Evens et al. 1991, SFEP 1992). "In these northern reaches rail numbers were: much higher in tidal marshes than in marshes with restricted tidal flow, generally higher in marshes along large tributaries than in smaller tributaries or along the bayshore; much higher in bayshore marshes located at the mouths of creeks, rivers, or sloughs than in bayshore marshes not bisected by water courses" (Evens

et al. 1991). Nesting birds are also patchily distributed in Suisun Bay marshes and the Delta (SFEP 1992). Recent field work suggests that black rails are more widely distributed in Suisun Marsh than previously understood, particularly in the northern most undiked marshes (B. Grewell, pers. comm.).

A survey of the entire Estuary, conducted from 1986-1988, detected 608 rails at 1,168 stations (Evens et al. 1991). All but two rail detections occurred in the northern reaches of the Bay, including San Pablo Bay, the Carquinez Strait, Suisun Bay, and the Delta. This survey detected rails at 87% of the San Pablo Bay stations, 20% of the Carquinez Strait and Suisun Bay stations, 5% of the Delta stations, <1% of the South Bay stations, and none of the Central Bay stations. Evens (pers. obs.) notes that the population at the Corte Madera Ecological Reserve is believed to now be extirpated.

A follow-up study in 1996 of those parcels surveyed in 1986-1988 (Nur et al. 1997) found stable populations in San Pablo Bay and Suisun Bay and detected no black rails in the Central and South bays. Although there was no overall trend for decrease in the San Francisco Bay population, in the outer coast marshes (smaller and more isolated than the Bay marshes), numbers of black rails were low and appeared to have decreased over the past decade and are considered in danger of extirpation. While this study found that individual marsh size was

not significantly related to overall black rail density, it did find a significant tendency for black rails to be absent from small marshes.

There are many records of adults and juvenile black rails in Central and South bays during the non-breeding season, but no breeding is known to occur in these areas (SFEP 1992). The lack of high tide refugia for birds and low marsh elevation in the Central and South Bay may explain why breeding populations are not found there.

Habitat Use and Behavior

This species prefers *Salicornia* dominated marsh habitat (Cogswell and Christman 1977). It is also known to occur in fresh, brackish, and salt marshes (Erhlich et al. 1988). In their survey of the San Francisco Bay during breeding seasons from 1986-1988, Evens et al. (1991) found the birds occurred almost exclusively in marshlands with unrestricted tidal influence. This study found very few birds associated with diked, impounded, or partially tidal marshes. Moreover, Evens and his colleagues found that rails during the breeding season were almost exclusively associated with more mature, higher elevation marshes dominated by *Scirpus* and *Salicornia*. Breeding birds were often associated with marshes that had significant amounts of *Scirpus* spp. Subsequent field work indicates that seasonal wetlands with muted tidal flow, especially those adjacent to tidally influenced marshes, may be utilized by rails in “wet” years when precipitation occurs late in the season and hydrates the substrate of marshes isolated from tidal influence, but supporting a dense cover of salt marsh vegetation, i.e., *Salicornia* (J. Evens, pers. obs.).

Newer, younger marshes with *Spartina* were not used by breeding birds, although rails could be found in these areas during the non-breeding season. Subsequent field work indicates that seasonal wetlands with muted tidal flow that are adjacent to fully tidal marsh and have 95-100% vegetative cover of salt marsh vegetation may be occupied in years of high precipitation (J. Evens, pers. obs.).

Josselyn (1983), citing Evens and Page (1983), noted that rails in Corte Madera Ecological Preserve were most commonly associated with areas of 90-97% pickleweed cover with a canopy height of 29 cm. These areas also had a “high degree of understory penetrability” which allowed rails to move easily through the pickleweed.

Evens and Page (1983) found that important components of breeding habitat were a dense pickleweed canopy and open structure below the canopy for nesting and easy movement. During nesting season, rails were associated with nearly solid pickleweed stands. Other important habitat parameters are elevation, timing and degree of flooding, marsh age and size, and proper soil and water salinity (Evens et al. 1991).



Rick Stallcup

Peripheral vegetation at and above mean high higher water is necessary to protect the birds during periods of extremely high tides. They may be able to use a range of cover species; at Corte Madera they used fennel growing at the edge of the marsh (Evens and Page 1983). The birds are very vulnerable at this time and, if not hidden, are subject to predation by northern harriers (*Circus cyaneus*), great egrets (*Casmerodius albus*), great blue herons (*Ardea herodias*), and probably many other predators (Evens and Page 1986). Observations at Tomales Bay suggest that bird abundances may be depressed by lack of sufficient, quality upland for refuge during high tides (Evens and Page 1986). Uplands can also be degraded by having pedestrians too close to the marsh, which inhibits the escape of birds to the upland during high tides (Evens and Page 1983).

Conservation and Management

This taxon is acknowledged to be declining (Evens et al. 1991, SFEP 1992) and is listed as threatened and as a ‘California Fully-protected Species’ under the California Endangered Species Act, and as a ‘Species of Special Concern’ (formerly ‘Category 2 Candidate Species’) under the Federal Endangered Species Act. Fragmentation and habitat loss associated with historic and ongoing pressures of agricultural practices, salt production, and urbanization are identified as the primary causes of the decline. The remnant tidal marshlands of San Francisco Bay occupy only 15% or less of their historic area (Dedrick 1989), yet even in this diminished capacity comprise 90% of all remaining California tidal marshes (MacDonald 1977).

Marshlands of San Francisco Bay and the outer coast still occupied by black rails have been degraded by the loss of the zone of peripheral halophytes that form a natural vegetative transition between the marsh and upland and provide high tide refugia for rails. Livestock grazing and diking have reduced or eliminated this transition zone in most of the marshes around the Bay and the outer coast, resulting in rail susceptibility to heavy predation by herons, egrets, and raptors during high tides (Evens and Page 1986). Predation by rats, feral cats, and red foxes are also likely to contribute to the problem (SFEP 1992).

Other pressures that threaten to alter or degrade San Francisco Bay habitat include continued diversion of freshwater inflow from the North Bay, a progressive rise in sea level, and contamination by toxic agents shown to have had adverse biological effects on other birds in the Estuary (Evens et al. 1991). The patchy distribution of black rails makes the population susceptible also to metapopulation dynamics and stochastic variables (Evens et al. 1991, Nur et al. 1997).

Recommendations

Increases in black rail populations will require the protection of existing habitat and the restoration of good quality rail breeding habitat. This habitat should be undiked (fully-tidal) salt marsh, with dense stands of pickleweed, and other halophytes characteristic of the salt marsh community. Upland refugium that provides cover during highest tides is critical. Formerly diked marshes that are restored to tidal influence may provide additional habitat for black rails if they encompass elevations at or above mean high higher water, are adjacent to extensive tidal marshes with full tidal influence, and include high tide refuge.

Control of non-native predators is also expected to benefit the rail. The largest, most resilient rail populations may not occur in newly established marshes, but may require the development of a mature salt marsh community. The age of the marsh necessary to support black rails is unknown. To ensure the continued viability of this taxon, it is critical that, as marshes are restored, current rail habitat be protected, and transitional vegetation be allowed to become established around the perimeter of existing habitat. It may be many years before restored marshes offer ideal habitat for black rails.

Rail habitat shares many similar features with salt marsh harvest mouse (*Reithrodontomys raviventris*) habitat, although the rail occupies a narrower band within the elevational marsh gradient. Whatever habitat improvements benefit the rail are likely to benefit the mouse, and *vice versa*.

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Common Moorhen

Gallinula chloropus

William G. Bousman

Introduction

A member of the rail family (Rallidae), approximately 12 subspecies of common moorhen are found worldwide, ranging through Europe, Asia, Africa, North America, and numerous islands in the Pacific and Indian oceans. The North American subspecies, *G. c. cachinnans*, breeds widely in North America and winters south to Mexico (AOU 1957).

In general, the common moorhen requires open fresh water with plant cover. An omnivorous forager, it consumes varying proportions of plant and animal materials. It feeds while swimming or while walking on land or floating plants (Cramp 1980).

A nest is normally constructed in vegetation above water. The typical clutch size is six to seven eggs; pairs are often double-brooded and experienced birds may even raise three broods in a season (Cramp 1980). Birds defend breeding territories and, where resident, reduced winter territories. Generally, moorhens are monogamous and the pair-bond is normally for just a single year. However, an extended bond may occur for resident birds (Cramp 1980).

Distribution and Abundance

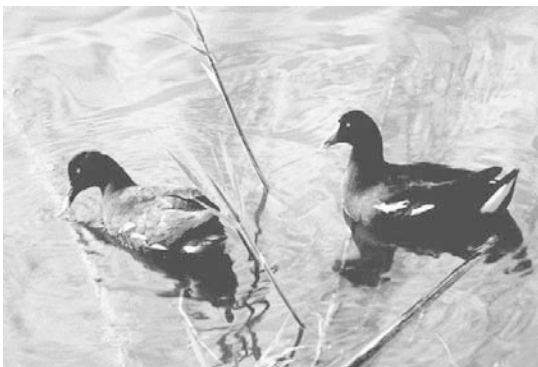
Modern Distribution - McCaskie et al. (1979) reported moorhens to be uncommon to fairly common in the interior (Central Valley) of Northern California and rare to very uncommon along the coast. More birds were reported to occur along the coast in the winter, but only stragglers were found along the northern coast. McCaskie et al. (1979) noted the primary habitats used were lakes and marshes. Garrett and Dunn (1981) reported that in Southern California, moorhens are uncommon to fairly common along the Salton Sea and in the Colorado River Valley, but occur primarily as a winter visitant

along the coastal slope. They noted that the moorhen was formerly more common along the coast, but it now breeds there only rarely and is largely extirpated because of the destruction of freshwater marshes.

In the last 25 years, comparable numbers have been found on the Benicia, Hayward-Fremont, and San Jose Christmas Bird Counts (CBCs), as shown in **Figure 7.5**. Elsewhere in the Bay, this species is at best a straggler. Aggregate numbers, based on the means of the nine CBCs shown in **Figure 7.5**, are 48, and this represents a lower bound on the winter population. The Benicia CBC has been showing a long-term decline in numbers (-10.1%, $p < 0.005$), while San Jose CBC has shown an increase (+5.8%, $p \sim 0.05$). The Palo Alto CBC, on the other hand, reported few birds until about 1980 when the Mountain View Forebay was constructed. Currently, within the Palo Alto count circle, equal numbers of birds are found on the CBC and the Summer Bird Count (SBC), indicating that the species is largely resident. This species is still considered uncommon in the South Bay, although it is regularly found in freshwater areas and is known to breed at the brackish Warm Springs Marsh near Newark. It is much less commonly found on the Marin CBCs and, in this respect, its distribution appears to be little different than that noted by Grinnell and Miller (1944).

Historical Distribution - In the earlier part of the century, Grinnell and Wythe (1927) noted records from San Francisco and Alameda but did not believe that the species bred within the estuarine system. Grinnell and Miller (1944) considered the common moorhen a summer resident of the Sacramento and San Joaquin valleys and the coastal district southwards from Alameda County. They noted that it did not occur north along the coast beyond San Francisco, and some birds were reported to remain through the winter. Within its preferred habitat of freshwater marsh, they considered it to be locally common. They noted a reduction in numbers in direct proportion to the reduction in available habitat, but pointed out that the species does take advantage of habitat created by irrigation, and this has offset the destruction of marshland to some degree.

Sibley (1952) considered this species to be an uncommon summer resident and noted records from W. E. Unglish of eggs taken from "Soap Lake." Sibley's map shows that his "Soap Lake" is what is presently called San Felipe Lake, just south of the Santa Clara line in San Benito County. Ken Schulz (*Audubon Field Notes* 11: 427) reported a high count of six adults and 12 immature birds at a 'colony' near the intersection of Singleton Road and Coyote River [sic] on 4 July 1957. Very small numbers of common moorhens were found throughout the 1970s in various areas along Coyote Creek in the southern Santa Clara Valley, but not in any locations along the Bay. Gill (1977), in his survey of South Bay breeding avifauna, did not include the common moorhen on his



Dan Sudia

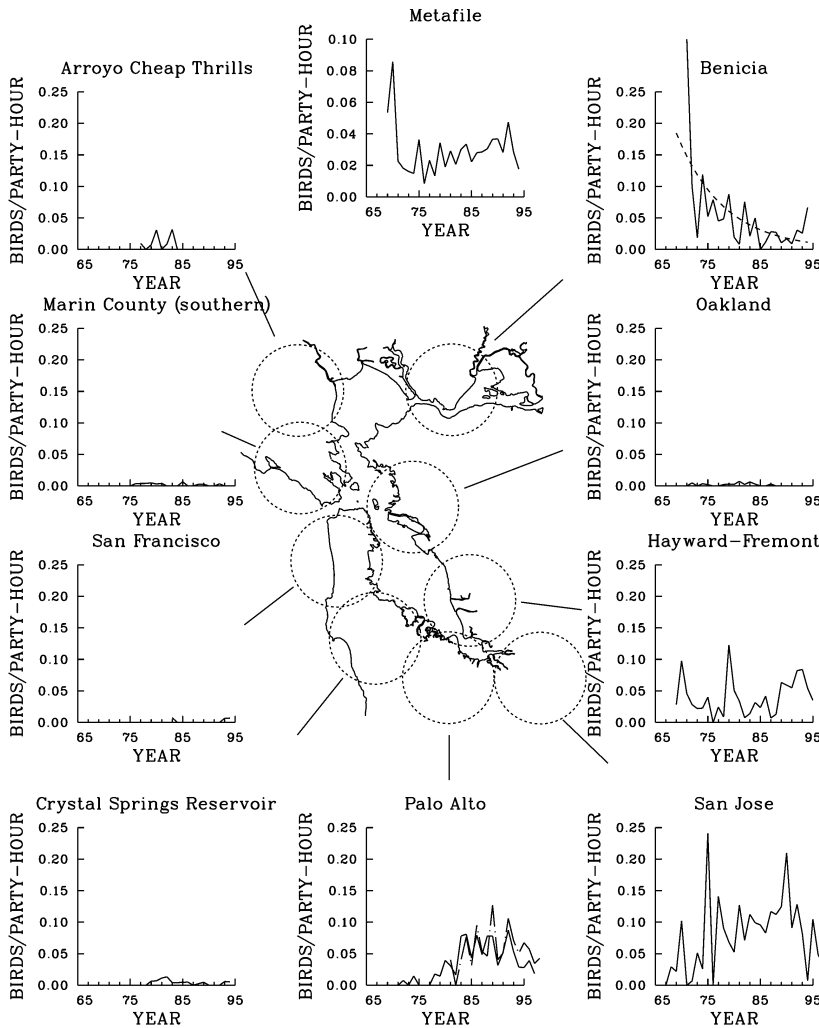


Figure 7.5 Christmas Bird Count data for Common Moorhen - Relative geographic location of Count circles indicated by dashed lines

National Audubon Society's *Audubon Field Notes*, and its successor publications, *American Birds*, and *Field Notes*, Volumes 24-51.

list, suggesting that he failed to find it in any areas he checked, including sites such as Coyote Hills Regional Park.

The historic abundance of the common moorhen is difficult to determine, not only because of the lack of historical data, but also because it appears that the San Francisco Bay estuarine system is near the northern limit of this species' range. The historical atlas clearly shows that there was more freshwater habitat available 200 years ago than there is today and, in the South Bay, there were a number of freshwater marshes associated with willow thickets and natural artesian systems. However, there are no records of moorhens having used these marshes, and it may be that this species is a recent colonizer of man-made freshwater habitats along the Bay edge.

Habitat Use and Behavior

The common moorhen appears to be tied closely to freshwater impoundments within the San Francisco estuarine system and, less often, along freshwater streams. These freshwater areas are usually dominated by cattails. For the most part, these freshwater areas are constructed

for other uses, and the moorhen invades once the vegetation becomes suitable for foraging and breeding.

The species breeds in small numbers in Marin County and was found in two atlas blocks near Novato during that county's breeding bird atlas. There are prior breeding records from Olema Marsh in 1967 as well and recent records from the Bolinas sewage ponds and Novato (Shuford 1993). It nests, as well, on Joice Island (C. Wilcox, pers. comm.) in the Suisun Marsh - this site being more typical of natural sites found in the Sacramento Delta than the highly modified man-made sites which this species uses along the Bay. The common moorhen also breeds in small numbers in Santa Clara County, but it is found more regularly there than in the North Bay. It nests every year in freshwater areas alongside the bay, such as the Mountain View Forebay and the Moffett channel at the Sunnyvale Water Pollution Control Plant. It also uses a number of the freshwater percolation ponds on the upper reaches of the Guadalupe River and, apparently, portions of the river itself. In wetter years, it extends its range to suitable percolation ponds with sufficient growth of cattails and tules, such as the small ponds at Coyote. Draining and maintenance

activities along Coyote Creek during the atlas period prevented breeding in a number of areas where the species nested previously (and may still do so in wetter years).

Conservation and Management

The common moorhen, perhaps more than any other single species, is directly tied to freshwater marshes with good cover of cattails. This species is an active prospector for new territories (Cramp 1980) and, in this limited sense, is adaptable to change. Examples of this adaptability include the development of a new breeding population following construction of the Mountain View Forebay in the late 1970s. As cattails started to grow in this freshwater area, birds moved in and breeding was detected by 1983. Peak population counts in this area include 20 birds counted by David Suddjian on 24 November 1985 (pers. comm.) and 20 there as well reported by Peter Metropulos on 13 August 1988 (pers. comm.). Similarly, a suitable freshwater marsh developed at Moffett Field in the early 1980s due to cooling water runoff and a blocked drain, and by 1983 at least three pairs were nesting in this area. With the repair of the drain and a different treatment of the cooling water effluent, this area is no longer suitable for common moorhen and they are not present.

The moorhen's inflexibility in habitat needs is balanced by its adaptability in finding new habitats when and where they occur. In this sense, this species can respond successfully to carefully designed freshwater management programs. At the present time, within the bounds of the San Francisco estuary, almost every location used by this species has been constructed to serve the needs of local communities in one way or another. As a consequence, these habitats are not designed to benefit the common moorhen and, in almost none of these situations, do the agencies that oversee these habitats include within their management plans an oversight and stewardship responsibility for the moorhen. This lack of responsibility by local agencies is regrettable and in most cases where their actions discourage or destroy this species' local populations, alternate approaches can be en-

visioned that would enhance the local population without significantly impacting local agency goals. There are numerous opportunities, both through education and legal mandates, to improve the management of freshwater habitats in the San Francisco Bay Area to benefit this species.

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California Gull

Larus californicus

Thomas P. Ryan

Introduction

California gulls are a recent addition to the breeding avifauna of San Francisco Bay, drawn here by the availability of remote nesting grounds and rich food sources provided by the salt ponds and local refuse dumps. They have steadily increased in number since their first breeding attempt in 1980. Associated species which use simialar habitats are Forster's tern (*Sterna forsteri*), Caspian tern (*Sterna caspia*), black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), killdeer (*Charadrius vociferus*), and Wilson's phalarope (*Phalaropus tricolor*).

Description

California gulls attain adult plumage in their fourth year. The adult California gull has a white head, chest, and underparts. The mantle (upperwings) is grey, their mantle is darker than similar appearing ring-billed gulls and herring gulls (Garrett 1985). Their wing-tips are black, with white mirrors. In breeding plumage their legs are bright yellow-green, this fades during the winter. Their bill is yellow with black and red subterminal spots (gonys). Juvenile birds are very dark with mottled underparts, pale undertail coverts, and pink legs (Garrett 1985). First year birds are a lighter grey-brown mottled with white, and have dull pink legs. The rump is barred. Second and third year birds have increasingly white underparts and more grey on the mantle, and the bill may have a black ring around it (Garrett 1985). Adult California gulls can be told from western gulls, herring gulls, and glaucous-wing gulls by their smaller size and yellow-green leg color. They can be distinguished from ring-billed gulls by a darker mantle, yellow-green leg color, and black and red subterminal spots.



Breeding Biology - California gulls begin to return to their breeding colonies three to seven weeks prior to breeding (Winkler 1996). The nest is a scrape in the substrate with bones, feathers, and vegetation placed within the cup (Winkler 1996). Nests are sometimes used in subsequent breeding seasons (Winkler 1996). Two to three, and occasionally four eggs are laid at daily intervals approximately one week after nest building begins (Winkler 1996, Baicich and Harrison 1997). Larger clutches (four or more) may be the result of female-female pairs. Eggs are laid in early to mid-May. Eggs at a given colony are laid within 20 days of each other, later clutches are often second attempts (Vermeer 1970, Winkler 1983, Jones 1986). The incubation period lasts 23-27 days (Winkler 1996); Jones (1986) reported a mean of 26.6 days at South Bay colonies. Both parents incubate the eggs (Winkler 1996). Chicks hatch at South Bay colonies in late May to early June. Chicks stay in or near the nest for the first week, from nine to 20 days old they have been found to run as far as seven meters from the nest for cover (Winkler 1996). Most chicks abandon the nest area entirely at 40-60 days, and fledge by 48 days (Winkler 1996). There is little association between adults and juveniles after fledging (Winkler 1996). California gulls are long lived with high survivorship, banded adults of 27 and 30 years of age have been reported (Winkler 1996).

Migration Ecology - California gulls appear to move continuously throughout the fall, winter and spring (Winkler 1996). Younger birds are found farther south in the fall and farther north in the spring. Individuals on the West Coast move farther north after breeding, and are driven farther south as winter storms increase in number and intensity.

Wintering Ecology - California gulls winter from central California, south to Guerrero, Mexico (AOU 1983). In California, concentrations are found in the Central Valley and along the coast. Local populations are found as far north as British Columbia. Birds banded as chicks at San Francisco Bay colonies have been observed at Pismo Beach in San Luis County and at Doheney State Beach and Seal Beach in Orange County.

Distribution and Abundance

In North America, California gulls breed at inland lakes from the Great Basin northward to the Northwest Territories (Canada) and southward to Utah, east to the Dakotas. They winter in smaller numbers in Utah, in Nevada through the Colorado River Valley, and at the Salton Sea in California.

On the Pacific Coast, California gulls breed at inland lakes east of the Sierra-Cascade axis from British Columbia through central California and in San Francisco Bay. The largest breeding population in California is at Mono Lake, Mono County (Winkler 1996).

California gulls winter along the Pacific Coast from British Columbia to Mexico. They are also found in the Central Valley and at the Salton Sea in California. Small numbers are found in the Columbia River Valley of Washington and Oregon and Willamette Valley in Oregon (Winkler 1996).

Approximately 5,000 California gulls nested at six sites in southern San Francisco Bay in 1997 (**Table 7.3**). They breed in the hundreds at Alameda Naval Air Station; this colony has been active since 1992 (L. Collins, pers. comm.). There are no known active colonies in the North Bay. They roost in large numbers during the winter in mixed flocks on the levees and in the salt ponds in the South Bay.

Population Trends - In 1982, Conover (1983) estimated the United States population at 276,000 California gulls. The worldwide population of this species is likely between 500,000 and one million individuals (Winkler 1996). Winkler (1996) notes apparent declines across prairies south and east from Alberta. However, he notes that patchy distribution of this species makes it difficult to determine any actual trend. The overall population appears to be increasing since the turn of the century, although there is debate about the rate of increase (Winkler 1996). This increase has been attributed to an increase in farmlands, increased availability of nesting sites at reservoirs, decreased harvesting of feathers and eggs, and increased winter food availability, especially at refuse dumps (Conover 1983).

California gulls first nested in the San Francisco Estuary in 1980 when 12 nests were encountered at Pond A6, near Alviso in Santa Clara County. We believe this was the first time California gulls nested in a coastal region. This colony grew each year, peaking in 1994 with 4,363 nests. Between 1994 and 1997, nest counts at Pond A6 decreased 26% to 3,241 nests. Beginning in 1984, California gulls began breeding at other sites within the South Bay. At Newark, 22 nests were found in 1984, increasing to 277 in 1985; this site was abandoned in 1989. In 1984, 33 nests were found at Pond A9 near Alviso, 2.2 km from Pond A6. Low numbers of California gulls nested here from 1984 to 1990, except

in 1985 when 187 nests were found. In 1991, the colony was abandoned. It was re-established in 1992, but failed in 1994 and 1995. However, in 1996 and 1997 the colony increased to 702 and then to 878 nests. In 1990, a colony established on Pond A1. This colony grew to 86 nests in 1994, and currently has an estimated 40 nests. In 1992, a colony was established near Mowry Slough in Alameda County, 3.5 km from Pond A6. This site has been characterized by year-to-year fluctuations in nest numbers. In 1996, this colony moved to Pond M1/2, 1 km west of the original site. Red fox had been found at Pond M4/5 prior to this move. In 1993, California gulls nested on an attached levee and a series of small dredge spoil islands at Pond B2 near Mountain View, Santa Clara County, 2.4 km from Pond A6. Initially, colony size fluctuated, but increased from 1995 to 1997.

Currently approximately 10,000 California gulls nest in South Bay. California gulls are abundant in the San Francisco Bay in the winter, although no reliable estimates of wintering numbers exist (Harvey et al. 1992).

Habitat Use and Behavior

California gulls are opportunistic feeders, and their diet varies greatly at different locations. In 1983-84, Jones (1986) found the diet at colonies in the South Bay included arthropods (brine fly larvae, brine shrimp, insects, etc), garbage, and fish. California gulls are often seen foraging at garbage dumps, and at the edge of salt ponds on rafts of brine fly larvae and brine flies. They are also observed feeding in fields and schoolyards, presumably on insects and human refuse.

California gulls roost in mixed species flocks on salt pond levees, salt ponds, and schoolyards. There is a large daily movement from the local refuse dumps to the roosting areas on the levees and salt ponds.

Conservation and Management

California gulls are documented to abandon colonies following predation events, and observations of feral cats and red fox in close proximity to their nesting grounds. There have been partial and complete nesting failures at all sites that are attached or become land-bridged to the mainland early in the nesting season.

California gulls in the South Bay require remote, insular, abandoned levees and abandoned islands for nesting. The continued presence of such levees and islands will provide them with adequate nesting grounds. They require high saline salt ponds for their primary natural food source, brine fly larvae, brine flies, and brine shrimp. These are also food sources for many other species that use salt ponds.

The largest colony of California gulls is at the original point of colonization, Pond A6, where in recent years 3,000 to 4,600 pairs have nested annually. These levees

Table 7.3 California Gull Breeding Sites in the South Bay

Colony Site	Status	1997 Nest Count
Alameda NAS	Active	100+
Pond A1	Active	22
Pond B2	Active	328
Pond A6	Active	3,128
Pond A9/A10 levee	Active	878
Mowry M1/M2 levee	Active	620
Newark	Historic	0

should be maintained as nesting habitat for this species. If this colony is flooded as has been suggested, approximately 7,000 adult, breeding California gulls will be displaced. This could also negatively impact the tern populations in the South Bay. It is unknown exactly what the result would be of a major disruption of this colony. The possible consequences should be studied in greater depth before such an action is undertaken.

California gulls provide us with a robust subject to study the reproductive biology of a salt pond associated species. We are studying the effects of predation on species nesting on insular *versus* non-insular levees. We are studying the re-colonization of an area by a colonially nesting species after major predation events. At Pond B2, nesting occurs on a series of different sized islands, providing a natural experiment for studying the effects of island size and colony size on the reproductive success of larvae.

In the 1980s, thousands of chicks were banded by San Francisco Bay Bird Observatory. Currently, 20-25% of the adults at these colonies carry U.S. Fish and Wildlife Service bands, and 5-10% carry color bands identifying them to cohort. As these birds are long lived, they provide an excellent subject for studies of survival, population dynamics, fall and winter movements and ecology, and eventually senescence, in addition to other banding related studies.

Acknowledgments

I would like to thank the Peg Woodin, Mike Rigney, and the late Richard Mewaldt for their meticulous efforts in studying the South Bay colonies in their early years; Laura Collins for her information regarding the Alameda Naval Air Station colony; and the many dedicated volunteer observers of the San Francisco Bay Bird Observatory.

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Personal Communications

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Forster's Tern

Sterna forsteri

Thomas P. Ryan

Introduction

The Forster's tern is a mid-size tern found in open water, salt pond, marsh, and estuarine habitats within the San Francisco Estuary. It nests and roosts on dredge spoil islands and degraded, insular levees. Forster's terns forage in salt ponds, open bay, slough channels and marshes. Associated species which use similar habitats are California gull (*Larus californicus*), Bonaparte's gull (*Larus philadelphia*), Caspian tern (*Sterna caspia*), American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*), and killdeer (*Charadrius vociferus*).



Photo by T.A. Iliff

Marshall Iliff

Description

Forster's terns are a medium-sized tern. In breeding plumage, they have an all white body, a dark cap, black eyes, grey upperwings, orange bill with a black tip, and orange legs. Forster's terns are distinguished from other terns by size, a black cap and nape, deeply forked grey tail with white outer feathers, and uniformly light-colored upperwings (Peterson 1990). In August, they begin to molt into winter plumage: the black cap becomes a mask, with black coloration around and behind the eye. The crown becomes white, the nape varies from grey to black, and the bill turns from a bright orange color to a uniform black (Peterson 1990).

Forster's terns occur in freshwater and salt marshes, seacoast, estuaries, and inland rivers and lakes (AOU 1983). They feed on small fish and arthropods. The call is a harsh, nasal "za-a-ap" and a nasal "kyarr" (Peterson 1990)

Breeding Biology - Forster's terns nest alone and in colonies ranging in size between two and 600 birds. Their breeding season spans from April until August. They usually begin breeding in their second to third year. First year birds remain on their wintering grounds year-round. During courtship, the males pass fish to the females. The pair will remain together for the duration of the breeding season (Bent 1921). The nests are usually scrapes made in the dirt, with vegetation, small stones, sticks, and bones placed in the cup (Baicich and Harrison 1997, SFBBO unpubl. data). They are placed both in vegetation and on bare dirt. Birds at the South Bay colonies lay two to three eggs from mid-May to mid-June. Both parents incubate the eggs; incubation lasts 23 to 25 days (Baicich and Harrison 1997). Chicks begin to appear in mid-June. The young hatch in a semi-precocial state, and fledge at approximately 28 days (Baicich and Harrison 1997). Most young have fledged by the end of August.

Migration Ecology - During September and November, most Forster's terns begin their southward migration to spend the winter in locations from central California to Mexico, and possibly as far south as Costa Rica (Gill and Mewaldt 1979, AOU 1983). Of 2,943 Forster's tern young banded by Gill and Mewaldt (1979) at South Bay colonies, five were recovered during migration in the Los Angeles - San Diego area, and the sixth was recovered in Sinaloa, Mexico. It appears that their migration route follows the coastline of California; whether they cross Baja into the Sea of Cortez or move around the peninsula is unknown.

Wintering Ecology - It is unknown exactly where the San Francisco Bay population of Forster's terns spends the winter. Circumstantially, Forster's terns are common along the coast of western Mexico during the winter months (Arbib 1974, 1975, 1976). These sightings and the six band recoveries noted above led Gill and Mewaldt (1979) to state that, "nearly all Forster's

terns leave the San Francisco Bay area each winter and that most juveniles and adults winter from coastal southern California well down the west coast of Mexico." Their habits and ecology are poorly known on their wintering grounds.

Distribution and Abundance

In North America, Forster's terns breed in the interior of the continent from central British Columbia to central Ontario, and south from Oregon to northwest Indiana. Along the East Coast, they breed from southern New York to South Carolina, and along the Gulf Coast from Tamaulipas, Mexico to Alabama. They winter from the Virginia coast to Florida and western Texas south to Mexico, casual to Costa Rica (AOU 1983).

On the Pacific Coast, breeding occurs from the coast of British Columbia south to Baja California. They winter from central California south to Oaxaca and Guatemala, casual to Costa Rica (AOU 1983).

In the North Bay, nesting occurs in the Napa River Marsh salt ponds, but there are no recent population summaries available for all colonies (Carter et al. 1990). Colonies were documented during the Napa County Breeding Bird Atlas Project at Russ Island (1989), Island #2 at the Can Club Duck Club (1989, 1991), Little Isle (1991), Knight Island (1990), and White Slough (1987, 1988, 1989, 1992, 1996) (R. Leong, pers. comm.) (**Table 7.4**). From counts done at these sites in various years, it appears that the total number of nests at these colonies are in the low hundreds in any given year. These colonies should be surveyed more completely to determine their actual size.

In 1997, Forster's terns bred at 21 colonies in the South Bay; two colonies were not surveyed. Since 1992, they have bred at 28 sites. These sites extend from Belmont Slough south to Alviso on the western side of the Bay, and from Baumberg south to Alviso on the eastern side (**Table 7.5**). They breed on dredge spoil islands, and degraded levees in current or former salt ponds, slough channels (Belmont), and diked marshes (Ravenswood).

Small numbers are found locally throughout the winter (W. Bousman, CBC data). Numbers increase during the spring, as migrants begin to arrive in April

Table 7.4 Forster's Tern Breeding Sites in the North Bay

Colony Site	Status
Coburn	Unknown
Island #2	Unknown
Knight Island	Unknown
Little Isle	Unknown
Russ Island	Unknown
White Slough	Unknown

Colony Site	Status	Colony Site	Status
Dumbarton ponds		Alviso ponds	
N1 (01)	Active	A5	Historical
N3 (02-04)	Active	A6	Historical
Baumberg ponds		A7	Active
P6 (01)	Active	A8	Active
P14 (02)	Historical	A16	Active
P12 (03)	Active	A17	Not accessible in 1997
P11 (04)	Active	A18	Active
Coyote Hills ponds		A20	Not accessible in 1997
NA2 (02)	Active	Mountain View ponds	
Hayward Shoreline ponds		A1	Active
HARD	Active	A2	Historical
3A	Active	A3	Historical
3B	Active	B2	Active
Turk Island ponds		Charleston Slough	
4C (01)	Active	Bair Island ponds	Active
7 (02)	Active	Ravenswood	
		OSP ponds (R1)	Active
		Belmont Slough	Active

Table 7.5 Forster's Tern Breeding Sites in the South Bay

(Harvey et al. 1992). Migrants and local breeders are found here until late October through November (Harvey et al. 1992).

Population Trends - Currently there are no estimates available for either the total North American population or the total Pacific Coast population. The only population estimates available from other coastal colonies are from the Bolsa Chica Ecological Reserve, where a colony established in the late 1980s and has increased to over 200 pairs (C. Collins, pers. comm.).

Forster's terns first bred in the San Francisco Estuary in 1948, when roughly 100 nests were found near the eastern end of the San Mateo Bridge (Sibley 1952). Gill (1977) found 935 nesting pairs at six South Bay colonies in 1971; this would be 1,200 nesting pairs if colonies "found outside the study area" were to be included. In 1972, 10 colonies were present, containing an estimated 2,000 pairs (Mansfield *in* Gill 1977). Rigney and Rigney (1981) estimated 2,500 pairs at six sites in 1981. Woodin (1988) summarized San Francisco Bay Bird Observatory data from 1984 to 1988 and reported that counts ranged from 2,183 adults present in 1987 to 3,610 in 1984. In 1988-89, 3,550 breeding birds were estimated at 21 colonies for all Bay Area colonies (Carter et al. 1990). From 1992 to 1997, between 1,842 and 2,365 individuals were observed, and between 1,012 and 1,754 nests were counted at peak breeding season counts at all South Bay colonies. Data collected in 1993 were not used in these figures as surveys were not as thorough as in other years. A decrease from 1,754 nests to 1,012 nests was seen between 1992 and 1994, a 42% decline. The number of nests increased to 1,362 in 1997.

Historically, the largest nesting site was at Pond B2 near Mountain View, with approximately 600 nests. The

second largest site was at the Baumberg salt pond islands and the former Knapp Property, near Alviso (Rigney and Rigney 1981, Harvey et al. 1992). In 1997, the largest colony was at Turk Island (300 nests), followed by Hayward Shoreline (226 nests), and Pond B2 (127 nests).

California gulls have colonized both B2 and the Knapp property. At B2, California gulls have expanded from zero to 328 pairs from 1992 to 1997. At the Knapp property, California gulls increased in number from 2,750 pairs to 3,241 pairs between 1992 and 1997. Additionally, since 1992, red fox have been noted preying Forster's tern colonies in both areas.

Forster's tern populations steadily decreased between 1971 and 1997 (the time of this writing). Population estimates place the number of Forster's terns between 1,870 and 5,000 individuals (\bar{x} =3,623; SD =1,599) between 1971 and 1981; 2,183 and 3,610 (\bar{x} =2,707; SD =536) between 1984 and 1988; and 1,842 and 2,365 (\bar{x} =2,137; SD =202.9) between 1992 and 1997. Although the population of Forster's terns in San Francisco Bay decreased across these periods, the large year-to-year fluctuations in the local breeding population make it difficult to determine if any significant trend exists.

Habitat Use and Behavior

Forster's terns forage on the open bay, slough channels, freshwater and salt marshes, and on salt ponds. During the breeding season, they are generally observed foraging singly and in groups. They are occasionally observed foraging with pelicans, egrets, gulls, and other terns in large foraging flocks on certain salt ponds, particularly in the late summer and fall. Forster's terns roost prior to, during, and after breeding on the dredge-spoil islands and levees. They also have been observed on docks,

Archimedes' screws, duck blinds, pilings, algal mats, floating debris, and other suitable structures surrounded by water. During the breeding season Forster's terns move singly and in groups between their nesting sites within the salt ponds and the aforementioned foraging areas throughout the day. Nocturnal movements, if any, are unknown.

Conservation and Management

In the San Francisco Bay Area, feral red fox (*Vulpes vulpes*) and domestic cat (*Felis domesticus*) are known predators of active Forster's tern colonies (SFBBO unpubl. data). Predation by great egrets and other ardeids is likely; other possible avian predators include raven, peregrine falcon, northern harrier, and red-tailed hawk.

It is unknown what effects, if any, contaminants have on Forster's terns in the San Francisco Estuary. Ohlendorf et al. (1988) found measurable levels of mercury, DDE, organochlorines, and PCBs in the eggs of Forster's terns at Bair Island in 1982.

In a few cases, colonies have been abandoned in association with off season levee maintenance and fluctuating water levels within ponds. High water levels can flood islands. Low water levels can land-bridge islands, making them more susceptible to mammalian predation. Most colonies are in areas of restricted human access, and at these colonies, disturbance does not appear to be a significant problem.

The continued presence of isolated, insular islands is crucial to the continued presence of Forster's terns in the San Francisco Estuary. In all cases, colonies are found within or in close proximity to former and current salt ponds. This habitat provides suitable nesting substrate isolated from human disturbance and makes access more difficult for mammalian predators. We recommend the continuation of programs to control mammalian predators, as this will likely decrease the impact of predation on these colonies.

A schedule of levee maintenance that will minimize disturbance to breeding colonies should be implemented. We recommend initiation of a management program that will: 1) minimize work near colonies during the breeding season (April 1 to September 1); 2) maintain islands by placing fresh dredge material on colonies after the breeding season is over (September 1st); 3) minimize the impact to the population in a given area by disturbing as few colonies within a given pond system as possible within a given year; and 4) construct more islands within salt ponds when possible.

The status of North Bay colonies is unknown due to a lack of available surveys, but it is likely that these colonies are still active. It should be noted that when South Bay Caspian terns were predated and disturbed in the South Bay, they shifted their nesting activities to the Central Bay and North Bay. These North Bay colonies could increase in importance in the event of a natu-

ral or man-made disturbance at the South Bay colonies. Our recommendations are to maintain or increase local nesting and foraging habitats. These areas include salt ponds, levees and islands associated with salt ponds, lagoons, shallow bay/strait, and marsh.

Research Needs - The reasons behind the decline of the South Bay Forster's tern population requires further study. Possible causes of this decline include encroachment by California gulls, predation by red fox and feral cats, disturbance by levee maintenance, and fluctuating water levels within salt ponds. Continued population monitoring is needed to document future population trends. Studies of reproductive success and fledgling success would be valuable in documenting problems with the year-to-year reproductive effort. Combining these studies with studies of predation, the presence and effects of contaminants would be valuable in detecting causes of the current decline.

Studies of their natural history and ecology on their wintering grounds in southern California and the west coast of Mexico are needed as well. The general decline in the total number of individuals returning and year-to-year fluctuations in the total numbers of individuals present may indicate problems elsewhere.

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Caspian Tern

Sterna caspia

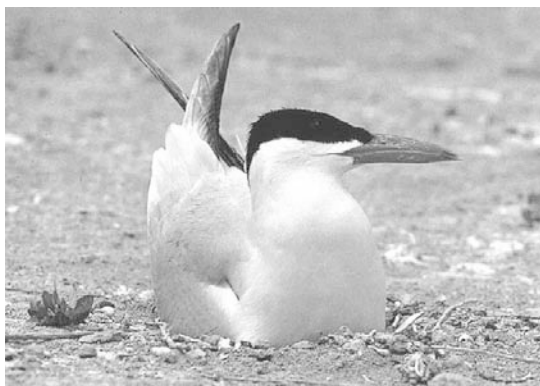
Thomas P. Ryan

Introduction

This large tern forages on the open bay, salt ponds, marshes, freshwater ponds, rivers, reservoirs, and in the open ocean near San Francisco Bay. They nest on sandy beaches and on salt pond levees and islands. The continental and Pacific Coast populations have both increased. However, declines have been seen at southern San Francisco Bay breeding colonies in recent years. Associated species include Forster's tern (*Sterna forsteri*), least tern (*Sterna antillarum*), and California gull (*Larus californicus*).

Description

The Caspian tern is the largest of the North American terns. The body and underwings are white, the under-



side of the tips of the primaries are black, the upperwings are a light silvery-grey, and the crown is black extending below the eye. The tail is shallowly forked. The bill is a deep red to orange-red with black on the tip. The legs are black in adults, and vary between orange, red, and black in the fall immature birds. Immature and winter plumage birds have white streaks in the cap (Peterson 1990).

The Caspian tern is a cosmopolitan species. They occur at lakes, bays, estuaries, marshes, and rivers, on all continents except Antarctica (AOU 1983). They forage by "plunge diving"—the bird hovers over the water before diving to or below the surface to catch their prey. They feed on fish, amphibians, and arthropods. Their call is a hoarse, low "kraa-uh or karr" (Peterson 1990).

Breeding Biology - Caspian terns breed on sandy beaches, dredge spoil levees, and islands. They are colonial, but will nest singularly (Baicich and Harrison 1997). They often nest with or near other larids. The nest is generally a hollow depression in the substrate, with plant and other debris placed in it (Baicich and Harrison 1997). In the San Francisco Bay Area, eggs are laid from May to July. They lay two to four eggs asynchronously at intervals of two to three days (Soikkeli 1973). Chicks hatch in June and July, and are present through August. The chicks are semi-precocial and move about the nesting colony after a few days; they fledge at 25-30 days (Baicich and Harrison 1997), but many stay near the colony as long as it is active.

Migration Ecology - Caspian terns which breed in San Francisco Bay migrate along the Pacific Coast to and from southern California and western Mexico (Gill and Mewaldt 1979).

Wintering Ecology - During the winter months, Caspian terns are found from central California, southward along the western coast of Mexico, to northern Colombia. Band recoveries indicate that Caspian terns that breed in the Bay Area winter along the west coast of Mexico, going as far south as southern Chiapas (Gill and Mewaldt 1979). Little is known about their winter ecology other than they are found at both coastal and inland sites (Gill and Mewaldt 1979). Christmas Bird Counts indicate that small numbers of Caspian terns winter locally throughout the Bay Area (W. Bousman, pers. comm.).

Distribution and Abundance

In the interior of North America, Caspian terns breed east of the Sierra-Cascade axis in the Great Basin from eastern Washington to California, and from Nevada through Utah to northwestern Wyoming (AOU 1983). In the Mid-West, they breed in northwestern Alberta, and central Saskatchewan east through the Great Lakes region south to North Dakota and central Michigan (AOU 1983). On the East Coast, they breed from Newfound-

land to South Carolina. They breed along the Gulf Coast from Texas to Florida (AOU 1983). Caspian terns winter from North Carolina south to Venezuela (AOU 1983).

On the Pacific Coast, Caspian terns breed from British Columbia, Canada south to islands off the coast to Sinaloa, Mexico. They winter from coastal central California to northern Colombia (AOU 1983).

The first breeding accounts in the San Francisco Bay Area are from the South Bay, where the majority of Caspian terns nested prior to 1990. Since 1990, the majority of birds nest at colonies in the Central Bay and North Bay. Former colonies in the South Bay exist at Baumberg, Turk Island, Bair Island, and Drawbridge/Mowry. Current colonies exist at Pond A7 near Alviso (104 pairs) and Coyote Hills (30 pairs). Single pairs have recently nested among Forster's terns at Ravenswood Open Space Preserve, and Hayward Shoreline.

The only North Bay breeding colony exists at Knight Island at the Napa River Marsh. This colony was first detected in 1989 (R. Leong, pers. comm.). In 1977, a small colony was detected at the Can Club, Island #2 (Gill 1977; R. Leong, pers. comm.).

In the Central Bay, colonies are found at Brooks Island and at the Alameda Naval Air Station (NAS).

Population Trends - The largest continental population of Caspian terns is found in North America, with a minimum of 35,000 pairs nesting throughout North America in the 1980s and 1990s (Cuthbert and Wires 1999). The North American population has steadily increased since at least the 1960s (Cuthbert and Wires 1999).

Prior to 1970, the largest reported breeding colony of Caspian terns on the Pacific Coast was in San Diego, California (Gill and Mewaldt 1983). In the early 1980s, the largest colony was at Gray's Harbor in Washington, where there were 2,157 pairs in 1981 (Gill and Mewaldt 1983). This colony was abandoned in the late 1980s, and relocated at nearby Rice Island, Oregon. Currently, the Rice Island colony is believed to be the largest breeding colony, with 8,000+ pairs (Cuthbert and Wires 1999). Other coastal colonies exist or have existed at Gray's Harbor and Willapa Bay, Washington; Columbia River, Oregon; Humboldt Bay, Elkhorn Slough National Estuarine Research Reserve, Salinas River Mouth, Bolsa Chica Ecological Preserve, Newport Back Bay Ecological Preserve, Salton Sea, and South San Diego Bay, California (Gill and Mewaldt 1983; Cuthbert and Wires 1999); and Laguna Figueroa (Palacios and Alfaro 1992), Scammon's Lagoon (Bancroft 1927), and Laguna San Ignacio (Danemann 1992), Mexico. Overall, the Pacific Coast population has shown an increase from at least 5,661 pairs estimated by Gill and Mewaldt (1983) to at least 12,263 pairs estimated by Cuthbert and Wires (1999). Most of this increase is accounted for in the Gray's Harbor/Rice Island colo-

nies where, roughly 2,300 pairs were estimated in the early 1980s (Gill and Mewaldt 1983), and over 8,000 pairs were estimated in 1996-97 (Cuthbert and Wires 1999).

In 1922, Caspian terns were first documented nesting in San Francisco Bay on a levee near the Dumbarton Bridge in the Coyote Hills salt ponds. This small colony of about seven nests increased over the next two decades, with a total of 287 nests in 1931 (DeGroot 1931), and 378 nests in 1943 (Miller 1943). This colony numbered approximately 299 pairs in 1966; however, because of levee maintenance between 1968-69, the colony was abandoned.

Several new colonies formed and disappeared in other regions of the Bay. A colony established itself in 1968 near the town of Drawbridge, adjacent to Mowry Slough, in Alameda County, which contained over 100 nests; 200 nests were counted in 1971 (Gill 1977). In 1968, colonies were also established at Baumberg and Turk Island. The Turk Island colony rose to 540 nests in 1985, but was abandoned in 1986, after levee maintenance in 1985 (SFBBO 1988). In 1971, a colony was discovered with 304 nests on a salt dike on outer Bair Island. This colony grew to between 500-600 nests by 1975 (Gill 1977) and 800-850 nests by 1981 (Rigney and Rigney 1981).

In the ensuing years, the activity and success at the outer Bair Island colony was erratic. After decreasing to 200 nests in 1983 and being abandoned in 1984 and 1985, the colony was reestablished and included 1,700 adults (850 pairs) by 1988. The colony was again abandoned in 1989 and then re-colonized in 1992 and 1993, but no young were produced. In recent years, both the Turk Island and outer Bair Island colonies have been deserted.

South Bay populations were estimated at 1,000-1,200 individuals in 1971 (Gill 1973) and 2,350 individuals in 1981 (Rigney and Rigney 1981). From 1984 to 1988 South Bay populations ranged from 1,120 to 2,111 adults (Woodin 1988), but in 1990 only 100 pairs were reported (Woodin *in* Harvey et al. 1992). A Bay Area-wide estimation of 2,818 individuals at five colonies in 1989-90 was made by Carter et al. (1990). In 1997, an estimated 1,400 to 1,500 pairs nested in the Bay Area, although only 136 pairs nested in the South Bay.

Nesting colonies have been growing in the Central Bay at Brooks Island and Alameda Naval Air Station (NAS), concurrent with the colony abandonments in the South Bay. The colony at Brooks Island began in the early 1980s, grew to 400 adults (200 nesting pairs) in 1990 (Carter et al. 1990), and had reached 500 nesting pairs in 1997. Six hundred pairs of Caspian terns were recorded at the Alameda NAS colony in the early 1990s (Harvey et al. 1992), and approximately 350 pairs nested there in 1977.

In addition to the colonies at Brooks Island and Alameda NAS, there are two other smaller colonies: one near Alviso with approximately 104 pairs, and one, a recently reoccupied (1997) historical colony at Coyote Hills, with approximately 30 pairs. The overall population of Caspian terns in the San Francisco Estuary has increased in the past 26 years. However, in part due to predation and levee maintenance, the population has decreased in the South Bay. **Table 7.6** shows some of the historic and existing colony locations around the Bay.

The only other nearby colonies are in Monterey County at Elkhorn Slough, which was active until 1995; and the Salinas River Mouth, which was abandoned in 1997 (J. Parkin, pers. comm.).

Habitat Use and Behavior

Caspian terns forage on the open bay, salt ponds, marshes, freshwater ponds, rivers and reservoirs, and at sea (Sibley 1952, SFBBO unpubl. data). They feed on small to medium sized fish, arthropods, and amphibians. In California, they have been reported to feed on fish and crayfish (Horn et al. 1996; Loeffler 1996; J. Parkin, pers. comm). Bent (1921) reported that they feed on shrimp, water mussels, and eggs and young of other birds. Ewins et al. (1994) added insects and larid eggshells from Caspian terns in the Great Lakes region.

Caspian terns roost on salt pond levees, sandy beaches, mudflats, and on islands in salt ponds, slough channels, marshes, and in the Bay. During the breeding season, the majority are observed roosting locally, near nesting colonies, although some are seen at local reservoirs (Almaden Lake Park, Los Gatos Creek Park, Calero Reservoir, Lexington Reservoir, Anderson Reservoir, Stevens Creek Reservoir) and along the outer coast. After breeding season, they disperse and roost in association with each other and with other larids at sites throughout the Bay. The post breeding season aggregations may be augmented by individuals dispersing from colonies elsewhere.

Table 7.6 Caspian Tern Breeding Sites in the San Francisco Bay

Colony	SiteStatus
Knight Island, Napa River Marsh	Active
Brooks Island	Active
Coyote Hills, west levee	Active
Baumberg	Historic
Turk Island	Historic
Drawbridge	Historic
Bair Island	Historic
Alviso, Pond A7	Active
Alviso, Pond A3	Historic
Hayward Shoreline	Active
Ravenswood OSP	Active

The majority of their foraging likely occurs in the Bay and surrounding marshes and salt ponds. However, Caspian terns are occasionally seen over urban areas carrying fish. Presumably, they are hunting in local reservoirs and ponds, bringing this prey to their nesting colonies in the South Bay (Cogswell 1977, SFBBO unpubl. data). A trout tag from a lake 16 miles away was found at a nesting colony in San Francisco Bay (Cogswell 1977). Additionally, local observers have noted small numbers of Caspian terns flying, perhaps daily, on north-south routes over the Santa Cruz Mountains to the Pacific Ocean. In 1987, 64 individuals were observed making such crossings, and 88 were observed in 1988 (W. Bousman, pers. comm.). After breeding, some adults and juveniles remain near the nesting areas, while others disperse within the Bay and beyond. Little is known about these post-breeding movements.

Conservation and Management

Caspian terns numbers have declined in recent years in the South Bay, in part due to predation, flooding, routine levee maintenance, and levee erosion. Routine levee maintenance is a threat to South Bay colonies because of the small number of larger colonies, and because of the tern's tendency to nest on levees rather than on dredge spoil islands. The colonies at Coyote Hills and Turk Island were deserted after levee maintenance. Alviso and Coyote Hills have been subject to flooding.

Their tendency to nest on attached levees also increases their exposure to predation. Predators have been observed to dig under and otherwise defeat barriers erected to protect nesting birds. The desertion of the Drawbridge/Mowry colony was associated with an increase in observations of predators, such as red fox and feral cats, in the area, with direct evidence of predation (SFBBO unpubl. data). At Bair Island, the colony was deserted following episodes of predation and erosion of levees leading to tidal inundation of the colony (SFBBO unpubl. data, Harvey et al. 1992).

Contaminants may also pose a threat to local Caspian tern populations. Ohlendorf et al. (1988) found high levels of DDE, mercury, and PCBs in the eggs of Caspian terns nesting at Bair Island. Additionally, the colony at Brooks Island may be exposed to contaminated prey from the Levin Richmond Terminal Superfund Site (Harvey et al. 1992). The impact of these contaminants on the reproductive success and populations of Caspian terns in the San Francisco Bay is unknown at this time. At Alameda NAS, the current plans for development and usage of the existing runways could adversely impact the nesting colony there.

Human disturbance is a potential threat at Brooks Island. It is important to restrict public access to the site prior to and during the breeding season, which spans from early April to the end of August. Other

colonies are in areas of restricted access where human disturbance is minimal, but they should be carefully monitored.

Caspian terns are known to re-occupy historical nesting areas many years after they have been abandoned, as was most recently demonstrated by the re-occupation of the Coyote Hills site. As predation is reduced and levees become suitable again after maintenance, Caspian terns may return to former nesting areas in the South Bay. Therefore, it is important to conserve and protect these areas even though there are no Caspian terns currently occupying them.

Research Needs - Colonies in the South Bay have declined from a mean of 1,626 individuals (SD=491) between 1971 and 1988, to 136 nests in 1997. Possible causes of this decline include predation by red fox and feral cats, disturbance by levee maintenance, flooding, and environmental contamination. Continued population monitoring is needed to document future population trends. Studies of reproductive success and fledgling success would be valuable in documenting problems with year-to-year reproduction. By combining these studies with studies of predation and the presence and effects of contaminants, we may better understand the causes of the current decline. Studies of nest site selection coupled with studies of reproductive success will provide information on which features of the habitat are most important to the reproductive success of these birds. This information can assist in lessening the impact of levee maintenance on the Caspian tern by allowing improved maintenance techniques with more rapid recovery of disturbed nesting areas.

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California Least Tern

Sterna antillarum browni

Leora Feeney

Introduction

The California least tern was first described from a specimen collected in San Diego County (Mearns 1916). It is currently one of three subspecies of least terns in the United States — *S. antillarum antillarum* is found on the East Coast (Lessons 1847), and *S. antillarum athalassos* is associated with the great interior river systems of the United States (Burleigh and Lowery 1942). The California least tern was listed as an endangered species by the Federal government in 1970 and by the State of California in 1971.



Tom Rountree

Description

The length of the least tern averages 23 cm. (9 in.), and its wingspan is about 51 cm (20 in.). The rump and upper tail of adults are a pale gray, concolorous with the back and upper wings. The outer primary feathers are black, creating narrow black outer wing edges. The tail is relatively short and forked. During the breeding season, the adult head is crowned in black, with a white triangular patch on the forehead. The bill is yellowish, and tipped in black. The short legs are a varying yellow-orange color. The basic plumage of some adults is sometimes observed in California late in the breeding season. These birds will have dark bills and legs. The definition of the black cap and triangular head patch is lost to a white face with sooty cap. It takes two to three years for least terns to mature. There sub-adult plumages are similar in complexity to other members of the gull group and are therefore not described here. It is impossible, for the most part, to separate least tern subspecies in the field, and races are usually identified by distribution.

The least tern bears a close physical resemblance to the little tern (*Sterna albifrons*), which is found seasonally along coastal waters of Great Britain, Europe, Africa, Asia, and Australia. During a period when combining or “lumping” species was a trend, the two accepted New World least terns, *S. antillarum antillarum* and *S. antillarum browni*, became subspecific (Hartert 1921) to the worldwide species. This was supported later (Peters 1934). Studies defining differences in morphology, behavior, and vocalizations (Massey 1976) provided the foundation needed to support the original separate specification, and in 1983, the American Ornithological Union split the American least tern from the more cosmopolitan little tern; the New World tern was once again *S. antillarum*. The least tern is slightly smaller than the little tern, making it the smallest member of the gull family, Laridae (Olsen and Larsson 1995).

Two other subspecies of least terns are in the literature, but are not found in the United States; *S. a. mexicana* is found along the east coast of the Gulf of California or the Sonoran coast (Van Rossem and Hachisuka 1937) and *S. a. staebleri* is found in southern Chiapas (Brodkorb 1940).

Breeding Biology - Least terns typically arrive at California breeding areas in middle or late April. Courtship is observed from the time birds arrive. Nesting is reported in “two waves,” the first from early May through early June, and the second from mid-June through early July. The species is a colonial nester, although single pairs are sometimes found.

Least tern nests are simple depressions in the substrate, called scrapes. One to three (usually two) eggs require about 21 days of incubation. The young are downy and able to walk soon after hatching. Least terns with adequate food resources fledged from about 17 to

21 days. Flight skills that allow young birds to follow their parents to foraging areas typically take longer (Laura Collins, pers. comm.). Both parents tend the young and share at some portion incubating, brooding, and feeding responsibilities. Young, well-fledged, least terns eventually leave breeding sites and disperse to localized post-breeding foraging areas where fish are plentiful and waters are calm. These post-breeding foraging areas, which offer young birds opportunities to develop foraging skills and provide all terns the food to build reserves for migration, are considered by some to be as important to the survival of juvenile terns as the nesting areas (Massey and Atwood 1984). Several post-breeding sites in the Bay Area are located at South Bay "intake" salt ponds. Shallow tidal areas are also used, such as at the E. B. Roemer Bird Sanctuary in Alameda and at Roberts Landing in San Leandro. California least terns most often finish breeding activities by late August and are usually absent from California breeding and post-breeding areas by late September.

Distribution and Abundance

The California least tern is migratory. Winter distribution is largely unknown, although least terns banded as chicks in California have been found as far south as southern Colima (Massey 1981) and Guatemala (Charles Collins, pers. comm.). Least terns have been found along the coast of Peru (Schulenberg et al. 1987), Panama (Vaucher 1988), and Costa Rica (Stiles and Skutch 1989, Barrantes and Pereira 1992), but these accounts do not specify *S. a. browni*. A better knowledge of winter locations and migratory routes for California least terns would greatly improve our understanding of this bird.

During the breeding season (spring and summer), California least terns are found nesting along the Pacific Coast as far north as Pittsburg, Contra Costa County, California (Collins 1988) and as far south as Bahia Magdalena (Palacios and Alfaro 1993). In addition, there are reports of *S. antillarum* nesting at the northern Gulf of California on the Colorado River delta (Palacios and Mellink 1994) and in northwestern Sonora on the Mexican mainland (Mellink and Palacios 1993), without reference to subspecies.

In the State of California, least terns nest annually at about 35 sites from San Diego County to Contra Costa County. Some colonies, though reported separately, are so close as to be considered related sites. For instance, the Mission Bay area in San Diego County has three small colonies. The breeding locations shift somewhat due to annual conditions; nearly 40 colony sites are monitored (Caffrey 1995a).

It was once thought by some that California least terns nested from the Mexican border north only as far as Monterey County (Wilbur 1974). However, records show the bird's presence further north in Santa Cruz

County from 1939 through 1954 (Wilbur 1974). Accounts of least tern numbers in California prior to 1970 are sketchy, however, colony numbers described as "abundant," in the "thousands," "good-sized," "1,000," "600 pairs," and "large numbers" were reported at numerous sites along California's coast at the turn of the century (as in Caffrey 1995b). By 1971, Craig (1971) reported less than 300 pairs over only 15 sites. Craig's work was limited and may have overlooked some sites. In 1973, Bender (1973) located 624 pairs statewide. After state and federal listings, recovery efforts and sometimes-intense management strategies were put into place. Recovery efforts succeeded. Surveys in recent years have indicated fluctuating numbers, but in 1995, approximately 2,536 pairs of least terns were estimated to have nested at about 35 California nesting locations (Caffrey 1995a).

Sightings in the San Francisco Bay Area date back to 1927. Curiously, the earliest Bay Area sighting was in the city of Alameda (Grinnell and Miller 1944), where the current largest northern California colony breeds, with over 200 pairs in 1996 (Laura Collins, pers. comm.). Although least terns, including groups with over 50 birds and juveniles, had been sighted in the Bay Area for decades (Allen 1933, Allen 1934, Chase and Paxton 1965), it was not until 1963 that nesting was confirmed at the Oakland Airport (Roemer 1963) and at another Alameda County location soon thereafter (Chandik and Baldrige 1967). These nest sightings caused some to speculate that breeding least terns had expanded their range. However, the fact that California least terns, including young, have been seen in the Bay Area since the 1920s could also support the contention that an infrequently seen population of the bird may have bred undetected here for decades.

At the present time, Alameda's least tern colony and two to three least tern pairs nesting at the Pittsburg Power Plant are the only known Bay Area nesting sites producing fledglings. In 1995, one to six pairs nested at the Oakland Airport, but all failed due to predation (Feeney 1996). In the past, least terns were documented to nest on Bair Island (CDFG 1981, Anderson 1970), and on various salt pond levees (CDFG 1981).

Although the history of the least tern in the San Francisco Bay Area is not clear, the Bay Area birds are today considered a critical population - vital to the statewide species recovery effort. In 1995, California Department of Fish and Game preliminary numbers showed that the Alameda Colony was the State's fourth largest producer of fledglings (CDFG, Unpubl. data).

There are currently large gaps between breeding colonies throughout the modern range of the California least tern, probably due primarily to disturbance and habitat loss. A particularly significant gap of 330 km (178 miles) occurs between the breeding Bay Area least terns and the nearest breeding colony to the south (Pismo Dunes) (Caffrey 1995b).

Habitat Use and Behavior

California least terns forage by hovering over shallow to deep waters and diving or, less often, dipping onto the surface of the water to catch prey. Least terns also make short skimming approaches onto pools of water left on mudflats during low tide to catch trapped prey items. Although California least terns have been known to consume a wide variety of fish species, they appear partial to northern anchovy (*Engraulis mordax*), and silversides (*Atherinidaesp.*) (Atwood and Kelly 1984, Collins 1985). To a much lesser extent there is evidence that least terns may take small invertebrates such as the water borne larvae of drone flies, *Eristalis tenax* (Laura Collins, pers. comm.; Leora Feeney, pers. obs.).

For nesting, least terns require tracts of open sand or fine gravel substrate with sparse vegetation. Loss of natural habitat has caused these birds to become opportunistic, using areas such as newly filled or graded lands and airports for nesting. Nesting areas must be located near open water, usually along coastal beaches and estuaries, and they must host adequate numbers of small elongate fishes to sustain adults and growing young.

Conservation and Management

Human development of least tern habitat, highway access to the coast, and summertime beach recreation have caused the destruction of breeding sites and resulted in least tern breeding failures. Although recovery efforts have brought about increased least tern numbers in California, some problems continue to challenge these efforts. It appears that for colonies to have guaranteed successes, they require intense management policies to protect nest sites, including regular monitoring of breeding activities, adequate barriers or supervision to restrict public access, persistent predator control, and vegetation management. These measures can be costly and funds are not always available for known breeding sites to be properly protected.

Predator management has become more difficult due to the recent introduction of red fox (*Vulpes vulpes*) on California's coast. Feral cats and the establishment of cat feeding stations in the State have added to least tern reproductive failures (Edwards 1919, Caffrey 1995b, Feeney 1996). Public support for feral animals has created additional problems with predator management programs. In recent years, there has been concern over reduced fish availability at some sites, which may be related to "El Niño" weather patterns or other phenomena (Caffrey 1995a).

To assure the future of a healthy least tern population in the San Francisco Bay Area, adequate habitat must be set aside and properly managed to support nesting and post-breeding foraging. These protected areas should be established at several locations around the Bay

to allow for alternative safe sites during potential localized habitat crises.

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Western Burrowing Owl

Athene (Speotyto) cunicularia hypugaea

Lynne A. Trulio

Introduction

The western burrowing owl is a small, semi-fossorial bird of prairie and grassland habitats. It is the only owl that routinely lives and nests underground. Burrowing owls in the western United States rarely dig their own burrows, but take over burrows dug by ground squirrels (*Spermophilus* spp.), prairie dogs (*Cynomys* spp.), badgers (*Taxida taxidus*) or other burrow digging species (Zarn 1974). The western subspecies of the burrowing owl lives west of the Mississippi to the Pacific Coast and from southern Canada into northern Mexico.

The species was listed by the California Department of Fish and Game as a Species of Special Concern in 1979. In November 1994, the U. S. Fish and Wildlife Service listed the species as a federal Category 2 Candidate for listing as endangered or threatened. The revised and shortened candidate species list in the February 28, 1996 Federal Register does not include the burrowing owl. In California, owl numbers have declined 50-60% in the last 10 years.



Joe DiDonato, bioQuest

Description

The burrowing owl is a small, brown and white mottled owl, approximately 230-280 mm (9-11 inches) tall. It is not easily confused with any other owl due to its semi-fossorial nature. Males and females are often difficult to distinguish in the field and, unlike many other raptors, the male is slightly larger than the female. Adults weigh an average of 150g (Zarn 1974). Chicks less than three months of age are distinguished from adults by their completely buffy breast and white collar. Chicks often emerge from the burrow weighing approximately one-half to two-thirds adult weight, and they reach adult weight within a month of emergence (S. Neudecker, pers. comm.; Trulio, pers. obs.).

Western burrowing owls are migratory throughout much of their U. S. range and leave their breeding grounds in the fall. Owls often return to the same or nearby burrows the next spring. This site fidelity is well documented (Martin 1973, Green 1983). In most parts of its range in central and southern California, the owl is a year-round resident.

Breeding Biology - Burrowing owls are primarily monogamous for the nesting season. They produce one clutch per year, but may lay a second clutch if the first is lost. Burrowing owls lay between two to eleven eggs (average four to six) in a chamber of the nest burrow. Eggs are laid between March and May depending upon location. The female incubates the eggs for approximately 26 to 29 days (S. Neudecker, pers. comm.; Zarn 1974). After the chicks hatch, they remain in the burrow for approximately three weeks. Just before or just after they emerge, chicks lose their natal down and gain juvenile plumage. An average of two to four chicks emerge, although clutches of six or eight are not uncommon. Generally, an average of two to four chicks survive to fledging (age at which they can fly), which occurs about one month post-emergence. Fledglings remain with their parents until fall and then disperse. They molt by this time and gain their adult plumage. Some young remain with their parents through their first winter (P. Delevoryas, pers. comm.).

Demographic parameters and their relationship to populations are not well known. Thomsen (1971) found a juvenile survival rate of 0.3 and an adult survivorship of 0.81 based on two years of study at the Oakland Airport, Alameda County. The longevity of free-living owls has not been documented, although an average of five years is informally used (Priest, pers. comm.). Fecundity is better known. Thomsen found an average of 3.9 chicks survived to fledging. At Moffett Field, Santa Clara County, Trulio (1994) found an average fledging success of 2.6 chicks per reproductive pair (SD=1.4) and an average of 1.8 chicks per pair (SD=1.7). An average of 73% of pairs produced emergent chicks. This level of fledging success is the second lowest reported in the literature.

Food and Feeding - During the day, owls may be visible at their burrows, but tend to do little hunting. They become active at dusk and do most of their feeding at night (Haug and Oliphant 1990). They use multiple feeding strategies, including running along the ground, but most often they can be seen hovering over fields and diving at prey. Haug and Oliphant (1990) found burrowing owls at their site in Canada had an average home range size of 2.4 sq. km, and owls confined 95% of their movements to within 600 m of their nest burrows.

Burrowing owls are mid-level carnivores preying primarily on large insects and small rodents, but they will take a wide variety of prey. Many studies have found that important food items include vole species (*Lagurus* spp., *Microtus* spp.), mice (*Peromyscus* spp., *Mus* spp., *Reithrodontomys* spp., *Zapus* spp.), pocket mice (*Perognathus* spp.), pocket gophers (*Tomomys* spp.), and young ground squirrels (*Spermophilus* spp.), as well as a wide array of beetles, grasshoppers, crickets, reptiles, amphibians, small birds, fish, and crustaceans (Zarn 1974). They forage in ruderal, manicured, or natural grasslands. Burrowing owl predators include the great horned owl, harrier, and the red fox.

Distribution and Abundance

Burrowing owls inhabit flat, dry, open grasslands in prairie and arid habitats throughout California, exclusive of the humid, northwest coastal areas and the forested and shrub-covered mountains. Burrowing owls are most abundant in wide, low, interior valley bottoms and in flat coastal lowlands (Grinnell and Miller 1944). DeSante and Ruhlen (1995) found that fully 92% of the breeding owls occurred in such lowland areas, generally below 60 to 300 meters in elevation.

Once a widely distributed and relatively common grassland bird, the burrowing owl has been declining significantly in California for at least the last 40 years (Grinnell and Miller 1944). At least 50% of the population has been lost in the last 10 years. DeSante and Ruhlen (1995) estimate that approximately 9,450 pairs of birds remain in the State. Over 71% of these pairs live in the Imperial Valley, an area subject to rapid human population growth and development in the near future (DeSante and Ruhlen 1995). In the San Francisco Bay Area, nearly all the owls, approximately 170 pairs, are found in the South and East Bay between Palo Alto and the Fremont-Newark area.

Researchers have noted burrowing owl declines, especially since the 1950s (Zarn 1974, Arbib 1979, James and Ethier 1989), although there was little quantitative data to support this impression until just recently. The Institute for Bird Populations completed an extensive, cooperative three-year study (1991-1993) of the burrowing owl population in California, exclusive of the Great

Basin and desert areas (DeSante and Ruhlen 1995; DeSante et al., *in press*). Overall, in the entire census area, nearly 60% of the breeding groups of owls known to have existed during the 1980s had disappeared by the early 1990s (DeSante and Ruhlen 1995).

The species has disappeared as a breeding bird from substantial portions of its former range. DeSante and Ruhlen (1995) showed that the burrowing owl apparently has been extirpated as a breeding species within the last 10 to 15 years from Marin, San Francisco, Santa Cruz, Napa, coastal San Luis Obispo, and Ventura counties, as well as from the Coachella Valley. It has been very nearly extirpated from Sonoma, Santa Barbara, Orange, coastal Monterey, and San Mateo counties. Perhaps only one to two breeding pairs still exist in most of these counties.

The basic threat to burrowing owls in California is the annual, methodical loss of breeding and foraging habitat to development by humans. Habitat loss to urban development and destruction of ground squirrels (DeSante and Ruhlen 1995, Trulio 1995) are two primary reasons for the decline. Other factors include soil disturbances such as disking, grading, and blading, vehicular strikes, and predation by non-native or feral species. In agricultural areas, where the majority of owls live, chemical spraying may be contributing to population declines.

Habitat Use and Behavior

Historically, owls were found in natural areas of open prairies or open shrub-steppe habitat (Butts 1971, Coulombe 1971). Human population growth and continuous land use changes have resulted in burrowing owls utilizing human-altered habitats ranging from agricultural irrigation ditches (Coulombe 1971) to urban habitats (Collins and Landry 1977, Trulio 1995, Thomson 1971). Burrowing owls have become quite tolerant of human presence, as long as suitable nesting and foraging habitat exist. Florida burrowing owls (*S. c. floridiana*) readily use suburban areas up to a density of approximately 60% development; when development densities exceed 60%, owl numbers drop (Wesemann and Rowe 1987).

Good burrowing owl habitat is open, dry, and sparsely vegetated with available burrows (Zarn 1974). However, several other subtle characteristics make some burrows more suitable than others. These characteristics include percent vegetative cover, height of vegetation surrounding the burrow, the presence of colonial fossorial mammals, soil texture, and presence of perches for horizontal visibility.

The California Department of Fish and Game's "Wildlife Habitat Relationships System" database lists 18 major habitat types that support burrowing owls. In most of these habitats, burrowing owls are generally found in open country, where tree or shrub canopies

cover less than 30% of the habitat. Typical habitats include annual and perennial grasslands, open agricultural areas, deserts, and vacant lots.

Burrowing owls are able to adapt to some human-altered landscapes. The land uses of sites where owls live include dry open grassland, the perimeters of agricultural fields, irrigation ditches, fallow agricultural fields, open fields prepared for development, airports, golf courses, military bases, and parks.

These owls can be found adjacent to the San Francisco Bay on levees next to salt ponds, open unmanicured grasslands, or manicured fields near the Bay's edge where ground squirrel numbers and foraging area are adequate. These birds are primarily terrestrial predators and in these locations still focus on mice and insects. However, they are opportunistic and will eat species associated with wetlands, including amphibians and crustaceans (L. Yuen, pers. comm.).

Conservation and Management

Increasing burrowing owl numbers will require adding more nesting and foraging habitat. Burrowing owls are an indicator of the marsh-upland edge of the San Francisco Bay. Within the structure of the San Francisco Estuary Goals Project, burrowing owl habitat may be increased by adding upland transition zones between the high marsh and lands converted to human use. These zones should include short grass habitat capable of supporting a healthy population of ground squirrels. Trees should be kept to a minimum.

Increasing habitat for burrowing owls should also provide upland refugia for marsh species that must escape high tides, such as salt marsh harvest mice, as well as black and clapper rails. Since burrowing owls are predators and since this habitat will also benefit marsh hawks, adequate cover for mice and rails must be provided.

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Salt Marsh Common Yellowthroat

Geothlypis trichas sinuosa

Scott Terrill

Introduction

The common yellowthroat (*Geothlypis trichas* spp.) is a small, insectivorous warbler common in most of North America. Twelve subspecies of common yellowthroat have been recognized in the United States (AOU 1957), however, yellowthroat taxonomy remains complicated and there is room for further work (e.g., see Howell and Webb 1995). Grinnell and Miller (1944) listed three yellowthroat subspecies that breed in California: the “western yellow-throat” (*G. t. occidentalis*), the “tule yellow-throat” (*G. t. scirpicola*), and the “San Francisco yellowthroat” (*G. t. sinuosa*), currently known as the salt marsh common yellowthroat. Based on Grinnell and Miller (1944), *occidentalis* is the most widespread and breeds over much of California (excluding the higher Sierra Nevada Mountains). The breeding distribution of *occidentalis* surrounds the breeding distribution of *sinuosa*, which is restricted to San Francisco Bay wetlands and adjacent riparian areas. However, the American Ornithologists’ Union (AOU) considers *occidentalis* as restricted to central eastern California and considers the subspecies that surrounds *sinuosa* as *G. t. arizela*. Thus, the AOU considers four subspecies to breed in California. The breeding range of *scirpicola* comprises the western portion of southern California and the Imperial and Lower Colorado River valleys. *Arizela* and *occidentalis* occur in the Bay Area in winter (Evens et al. 1997).

The salt marsh common yellowthroat was first identified as a distinct subspecies by Grinnell (1901). He described this subspecies as being darker dorsally and

laterally and smaller than the other two subspecies of yellowthroats found in the State. Mewaldt and Rigney attempted to repeat Grinnell’s results and were unable to do so with respect to coloration (Rigney, pers. comm.), however, size (specifically wing chord) did appear to hold up, and thus small size may be the primary characteristic for distinguishing this taxon (Rigney, pers. comm.). Foster (1977a,b) compared specimens of all three subspecies and found wing length difference to be significant at the 95% confidence level. Raby (1992) found that 81% of *sinuosa* and *arizela* populations were distinguishable from one another by song. Marshall and Detric (1994) indicated that *sinuosa* can be distinguished by dark coloration and small size. These authors found that birds in prealternate molt (July through September) can be distinguished by the darker coloration of the emerging feathering on the back and flanks relative to pale “*occidentalis* (often called *arizela*.” Raby (1992) found that the Grizzly Island population represented a zone of intergradation between *sinuosa* and *arizela*, and more work is needed to clarify the taxonomic situation in Suisun Bay.

Associated species that use similar habitats include the marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), and the salt marsh song sparrows (*Melospiza melodia samuelis*, *M. m. pusillula*, *M. m. maxillaris*).

Description

The name “salt marsh common yellowthroat” is somewhat of a misnomer, since *sinuosa* occurs in salt marsh only in winter (Foster 1977a,b). Rather, this subspecies breeds in fresh and brackish marsh associated with and close to Bay wetlands. Thus, this taxon has also been referred to as San Francisco yellowthroat (Ray 1916, Schussler 1918, Sibley 1952).

Breeding Biology - Male salt marsh common yellowthroats begin establishing territories by mid-March and the nesting season extends from early March through late July (Hobson et al. 1986). Females construct the nest relatively close to the substrate (ground or water). Yellowthroats lay three to five eggs, which are incubated for 12 days. The young remain in the nest for 10 days and are fed by both parents for at least two weeks following fledging (Hobson et al. 1986).

Food and Feeding - Yellowthroats are primarily insectivorous and glean insects on or near the ground (to about five or six feet above the ground or water) from low herbaceous vegetation, bushes, and small trees, or from the surface of mud — although they will forage substantially higher during the non-reproductive period (Shuford 1993). Yellowthroats in California eat 99.8% animal matter (Shuford 1993). The main dietary items in a sample of 114 were ants, wild bees and wasps, true bugs, beetles, caterpillars and moths, flies, grasshoppers, and spiders.



Les Chibana

Predators - There is little direct information on predators of salt marsh common yellowthroats. However, likely predators include species that typically prey on passerines, including feral cats, raccoons and red foxes (eggs and nestlings) and raptors such as Cooper's and sharp-shinned hawks.

Distribution and Abundance

Salt marsh common yellowthroats have been collected in San Luis Obispo, Los Angeles, and San Diego counties (Grinnell and Miller 1944). Sibley (1952) referred to *sinuosa* as a resident species, although the collection of specimens outside the breeding range indicates at least a migratory element to the population. It should be added that there is an influx of other races of common yellowthroats into the San Francisco Bay Area during migration and in winter. The relative numbers of "western" common yellowthroats and salt marsh common yellowthroats in Bay wetlands at this time of year is entirely unknown. I assume that some specimens of *sinuosa* were collected from salt marshes during winter and that these specimens provided the basis for the statement that salt marshes provide wintering habitat for salt marsh common yellowthroats (Foster 1977a,b). However, Foster (1977) stated that it seemed *likely* that the birds that winter in *Salicornia* marshes of San Francisco and San Pablo bays breed in adjacent brackish marshes, and Hobson et al. (1986) indicated that some populations (of *sinuosa*) moved from fresh and brackish marshes to the outer margins of the Bay to areas dominated by *Salicornia* or *Spartina*. Because other races could be occurring in salt marshes during the nonbreeding period, and because specimens of migrant *sinuosa* have been collected outside the breeding range, specimen (or individuals captured in mist nests and measured) evidence would be necessary to document this habitat shift in *sinuosa*.

Foster (1977a,b) found populations to be at critically low numbers in the South Bay and Peninsula areas and greatly reduced from historic abundance throughout the breeding range. During the 1975-76 season, Foster identified breeding habitat at Olema Marsh, Limantour Estero, San Pablo Bay, Napa Marsh, Lake Merced, Sharp Park, Searsville Lake, Palo Alto Marsh, "Alviso" Marshes (including the San Francisco Bay National Wildlife Refuge in the vicinity of Artesian Slough), Coyote Hills Regional Park, Alameda Creek, San Gregorio Creek, and Pescadero Marsh. Foster (1977b) estimated that 200 pairs were present in all areas occupied in the 1976 breeding season. This estimate increased to 230 pairs the following year with more thorough coverage. However, 1976 and 1977 were severe drought years with significant impact on marsh vegetation, and it was recognized that Foster's yellowthroat status reports during those years might not have been representative of normal conditions. This assumption was supported by

surveys conducted in 1985 in which breeding populations of salt marsh common yellowthroat in many areas were higher than in 1977 (Hobson et al. 1986). Foster (1977b) assumed the density of yellowthroats in suitable habitat was the same before alteration of marsh areas began, and estimated that the population under pristine conditions was probably on the order of 2,000 to 2,300 pairs (but see below for more recent, higher estimates). Finally, Foster (1977b) calculated that the population of salt marsh common yellowthroats had been reduced by 80 to 95% in the past 100 years based on calculated loss of suitable habitat. Hobson et al. (1986) estimated that fewer than 900 breeding birds occurred in all habitats.

The estimates of both Foster (1977b) and Hobson et al. (1986) may have been low. In a very recent study (Evens et al. 1997), 239 pairs were estimated to breed at Point Reyes alone. An earlier study (Hobson et al. 1986) estimated 135 pairs from the Point Reyes Peninsula. Evens et al. (1997) attributed the increase in estimated population size to increased coverage, increased habitat values due to changing land-use practices, and to more favorable weather patterns in 1996 relative to 1986. The most recent estimate on population size in tidal marsh alone, presented in Nur et al. (1997), was 6,000 to 11,000 breeding birds.

No salt marsh common yellowthroats have been collected during the breeding season outside the range described by Grinnell and Miller (1944), which is bounded by Tomales Bay on the north, Carquinez Strait on the east, and Santa Cruz County on the south (Foster 1977a,b). Within this range, all specimens collected between March and August were *sinuosa* (Foster 1977a,b). Sibley (1952, p. v), evidently, erroneously distinguished between common yellowthroats breeding in South Bay freshwater marshes as "yellowthroats," and yellowthroats breeding in salt marshes around the shores of San Francisco Bay as "race *sinuosa*." There does not appear to be any substantiation that any race other than *sinuosa* breeds in South Bay marshes.

Habitat Use and Behavior

Common yellowthroats form a complex of superspecies and subspecies that inhabit North and Central American dense, brushy habitats, generally associated with wetlands or moist areas. In California, yellowthroats are found in freshwater marshes, coastal swales, swampy riparian thickets, brackish marshes, salt marshes, and the edges of disturbed weed fields and grasslands that border soggy habitats (Shuford 1993). In the San Francisco Bay region as a whole, about 60% breed in brackish marsh, 20% in riparian woodland/swamp, 10% in freshwater marsh, 5% in salt marsh, and 5% in upland vegetation (Hobson et al. 1986, Shuford 1993).

Yellowthroats frequently use borders between these various plant communities, and territories often straddle

the interface of riparian corridors and ecotones between freshwater or tidal marsh and the upland vegetation of weedy fields or grassland (Shuford 1993).

Breeding habitat has been divided into three main categories (Foster 1977a,b): (1) woody swamp (e.g., Olema Marsh, Searsville Lake, etc.); (2) brackish marsh (e.g., Napa Marsh); and (3) freshwater marsh (e.g., Coyote Hills Regional Park). Nests are well concealed and are primarily found on or near the ground in grass tussocks, low herbaceous vegetation, cattails, tules, and bushes to approximately five feet above the ground (Kendeigh 1945, Gross 1953, Stewart 1953, Shuford 1993). Breeding generally starts in mid-March to April, and second clutches take the breeding season into August (Foster 1977b).

Conservation and Management

Foster (1977b) attributed an estimated salt marsh common yellowthroat population decline of 80-95% over the past 100 years to increasing urbanization of the Bay Area and consequential loss of habitat.

Based on Foster (1977a), California Department of Fish and Game (Fish and Game) staff recommended that suitable salt marsh common yellowthroat habitat be maintained and protected in parks and refuges. Other specific recommendations included the preparation of a management plan for Olema Marsh and Limantour Estero, development of fresh and brackish water marsh areas in a portion of New Chicago Marsh, protection and enhancement of habitat in Coyote Hills Regional Park, and incorporation of salt marsh common yellowthroat habitat protection into management of Napa Marsh and Skaggs Island Naval Base. The staff report also recommended that planning agencies in Marin, San Francisco, San Mateo, Santa Clara, and Alameda counties, as well as other agencies and entities that manage or otherwise influence yellowthroat breeding habitats, be advised of yellowthroat breeding habitats in their respective counties and be encouraged to assist in efforts to preserve and enhance these areas. Fish and Game staff concluded that further study should be conducted to determine the location, quality, and extent of salt marsh common yellowthroat wintering grounds; seasonal movement patterns; minimum size of marsh habitat that will support breeding birds; and relative productivity of the various marsh habitat types used by breeding yellowthroats.

Foster (1977b) made the following additional management recommendations:

- Purchase (by county, state, or federal agencies) unprotected breeding sites.
- Protect any area that includes yellowthroat breeding habitat from diking, draining, or removal of vegetation. Protection should be extended to include a buffer zone around the actual occupied area.

- Encourage water treatment plant operations that allow treated discharge to flow into the Bay at places where it will support marsh vegetation, rather than discharging it in the deeper parts of the Bay by means of pipes.
- Encourage parks and other agencies that have yellowthroat breeding habitat in their jurisdiction to ensure the water supply to these areas, by artificial flooding if necessary. Foster (1977a) noted that the yellowthroat habitat least affected by a drought (1975-76) was habitat in which water levels were artificially maintained. Such areas included Coyote Hills Regional Park and outfalls of sewage treatment plants.

Research by Hobson et al. (1986) concluded that continued loss of habitat (due primarily to development), poor habitat management, and drought or flood could seriously affect the future of this subspecies. They recommended further study involving systematic banding, recovery, and resighting; a study of dispersal corridors, buffer zones, and nonreproductive season habitat requirements; and more taxonomic work on the Suisun Bay population to determine the eastern boundary of *sinuosa*.

More recently, Nur et al. (1977) recommend extensive surveys of salt marsh common yellowthroats to derive reliable estimates of population densities in a diversity of potential habitats. Nur et al. (1977) also recommend a molecular genetic analysis to clarify the genetic relationship of this "taxon."

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Savannah Sparrow

Passerculus sandwichensis

Howard L. Cogswell

Introduction

The savannah sparrow is a small (12-15 cm), inconspicuous, and unobtrusive bird whose usual perch is a weed stalk in a meadow and seldom anything higher than a fence post. Although this bird bears some resemblance to the song sparrow, it is grayer and smaller than its cousin, and its tail is shorter and slightly notched, that of the song sparrow being somewhat rounded. Adults have a dark brown crown with a distinctive pale yellow mark in front of the eye. The savannah sparrow's song is a weak, buzzy trill, preceded by two introductory notes of differing pitches.

Some 17 subspecies of savannah sparrow are currently recognized (Wheelwright and Rising 1993), all of the northern ones being migratory. The southernmost subspecies in the west are all resident or nearly so, including *P. s. beldingi* of the salt marshes from Morro Bay, California, south into northwestern Baja. That subspecies, now officially listed as threatened, occupies a very similar habitat within its range as do the three salt marsh races of the song sparrow in the San Francisco Bay Region (see report on song sparrows, this publication). The "Coast" subspecies of the savannah sparrow, *P. s. alaudinus*, breeds from Humboldt County south to San Luis Obispo County where it intergrades with *beldingi* at Morro Bay. Through much of its range, *alaudinus* occupies some salt marsh areas, but also the more moist sorts of grasslands of the Coast Ranges. Unlike the very



Don DesJardin

dark *beldingi*, which is easily distinguishable in the field from other races, that winter in its range, birds of the *alaudinus* subspecies (which includes the former *P. s. bryanti* of narrower range) are not readily told from those other races except by close comparison and often measurements in hand. So data on relative numbers of birds of the different wintering subspecies within our area of interest are nearly non-existent.

Description

The 28-page account for savannah sparrow in the new "Birds of North America" series (Wheelwright and Rising 1993) should be a primary source for anyone investigating this species. It includes some information about the various subspecies, particularly the "well-marked" ones of southern California and west Mexico, as well as the pale *P. s. princeps* that breeds on one island off Nova Scotia. The account includes distinguishing characteristics, distribution, migration, habitat (but this lacks any quantification - see below), food habits, sounds, behavior, breeding (including development of young, parental care, etc.), demography and populations, conservation and management, appearance (including molts and geographic variation), and measurements. A few items about the species of special interest for resource managers, as gleaned from this account, seem worth mentioning here.

Male savannah sparrows defend territories (announced by song from frequently used perches), which usually include or may be adjusted to include the much smaller territory defended by nesting females. Polygyny has been noted in a number of populations in good habitat (thus, a census of just singing males may under-report the size of a breeding population). Nests are normally on the ground, well hidden under tussocks of grass or low shrubs and often with an approach tunnel of up to several inches.

From studies in eastern Canada and eastern United States to the Great Lakes area, annual survivorship of adults ranges from 28 to 70%, varying both by location and by years. As with most small birds, mortality in the first year is high, but once a savannah sparrow is a year old the rate remains relatively constant for five to six years, after which it rises abruptly. So an expected maximum life span would be about that number of years.

Although the population dynamics of *beldingi* and *alaudinus* seem not to be reported in the literature, studies from other areas may provide some insight. According to the reference by Wheelwright and Rising (1993), young birds from island populations (especially *princeps*) show a much higher natal philopatry (tendency to return to the area where they were hatched/raised) than do the young from mainland areas. The mere fact that *beldingi* is so strongly differentiated in its markings while *alaudinus* is not, would indicate a similar relationship between these races in California.

During the breeding season, savannah sparrows feed primarily on insects of various orders and all stages of development, spiders, and small crustaceans. In the non-breeding period, the diet is predominantly small seeds and fruits gleaned from the ground or low vegetation - the shift occurring as the young sparrows are fledged in mid-summer. Even when breeding, these sparrows do considerable amounts of foraging off their territory. In the non-breeding period, they may appear to be gregarious, but the "flocks" are probably primarily aggregations drawn together by attraction to a good food supply and have no ongoing social structure.

Predators that take savannah sparrows or their eggs and young are extremely varied; an instance of a clapper rail doing so is cited.

Effects of human activity on savannah sparrow populations have probably been beneficial, over-all, due to extensive clearing of forests and maintenance of agriculture and grazing lands. Pesticides applied to habitats occupied by the species are probably detrimental, but this seems not to have been documented. (These authors do not mention filling or draining of wetlands as a factor - perhaps because of the northeastern emphasis in the research that has been carried out on the species.)

Distribution and Abundance

Savannah sparrows are found nearly continent-wide at the appropriate season, wintering commonly from northern California, Missouri, and New Jersey south to Central America, and irregularly or sparsely as far north as New England and coastal British Columbia. The overall breeding range extends from Arctic shores of Alaska and Canada, south to northern Georgia and Illinois to Colorado, northeastern Arizona, and through California west of the southern deserts, with additional populations in western Baja California, Mexico and on the Mexican tableland.

In various parts of its range, the savannah sparrow is found occupying open, mostly un-wooded habitats of many sorts - from arctic tundra and mountain meadows to hayfields (particularly old or unkempt ones) to cultivated croplands, wet (but not flooded) meadows, marsh borders, and near-desert grasslands in some locations. Wintering savannah sparrows of various subspecies are also to be found in any such open habitat in the Bay Area (more on non-breeding numbers, below). However, the habitats selected by the breeding form, *alaudinus*, were summarized by Johnston (1968) as follows. "It maintains populations in two main types of habitat in coastal California: the *Salicornia* association of tidal marshes and the grassland associations of the coastal fog belt." Comparing its habitat niche with that of the salt marsh races of the song sparrow, he also wrote that the savannah "on salt marshes is limited to the broad expanses of low-lying *salicornia* (*Salicornia ambigua*) on

the older and higher parts of marshes... [that] lie back of that salt marsh vegetation (cordgrass, *Spartina foliosa*) best suited to frequent submergence by tidal flooding” (Johnston 1968). Eight nests were found in 1971 by Gill (1977) in his survey of breeding birds around the Bay south of San Mateo Bridge, the preferred nesting habitat being “levee tops grown to annual grasses and high pickleweed growing on the levee banks.” Gill (1977) further estimated the overall nesting population of savannahs in his study area to be from 800 to 1,000 pairs; but the large size of area he surveyed precluded any calculation of densities for any type of habitat.

Savannah sparrows have been reported in at least 17 breeding-bird censuses¹ on measured plots in California, although on several of these they were listed only as “visitors” to the plots. Five of these censuses were in bayside marsh or adjacent grasslands and, thus, sampled the gradation of habitats - from marsh to unwooded uplands - which this species exemplifies (**Table 7.7**). Only one of the five surveys listed in **Table 7.7**, the San Pablo Creek survey, was from within the geographic limits of the Goals Project. A similar census on a plot of brackish marsh and adjacent grassland at Southampton Bay did not find any savannah sparrows (Stoner et al. 1963), nor did one of the somewhat brackish “diked

coastal saltmarsh” three miles northwest of Alviso (apparently part of what is now called Triangle Marsh) in 1983 (Anderson and Jennings 1981). However, two census plots including habitat of breeding *beldingi* in southern California showed much higher densities for those strictly marsh-inhabiting birds: 60.8 territories per 100 acres along Ballona Creek in western Los Angeles (Dial 1978), and 104 territories per 100 acres in the Bolsa Chica Ecological Reserve in Orange County (Alexander 1974).

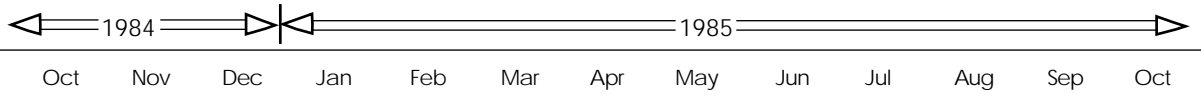
Winter population densities of savannah sparrows have been obtained for a few discrete plots on Humboldt Bay, near Marshall on Tomales Bay, and in coastal southern California. However, I know of no winter population counts for San Francisco Bay, except for some of intertidal mudflats that had a remnant bit of marsh at the edge - hardly a useful sampling for this species.

Some indication of typical numbers (subspecies not distinguished) may be gleaned from counts made two or three times a month for one year in the north-Newark and northwest-Fremont area (**Figure 7.6**). In these studies, several assistants and I made counts of all bird species on three properties of the Leslie Salt Company and three other “comparison” plots in the period of October 1984 through October 1985 - although songbirds were not a targeted subject for the counters until March 1985. Some of the plots were too large for the counts to be considered total censuses, thus the numbers counted are very likely well below the true densities.

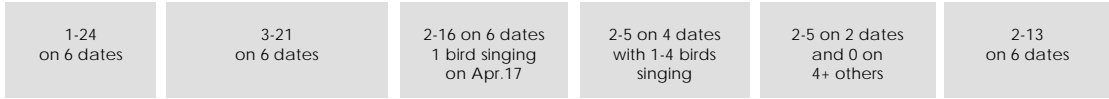
¹ A full listing of these California breeding-bird censuses may be obtained from the author at CA BIRDS@aol.com.

Table 7.7 Censuses in California Bayside Marsh or Adjacent Grasslands Where Savannah Sparrows Were Reported

Location (all are in California)	Habitat Description	Date	Population Density (territories/acre)	Reference
San Pablo Creek , Contra Costa County	Tidal marsh (<i>Salicornia</i> , <i>Spartina</i> , <i>Grindelia</i> , etc.)		5T/70 ac. [=7T/100ac]	Johnston 1952
Humboldt Bay , 3 mi. So. of Eureka, Humboldt County	“ marsh” (but with much grass and some subshrubs)		5.5T/26 ac. [=21.2T/100ac]	Sorenson and Springer 1977
Freshwater Slough , <1mi. E. of Eureka, Humboldt County	Diked marsh	(1979)	3T/19.46 ac. [=15.4T/100ac]	Jacobson 1980
	Diked marsh	(1980)	3T/19.46 ac. [=15.4T/100ac]	Jacobson 1981
	Diked marsh with part of plot open to tidal action	(1981)	2+ as visitors only	Jacobson et al. 1983
Humboldt Bay , 1 mi. So. of Eureka, Humboldt County	“ marsh” (brackish, with various herbs and coyote bush)	(1980)	1+ as visitor only/20.3ac	Base 1981
		(1981)	1.0T/20.3 ac. [=4.9T/100ac]	Base 1982
Coastal Prarie , Cypress Grove ACR property, Marshall, Marin County	Marine terrace grassland adjacent to bayside freshwater marsh	(1988)	1+ visitor/31.0 ha.	Kelly 1989



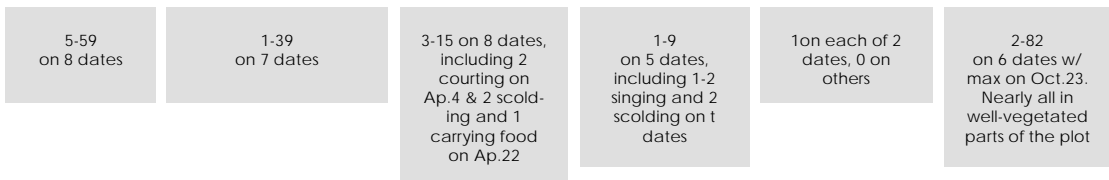
Hickory Tract, Newark 65 acres, partly barren old salt ponds, diked pickleweed marsh, old head of Newark Slough, several acre patch of partly filled land with grass and forbs.



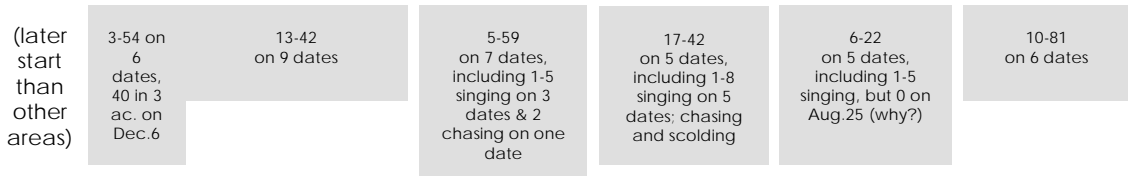
Coyote Tract, Newark About 174 acres, only about 60 of which were vegetated, mostly used as pasture.



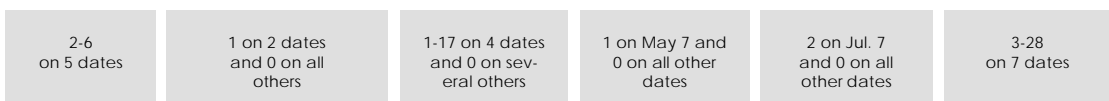
Coyote Tract, Fremont About 100 acres, some 60 acres being nearly barren former salt ponds, the remainder well vegetated former gun club ponds re-grown to various herbs, including dock, spike-rush, grass, and local cat-tails; two small ponds much enlarged in winter.



Coyote Hills Regional Park 37 acre plot marked off with posts in 209-ft. squares. Seasonal wetlands with *Salicornia*, *Scirpus robustus*, *Frankenia*, local *Rumex* and other tall forbs, grasses in western 1/4, a belt of tall *Typha* marsh along a shallow ditch in eastern and northern parts; all in floodwater storage basin with water covering varying parts of the plot shallowly (many plants protruding) in winter.



Don Edwards S.F. Bay National Wildlife Refuge Headquarters Flat (LaRiviere Marsh) Approximately 105 acres west of Thornton Ave. and south of route 84. Former salt crystallizers and ditches and dikes, plus smaller ponds becoming more marsh than barren; western 1/4 opened to tidal action in previous year, and large central part to muted tidal action (or diked off when gate closed) beginning in spring 1985. Dikes in north-central to northeastern and northwestern parts were usually not walked, so some savannah sparrow habitat was missed. *Note: there was no singing or other evidence of breeding in this plot.*



Newark Slough Tidal marsh from the southwest corner of the south tip of Coyote Hills to the slough-head at Thornton Ave. Approximately 60 acres, including the main channel, which was here only about 2-10 feet wide. A few old dikes are in the eastern part, including one at the actual Mayhews Landing site that has tall forbs on it, the others fully covered by pickleweed and various high-marsh plants. Many of the savannah sparrows noted were along the levee between the marsh and the adjacent salt evaporator on the southwest, where there was a narrow, interrupted fringe of upland plants. *Note: Larger numbers in Mar. and Oct. '85 were found by walking the very narrow shoulder of Thornton Ave. fringing the marsh.*

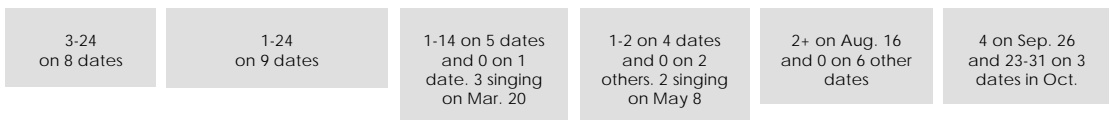


Figure 7.6 Summary of Data from Six Bird Count Studies Conducted Between Late Fall 1984 and Winter 1985. Data from Cogswell (1986) and author's personal raw data records.

Conservation and Management

The local population data for the savannah sparrow are so meager that they provide no indication of any local historical population changes. For the continent as a whole, there may be notably larger populations now than occurred before European settlement and expansion (Wheelwright and Rising 1993); however, this can be presumed not to be the case on the periphery of San Francisco Bay. The filling in of the upper parts of many tidal marshes and the urban development that has taken place on uplands so created would have decidedly decreased habitat acreage and quality for savannah sparrows, at least in the central section of the Bay. The conversion of tidal marsh to salt evaporators also eliminated much of the marsh areas in the South Bay - particularly when this conversion is considered in combination with the subsequent urban expansion to the very edge of those salt ponds. Only the conversion of former tidal marshes to bayside or near-bay upland fields - such as the diked farmlands near San Pablo Bay and the gun club/grazing lands established years ago around parts of Suisun Bay - may have been favorable to savannah sparrows. Modern data on the distribution and numbers of the species, especially during the breeding season, are sorely needed from those areas. Such data would be of most value to resource managers if they were obtained with reference to the different vegetation and the changes in it emanating from various land-use practices over all seasons and for years of different rainfall patterns.

The savannah sparrow (especially its subspecies *alaudinus*) is an ideal target species to represent those birds dependent upon both Bay-related marshes of most kinds and the adjacent upland grasslands and fields of various sorts. The relative densities of its populations in the grasslands of higher elevations of the Coast Ranges and in the apparently relatively few areas where it breeds in valleys between these ranges are unknown. Maintenance or restoration of as much vegetation that is transitional from marsh to upland, in various parts of the Bay system where it is still possible, should be a goal until the comparison of qualities of this habitat combination to strictly upland types can be made. I suspect that the transitional marsh-upland habitat will be found to support far higher densities.

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Song Sparrow

Melospiza melodia samuelis

M. m. pusillula

M. m. maxillaris

Howard L. Cogswell

Introduction

As a breeding species, the song sparrow (*Melospiza melodia*; Emberizidae/Emberizinae) is found across North America from southern Alaska and central and eastern Canada to northern Florida and Mexico, in the drier regions being restricted to riparian or other wetland habitats. As of 1957, some 31 subspecies were recognized as valid on morphological grounds (AOU 1957), including a very pale one in the southwestern desert area, and several quite large ones resident along the Aleutian-Alaska coast area. A population of “ordinary” song sparrows (regular-sized at 6.25 inches total length) breeding in Cincinnati, Ohio was the subject of intensive study using colored leg bands for a number of successive years. The resultant monographs (Nice 1937, 1943) made the song sparrow, for many years thereafter, the best known of any species of American song bird. The study provided details on the bird’s home range and territory, mating system (mostly monogamous), tendency to migrate (males there included some that left for the winter, but others that stayed), nesting, production, and survival of young, etc. Nice (1937, 1943) also set a high standard for others in her exhaustive search of relevant literature from throughout the world.

Tidal marshlands along the Atlantic Coast from Long Island to Virginia are occupied by a distinct subspecies of song sparrow (*M. m. atlantica*), but it has

apparently been little studied. At least the northern populations of that race are migratory (AOU 1957). In the tidal marshlands about San Francisco Bay, however, three distinctly separate subspecies have evolved, and all of them are apparently quite resident year-round within those marshlands or immediate vicinity. These are:

- *Melospiza melodia samuelis* of San Pablo Bay and northern San Francisco Bay (south to Sausalito and north Richmond); it was first recognized as distinct in 1858.
- *Melospiza melodia pusillula* of the balance of San Francisco Bay shores (breeding originally from San Francisco and southeast Richmond south to Alviso); first described in 1899.
- *Melospiza melodia maxillaris* of the Suisun Bay marsh complex and west to include Southhampton Bay; first described in 1909.

Marshall (1948a, 1948b) studied all of these subspecies from the standpoint of the habitats occupied, and the very tenuous connections their populations had with adjacent upland forms of the song sparrow. The gist of his findings was that all are quite distinct in size or proportions of bill, wings, tail (etc.) and/or coloration from the upland subspecies. Only one of these subspecies, *samuelis*, has been studied in detail using banded birds (Johnston 1954, 1956a, 1956b); but findings from that study that pertain to the birds’ adaptations for life in an intertidal area have been supported by incidental observations made on both *pusillula* and *maxillaris* and are used in this account as applicable to all three of these forms. The same assumption was a key aspect of the California Department of Fish and Game staff report to the Fish and Game Commission (Larsen 1989) when a petition to list *maxillaris* as Endangered was forwarded with the recommendation that Threatened status was warranted. A general survey of the status of all three San Francisco Bay races of song sparrows was done by Walton (1975), and Marshall and Dedrick (1994) presented an updated review that ties the estimated populations to the acreages of remaining tidal marshes. The last paper also has a color figure that illustrates diagnostic features of each of these subspecies compared to their adjacent upland relatives.

The presence within such a small, overall region of three such narrow endemics is in itself a highly valuable sample of evolution at the critical “not-yet-species” level - the case histories of which serve to illustrate early stages of the gradual process of speciation.

Description

Song sparrows of most of the United States are “typical” Emberizine sparrows about six to 6.5 inches in total length, with rather average body, neck, head, bill, and leg ratios. They have somewhat shorter wings (approx-



Don DesJardin

mately seven inches spread) and longer tail (2.6 inches) than other species in the subfamily that occupy more open habitats. They are brownish above and whitish below, with darker brown to blackish streaks (varying in marginal hues among the subspecies). On the mid-breast, the dark streaks tend to be grouped, forming an irregular blotch. The tail is even-ended or somewhat rounded (not notched as in many sparrows), and is usually moved up and down as the bird flies from disturbance into cover.

Birds of the *samuelis* race are slightly smaller, and considerably less rusty-toned in dorsal color than *gouldii* of the adjacent Marin and Sonoma County uplands. The South Bay *pusillula* birds are still smaller, especially the bill, and with a tail averaging 10% shorter than the upland form there, *santacruceis* (included in *gouldii* by the AOU). Marshall and Dedrick (1994) show *pusillula* as being generally grayer in background tone, with a distinct light gray collar (but brown-streaked) on the hind-neck; but at the Museum of Vertebrate Zoology in Berkeley, H. Cogswell surveyed over 50 spring-summer specimens of *pusillula* (many collected by Marshall himself) and could not distinguish this grayness on at least half of them. The degree to which differences persist or disappear with wear of the feathers apparently remains to be worked out. The Suisun Bay birds, *maxillaris*, are more nearly equal to typical upland song sparrows in size, and show much rusty coloration in the lighter areas above and on the back of the neck and the tail; but their most distinctive feature is a somewhat swollen basal half or so of the bill (noticeable only on very close inspection). This last feature should be the easiest clue to distinguish them from *mailliardi* of the adjacent Sacramento and lower San Joaquin valleys, but Marshall and Dedrick (1994) do not illustrate that subspecies.

Breeding Phenology - Territories of salt marsh song sparrows are apparently “held” all year, even if not actively defended in fall and early winter. Singing by males is prevalent by February, however, and one of the major adaptations discovered by Johnston (1954, 1956a) for *samuelis* is that the peak date for completion of the first clutch of eggs is more than two weeks earlier than that of song sparrows of the nearby upland race. The mode of this laying comes about March 27 with fair numbers of birds completing first clutches up to mid-April. The advantage of early laying is that the nests are less vulnerable to being flooded by the gradually increasing height of high tides that occurs annually in late April and even more in late May and June, the young of the early nesters fledging before then. In some years, the first clutch layings were delayed by bad weather, and loss of eggs or nestlings to flooding was widespread. Nests are not always placed in the highest vegetation available, a trait that Johnston attributes to the selective pressure of nest-predators. He also found a lower peak of clutch-completion in mid-May and a third small one (seven

nests out of 111 total) in June, when spring-phase high tides would almost certainly flood most of the marsh. These may include re-nestings by birds that lost their first brood, but many were apparent attempts to raise a second brood even if a higher percentage are then flooded out. Indeed Johnston (1968: 1548) says “almost all pairs nest twice in a season. If replacement nests are considered, each pair will nest on the average 2.5 to (rarely) three times each season.”

The same seasonal time pattern for clutches of eggs is seen in *pusillula*, of which many sets of eggs were taken by collectors prior to 1940, and presumably also for *maxillaris*, for which relative few data are at hand¹. Of 80 egg-sets of *pusillula*, 50 were taken in April, 25 in May, five in March, and only one in June. There were 14 sets of *samuelis* eggs, all of which were taken between April 8 and May 7, and seven sets of *maxillaris* eggs, all of which were taken between the first and 23rd of May. Whether there is a difference in timing for individual birds of any of these subspecies that hold territories adjacent to a suitable dike or other bit of upland that permits nesting above the level of the June high high tides has not been investigated. Johnston’s study area had a dike only along its northeastern side, with channels attractive to sparrows only at its two ends, so the question was not addressed.

Nests of *samuelis* were found by Johnston (1956a, 1968) to be placed on average 9.5 inches above ground, but averaging 12 inches in the marsh lower in the tide range. Any of the four main marsh plant species (*Salicornia*, *Spartina*, *Grindelia*, *Distichlis*) were used for nest support; but the uppermost parts of the tallest (*Grindelia*) were avoided, which Johnston attributed to the selective effect of predators finding nests there more readily.

Productivity - The mean clutch size of 157 nests found in Johnston’s study varied among years from 2.91 to 3.42 eggs, with the mid-season (April 6 to May 25) nests having a slightly larger mean number (3.23) of eggs than the earlier or later ones. However, the mid-season group for 1953, the year with highest success of early nestings, was almost identical to the later nest group which Johnston (1956a: 37) suggests might be a response to the saturated population, including the many juveniles still on hand from the early nests.

Basic natality (number of eggs/pair/year) ranged from 7.5 to 9.1 in the years 1952-55 of Johnston’s study (1956b: 260). Since his studies of dispersal (see below) indicate a very strong tendency of the song sparrows to remain in the area where they were hatched and raised, he assumed that a color-banded individual that disap-

¹ This author maintains a database (dBase IV format) containing the data from the egg sets in most museum collections, as well as all other published and many unpublished records of song sparrows of any race in or near the Bayland marshes.

peared had died. Using these data and the ongoing numbers of birds, he also calculated a life-table showing the survivorship for this population. It shows a 26% mortality (=2% per day by my calculation) for the first 13 days of a young bird's life (the nestling period), 30% (3.3% per day) for the next 10 days (fledglings still cared for by adults), and 80% for the balance of the first year (341 days, or ca. 0.23% per day). From age one to age two, his data show a mortality of 43% and the same for age two to age three, and he assumes this rate continues through the several remaining years of the relatively short lives of these birds - a little higher than the 30-35% typical, after their first year, of other sparrows handled in large numbers by banders, e.g., white-crowned and golden-crowned sparrows.

Mortality factors applicable to the egg and nestling phases of the birds in the study by Johnston (1956b: 266) show predation and high tides accounting for 20% and 11%, respectively, of the losses. Storms were irregularly important, as in 1955 for 13% of the deaths. Brood-parasitism by the brown-headed cowbird is listed as a factor in five deaths (5% of the 1955 total of eggs and nestlings), but is not discussed. In more recent years, at least at the Hayward Shoreline, pairs of *pusillula* have been often noted feeding cowbird fledglings, so the increased population size of the cowbird now may be a negative factor of significance for these marsh-inhabiting sparrows. Johnston (1956b) also recorded about 49% mortality of eggs attributable to rodent predation (mostly Norway rats), and 59% loss of nestlings from the same factor. These were higher figures than all losses from high water and desertion. Other predators of minor influence were thought to be northern harriers and short-eared owls - but only four song sparrow skulls were found in 491 pellets he examined from the owls in a four-year period (Johnston 1968: 1550).

Dispersal - Johnston's (1956a) study of the *samuelis* population on San Pablo Creek Marsh in the 1950s included the distances from hatching site to breeding site of 34 juveniles, in 23 of which that being 200 meters or less, and in only four birds was it more than 600 meters. Some authors have objected that his single study area was too small to really check on this. However, there was a pronounced exponential drop-off in distance from the peak at 100-200 meters, and nearly 15% of the 241 nestlings he banded were found subsequently breeding in the study area - a very good number when one takes into account the 50% or higher nestling and early fledgling mortality. Furthermore, the Poisson statistical test for randomness in the observed distances showed that while most birds moved very little, a small percentage of individuals had a tendency to move a distance much greater than the mean - beyond the 500-600 meter distance where none were found. This pattern was true also with Nice's song sparrows in Ohio, so is probably a genetic feature in the species - only the

absolute distance being shorter in *samuelis* and presumably also the other salt marsh subspecies. The significance for conservation of the populations of these subspecies is that *continuity of habitat* is of very great importance in ensuring their ability to repopulate local areas where all or most individuals are eliminated by geographically and time-limited factors, i.e., local ecological disasters.

Trophic Relationships - The salt marsh races of the song sparrow, where present in the fully tidal marshes to which their evolutionary history fits them, are the most abundant of the passerine birds to be found there. Therefore, they must constitute an important segment of the food web in such communities. But just where should that segment be placed? On a year-round basis, they must be classed as omnivores; but in most of their breeding period from March through June or so, their mostly animal food would shift them upward trophically into the carnivore blocks - to some extent even into a secondary or tertiary carnivore position because they eat spiders and many carnivorous insects. But what does one do with the carnivore or omnivore that eats detritus-feeders on a large scale from the intertidal mud, which these birds do at least at times? The simple producer/consumer trophic picture is complicated by large quantities of detritus being recycled into the same trophic chains as are the organic products of green plants. Until a more thorough analysis of the percentages of the various types of food taken by birds of these three subspecies has been done, any detailed diagram could have no quantification of the relative importance of the connections shown.

Nearly the same lack of quantification is true for the known trophic relationships that would show song sparrow biomass passing on into predators, parasites, and scavengers, or for the reduction in the sparrow population success that is attributable to the brood-parasitic brown-headed cowbird. The behavior of the song sparrows on a salt marsh when a northern harrier or short-eared owl flies within its view indicates that these predators do indeed take some of the birds. However, the few song sparrow skulls Johnston (1956a) found in pellets from these owls indicates that the transfer of biomass to that species would be a very minor link in the food web. On a population basis, the most important predators of the salt marsh song sparrows are no doubt the Norway rat (*Rattus norvegicus*) and garter snakes (*Thamnophis* sp.), with now, in recent years, the non-native red fox (*Vulpes fulva*) added to the list, and in the parts of the marsh near a dike or upland, feral cats as well.

Habitat Use and Behavior

Except as otherwise indicated, this section is essentially summarized from Johnston's (1956a,b) results for a population of *samuelis* north of Richmond. He had some difficulty in attracting adults into traps, but was able to

color-band 33, plus 13 juveniles; most of his data, however, came from the 241 nestlings that he so marked. The marsh in his whole study area covered about 200 acres in 1950-55, but the song sparrows did not inhabit the bayside one-tenth or so that was dominated by *Spartina*, nor the 60% or so that was relatively unbroken *Salicornia* lacking small curving channels. Instead, they were in the parts of the *Salicornia* zone next above the *Spartina* zone and along Wildcat Creek itself and smaller channels with frequent small branch channels or sloughs where scattered to numerous *Grindelia* subshrub “bushes” provided both song perches and usual nest placement above the level reached by most spring tides. Other plants found in this and the upper marsh zone are also listed by Johnston (1956a: 27). During lower tide periods, the mud along the same small side-channels (areas where marsh plants are typically overhanging) provided primary forage areas for these birds.

The territories of salt marsh song sparrows are much smaller, at least in this optimum habitat, than the average of one acre or a little more found by Nice in Ohio, and by many others elsewhere if one judges from the densities reported in various breeding-bird censuses even in “good” riparian situations. Johnston (1956b: 256) showed the linear arrangement of the 14 to 22 territories along one particular tidal channel through six successive years. He reported (p.254) that “thirty feet represents the average width of territories along sloughs *within which the birds perform practically all their activities* [emphasis added] ... With this as definition of the area in which [these] song sparrows live, the actual density in a year of high numbers [1953] is seen to run from 8 to 10 pairs per acre. This is not as unreasonable as it may seem, for 10 pairs of song sparrows per acre would give each pair about 4,350 square feet per territory...” — about a 30- by 150-foot swath along one of the small sloughs, as he in fact found to be true. The density per unit area based on the whole marsh, including the parts not inhabited by song sparrows, would of course be much lower. For example, 74 territorial males were found in 70 acres of this same marsh (105 per 100 acres) and reported by Johnston (1952) in a census that included only two other breeding bird species: five territorial male savannah sparrows and four clapper rails. Year-to-year variation in a 100-acre part of this marsh (presumably including the 70-acre 1953 plot) was estimated to range from 87 to 124 pairs. Four different small sloughs supported song sparrows at “linear” densities along their length of a pair every 130 to 170 feet in 1953. The extremely sedentary nature of the territory holders is shown by data in Johnston (1956a), summarizing those birds with territories mapped in two or more successive years. Of the 48 instances of possible movement (24 birds) where movement could have happened, the only cases where territory centers were more than 16 meters from the previous year were

two for males and three for females, and none was moved more than 35 meters.

Johnston’s two papers (1956a,b) contained but the barest mention of what happens to song sparrows that hold territories in the salt marsh when the tides are high enough to flood most of the vegetation in the *Salicornia* zone - as they are on the high high tides of May through June and again in November through December. He stressed the shift in breeding times, but did not report on the behavior of post-breeding birds. A selection of records from my own notebook (unless otherwise indicated) and a few other sources indicate that there is often temporary aggregation at the upper fringe of the marsh and particularly on any adjacent dike or fill with vegetation; for example:

- About 50 (5+ juveniles) were at the upper end of Plummer Creek, south-southwest of Newark, at high water on August 19, 1956;
- A similar number was seen while driving the dikes along Mt. Eden Creek, southwest Hayward, on September 10, 1964;
- Thirty to 50 were seen along the railroad fill that crosses the large Dumbarton Marsh on various summer and fall dates, and 100 or more on October 10, 1953 when the railroad was walked eastbound and the nearby San Francisco Aqueduct back westbound (Cogswell 1953, 1956);
- About 120 were seen from a boat plus a short distance afoot (along the railroad) in this same marsh on October 26, 1969 spanning a 7.5 foot high-water;
- About 185 were estimated in walking from near Dumbarton Bridge to Newark Slough along the railroad on January 27, 1979;
- An estimated 75 were seen in two miles of dike through a salt marsh near Alviso on November 19, 1949 at high water (Sibley 1955);
- From 51 to 86 were counted in the marsh fringes along Alvarado Channel (Old Alameda Creek) and/or the northern side of the new Alameda Creek Channel on Christmas Bird Counts from 1967 to 1981 at various times of tide, including a “flock” of 18 feeding on driftwood massed in a salt pan in the marsh at high water on December 31, 1967.

Elsewhere in the Bay, high estimates have been: 200 along Sears Point Road (= *samuelis*) on January 28, 1938 by Graham and Stoner (publ. in *The Gull*), and 150 by myself on November 19, 1950, during an Audubon group trip by boat down Suisun Slough with walking about on a part of Joice Island (= *maxillaris*). I believe that these aggregations include many territory holders, perhaps mostly in areas without significant number of *Grindelia* or other plants that would still provide cover at the higher high tides, and that these birds return to their territories as the tide ebbs. Johnston (1968: 1552) later reported some limited

investigation of such aggregations during winter high tides, at one time having 17 birds perched on the raft he was using to explore the marsh just after a northern harrier flew by.

Food and Foraging - Johnston (1968: 1551-2) gives considerable detail of the foraging behavior of song sparrows in the salt marshes, presumably based on his four years of study of *samuelis*. Preferred forage sites are the muddy edges of small channels, but they also obtain food on the firmer ground under and from the marsh plant surfaces themselves. While they engage in the double-scratch bouts separating periods of pecking at the ground surface, like other sparrows, they also specialize at times on the small molluscs and other marine invertebrates in this intertidal mud. They also feed at the maturing heads of the *Grindelia* flowers, and in autumn (when fresh water from insect foods is at a low ebb) eat the fleshy fruits and tiny seeds of the *Salicornia*. In winter, after the seeds of the latter have been released from the dried spikes, they are washed up in the drift from high tides, and the salt marsh song sparrows spend much time picking at such accumulations, taking both seeds and various invertebrates. In spring and early summer, the young are fed almost entirely on insects [and other invertebrates], some of which are obtained by short hops or flutters approaching flycatching.

Quantitative study of the diet of these subspecies has been very minimal, although Beal is said in the literature to have reported in 1910 on some stomach contents of *samuelis*. Without regard to subspecies, the varied diet of song sparrows in general as reported in various early accounts is summarized by Nolan (1968).

Quality Habitat - The intensive study of a *samuelis* population by Johnston (1954, 1956a,b), the follow-up surveys of *maxillaris* populations from Southampton Bay through the Suisun Marsh complex as summarized by Marshall and Dedrick (1994), and numerous but more casual observations of *pusillula* populations in the Hayward, Newark, Alviso, Palo Alto, and Redwood City areas all lead to the general picture of highest populations of each of these subspecies being found in fully tidal marshes. This is true even though the vegetation differs very significantly in the marshes about Suisun Bay compared to San Pablo Bay and that in turn differs somewhat from the marshes of the southern arm of San Francisco Bay. The partiality shown for foraging along the banks of the sinuous minor channels within the tidal marsh, and the greater availability of nest sites and song perches in the *Grindelia* "bushes" that tend to grow along these same channels are probably the prime factors in supporting higher populations there. Johnston found no song sparrows with territories in the pure *Spartina* marsh adjacent to the mudflat along the open bay, but at Palo Alto they are moderately numerous in mixed *Salicornia-Spartina* marsh with a channel or adjacent dike and along the boardwalk that traverses

the marsh. Various subsequent searches of open *Salicornia* flats have confirmed Johnston's finding that the two subspecies that inhabit adjacent more complex marshes avoid at least breeding season residence where there are no small channels or adjacent mudflats or dikes.

The extent to which birds of each of these subspecies utilize, and indeed occupy for breeding purposes, the various types of diked marshlands near the tidal marshes is poorly understood. For *maxillaris*, the petition for that race to be listed as Endangered (Marshall and Mewaldt 1988) and the California Department of Fish and Game staff report that accompanied it (Larsen 1989) both indicated that diked-off, managed marshes were not inhabited by birds of that race. However, surveys of many parts of the North Suisun Marsh in 1990 by Marshall and several assistants located 79 pairs in non-tidal situations compared to 334 pairs or singing males on the 621 acres of tidal brackish marsh surveyed. Habitats mentioned for the non-tidal birds included coyote-bush (*Baccharis pilularis*) and roses close to a tidal slough (where those birds might have foraged at times). Seven birds were found in "hedges" of giant *Atriplex* and/or dry grass along a ditch with only water at the ends, and even a few were seen in dry fields with clumps of non-emergent tules. Cogswell's South Bay field notes have for years regularly noted a few *pusillula* living, foraging, and singing along outer-levee rip-rap with only traces of salt marsh vegetation, and others at least foraging frequently in diked-off *Salicornia* with various herbs and sometimes a few shrubs admixed. However, all or most of these sightings were within a few hundred feet from a tidal channel or the outer bayshore. It is not clear from observation with binoculars whether the several birds that regularly sing from coyote-bushes or tall clumps of sweet fennel (*Foeniculum vulgare*) on the western side of Coyote Hills, Fremont, are *pusillula* or upland-race birds. The only mud available to them by May is in the adjacent tidal or diked-off marshes.

Table 7.8 shows the relevant Goals Project "key" habitats, and summarizes their usage by each of the three salt marsh song sparrow races.

Distribution and Abundance

Because there is insufficient data on the actual locations and population sizes of song sparrows, this section outlines the historical changes in the extent (and quality) of suitable habitat, and provides estimates of population sizes based on habitat availability.

M. m. pusillula - Dedrick (1993) measured the total historic (pre-diking) suitable habitat within the range of this subspecies at 65,871 acres and the present habitat area as only 10.2% of that, or 6,678 acres (Marshall and Dedrick 1994: table 1). I performed a separate evaluation to estimate the remaining tidal marsh habitat in the range of *pusillula*, and to rank the quality

Table 7.8 Key Habitats Usage by Three Salt Marsh Song Sparrow Races

	<i>M. m. pusillula</i>	<i>M. m. samuelis</i>	<i>M. m. maxillaris</i>
Tidal Salt Marsh	Optimum habitat for all life needs provided the marsh has the characteristics detailed in text.	Used for all life needs, with conditions as for <i>pusillula</i> . The "magnificent Petaluma Marsh" cited as a stronghold of this form (Marshall and Dedrick 1994).	
Tidal Brackish Marsh	May be used for nesting*.	May have limited use for nesting.	Occupies marsh with often tall to very tall <i>Scirpus acutus</i> , shorter <i>S. robustus</i> , and local areas of <i>Salicornia</i> and <i>Grindella</i> .
Seasonal Wetlands	Used at least for foraging and some singing, provided the wetlands have some of the elements of a salt marsh and adjacent mud for foraging.	Presumably some limited use similar to <i>pusillula</i> .	Sometimes found in the diked/managed marsh of the Suisun complex, but in much lower numbers and with no information on the success of any breeding that may take place there.
Salt Ponds: dikes or levees	Areas adjacent to tidal marshes used for some foraging, or locally even for singing, (hence nesting?) where rip-rap and herb or shrub vegetation are mixed.	Presumably some limited use similar to <i>pusillula</i> .	
Intertidal Mudflats	The upper fringe of open mudflats used for foraging only, where adjacent to any other habitats that support more permanent occupancy.	Presumably some limited use similar to <i>pusillula</i> .	
Adjacent Uplands (mixed grass and tall forbs or shrubs)	Used provided they are adjacent to salt marsh or channels. Some nesting may occur in the upland area.	Presumably some limited use similar to <i>pusillula</i> .	

* The presence of 17 territories of *M. m. pusillula* in a 14.7 acre plot of tidal salt to brackish marsh (*Spartina foliosa*, *Salicornia virginica*, *Scirpus robustus*, *Frankenia*, *Distichlis*) NNW of Alviso (Anderson and Jennings 1981) with two nests found in *S. robustus* is the best indication of breeding by this subspecies in brackish tidal marsh.

of this habitat as well. For this work, I measured on 1977-84 aerial photographs (courtesy H. T. Harvey Associates) every habitat block or portion of block that could be classified by close inspection (using some magnification) as of "high," "medium," or "poor" quality for this subspecies. Areas of high quality were those containing tidal marsh with numerous small channels and complex vegetation structure. Areas of medium quality were those with fewer channels or small parcels remote from major parcels. Poor quality was assigned to those tidal marsh areas that did not have the features indicated for high or medium quality. I then considered the position of each habitat block within the landscape and rated each block in overall quality categories of A, A-, A/B, B, B-, B/C, and C quality categories (with a few even of D level). I then summed the total acreage in the highest three categories (A through A/B) and the next three highest categories (B through B/C), and got 3,989 acres and 2,511 acres, respectively. Together these total 6,500 acres, compared to Dedrick's 6,678 total. The acreages of the eight largest single blocks rated as A, A-, or A/B were:

- Dumbarton Marsh (incl. adjacent "Aqueduct Marsh") - 836.9 acres²
- Greco Island (Redwood City) - 740.4 acres
- Outer Bair Island (incl. 474.9 ac. reopened to tide) - 603.5 acres
- Mowry Slough mouth to Newark Slough Mouth - 326.1 acres
- Mundy Marsh (Palo Alto) & Faber Tract to Cooley Landing - 316.2 acres
- Whale's Tail Marsh (N&S of Alvarado Channel, Hayward) - 271.1 acres
- Corkscrew Slough (in several segments) - 200.4 acres
- "Ideal Marsh" (Ideal Basic Industries, west of Coyote Hills) - 128.3 acres

² Marshall and Dedrick (1994) give the current size of the Dumbarton Marsh as 906.1 acres, but from their text it appears they included all of the marsh belts along Newark Slough up to its head, whereas I kept them separate above the first points where diked salt ponds restrict the marsh to belts along the sloping slough banks.

These blocks are all separated from other sizeable habitat blocks by distances or channels wide enough that they probably constitute a deterrent to free dispersal by the sedentary song sparrows, even though the full-grown birds would have the capability of flying the distance involved. These larger blocks can be grouped with intervening smaller ones to obtain a more geographic comparison. When this is done, the “West Bay” optimum of Bair and Greco islands south through Palo Alto has a total of 1,544.3 acres of “good quality” tidal marsh, while the nearly contiguous marshes in the Dumbarton Point-Newark Slough to Mowry Slough and south to outermost Coyote Creek (where still not very brackish) has 1,719.7 acres.

Using Johnston’s (1956b) published population density figures for *samuelis* (1.11 territories per acre), Marshall and Dredrick (1994) estimated the total *pusillula* population to be 7,412 pairs - a little over 10% of that preceding the diking and/or filling of the tidal marshes. Johnston’s density figures assumed no song sparrows in those often rather large parts of a tidal marsh more than 10 meters or so distant from a channel. Additional fieldwork is yet to be done to check the actual species population densities at the locations which I quality-rated in my study; until such quantitative checks are completed, no better overall population estimate for *pusillula* than those arrived at by Marshall and Dredrick (1994) can be derived.

M. m. samuelis - Marshall and Dredrick (1994) gave the results of planimeter measurements on the Nichols and Wright (1971) map of historic tidal marshes within the range of this subspecies as 63,690 acres, as well as Dredrick’s (1993) 1992 measurement of the tidal marshes remaining - 14,060 acres. At 22.1% of the original, this is the best record of marsh retention among the three salt marsh song sparrow ranges, despite the fact that many blocks are narrow and/or isolated about the shores of San Pablo Bay. These authors reported examples of locations where birds of this subspecies were found and some captured in a 1986 survey, also noting that some “verdant marsh” [but diked] areas (e.g., on Tubbs Island) lacked them. Nor were any found in the 2,416-acre bayfront marsh between Sears Point and Mare Island, although Marshall’s notes from 1947 indicated they were “abundant” there at that time. Nine birds were caught in November 1986 at Dutchman’s Slough off the Napa River, where they used *Baccharis* bushes along the levee (as well as the tidal marsh). By far the largest remaining block of marsh, with an estimated population of 3,548 pairs of bird of this subspecies, is the “magnificent Petaluma Marsh” of 3,196 acres. This is nearly 23% of the admittedly optimistic total of 15,607 pairs estimated by these same authors for the subspecies throughout its estimated 22 square mile (14,080 acre) range.

By rough approximation on 1:24,000 topographic maps of the area, and using Marshall and Dredrick’s

(1994) figure 3(b) map of present tidal marshlands as a guide, acreages of the next 10 largest blocks are:

- San Pablo Bayfront (Sonoma Creek-Mare Island) - 3,500 acres (expanded over the 1950s topographic map)
- Southwest San Pablo Bayfront - 732 acres
- Coon Island-Fly Bay, 610 acres
- Fagan-Steamboat Slough-Bull’s Island - 570 acres (or 112 less if Bull’s Island is still diked as shown in 1950s map)
- American Canyon Creek-mouth to Sears Point Road - 550 acres
- Mare Island Bayfront - 400 acres (expanded since 1950s)
- Petaluma River below the large marsh - 400 acres
- Sears Point to lower Tubbs Island - 340 acres
- Wildcat Creek-mouth vicinity - 212 acres
- San Pablo Creek-mouth vicinity - 150 acres
- Muzzi Marsh and nearly contiguous tidal marshes along Corte Madera Creek - 150 acres (approximate)

Most of the blocks from southwest San Pablo Bay (Gallinas Creek vicinity) north to the big marsh near Petaluma and east to Mare Island are connected by at least a narrow bay- or slough-front marsh. Except for the American Canyon to Sears Point Road block, there are also fairly good dispersal corridors along the sloughs from the Napa River to the Petaluma River, although the slough-bank marshes in some cases may be too narrow to be optimum breeding habitat. The smaller blocks on the Contra Costa County shore and in Marin County from San Rafael to Richardson Bay are mostly too isolated for much dispersal among them, except possibly by that small fraction of young that go farther than the limits of Johnston’s 1950s study area (the Wildcat Creek-mouth marsh).

An area of 80 ha in the central part of the Petaluma Marsh was surveyed intensively for song sparrows (Collins and Resh 1985). In this study, the vegetation was sampled along transects perpendicular to channels, and the marsh variations grouped into four habitat-types for analysis of the song sparrow data (sloughs, natural channels, mosquito-control ditches, and areas 10 m or more from any channel or ditch). The sparrow’s territories were mapped by following the birds and the polygon of each male’s mapped song-posts measured. Seven replicate plots in each habitat-type other than the areas beyond 10 m from a waterway (which were found to have no sparrows) were thus surveyed.

In general, territory placement and sizes along natural channels were found by Collins and Resh (1985) to be very similar to that reported by Johnston (1956b), but the plots along the constructed ditches had fewer and larger territories. Collins and Resh (1985) attributed this difference to a lower level of food and nesting-site (and predator-avoidance) resources than was present along the

sinuous natural channels with their much greater vegetation diversity. The density of the *samuelis* sparrows was also checked in the non-breeding season during the dispersal phase of the young, thus reflecting the relative attractiveness of each habitat-type. Even then, the natural channel and slough-bank areas were occupied by from 1.5 to three times the number of birds as were found near the ditches. Collins and Resh (1985) concluded “ditches are not preferred habitat for the salt marsh song sparrow, primarily because ditches support shorter and spatially less diverse vegetation than apparently occurs along sloughs and natural channels. However, ditches do provide additional habitat that has increased the carrying capacity of Petaluma Marsh for salt marsh song sparrows...” [because the ditches are better than having no small channels at all]. The amount of marsh along tidal waterways [of any sort] was increased by 300% by such ditches and thus “ditching has added more than two thousand salt marsh sparrow territories to the Petaluma Marsh” (Collins and Resh 1985)

M. m. maxillaris- In their petition to list the Suisun song sparrow as endangered, Marshall and Mewaldt (1988) estimated the 1850s extent of tidal marshes within the range of this subspecies, plus those that developed as a result of sedimentation from placer mining at 66,618 to 73,712 acres. Such marshes, they also estimated, would have supported 69,949 to 77,398 pairs of these birds. These authors also cited a 90.4% reduction in area of such marshes, the total areas they had planimetered being 6,762 acres in 1986, which they estimated then supported about 5,666 pairs. Sizes and estimated populations were given for 10 different blocks of such marsh, and the distinctiveness in morphology and ecology of the taxon is summarized. Sites where previous investigators had conducted special studies or censuses were mapped and their results summarized. The petition included a map showing sectors of the Benicia Christmas Bird Count circle that included any tidal and adjacent marshes, and a graph showing the number of song sparrows (probably most, though not all of this subspecies) recorded in those sectors in the years 1977 through 1986 (compiled by Robin Leong). Year-to-year numbers varied considerably as census effort and methods of access varied. Thus they “do not reflect population changes but they show that the birds were constantly found over the years in optimum habitats” (Marshall and Mewaldt 1988). Michael Rippey’s measurements of seeds available to the salt marsh sparrows of San Pablo Bay-Napa River marshes and the Suisun Marsh area were also cited: the largest common seed of Suisun being that of alkali bulrush (*Scirpus robustus*) at 5/32 inch, which is notably larger than seeds of *Distichlis*, *Grindelia*, and *Salicornia* - a food resource feature that may help to explain the advantage for birds of this subspecies in having a swollen bill shape.

A California Department of Fish and Game staff report (Larsen 1989), forwarded to the Commission with the Marshall-Mewaldt petition, cited a number of additional pertinent studies and supported most of the petition’s findings, but the petition was rejected by the Commission. Nevertheless, these two reports in combination present an amount of detail for this subspecies not yet attained for the other two salt marsh races, for the details of the ecology of *samuelis* as learned by Johnston (1956a,b) were included as applicable to *maxillaris* as well. Under “Essential Habitat,” Larsen (1989) listed many details of the description by Marshall (1948a) for this subspecies. She summarized: “Suisun song sparrows use the tallest *S. acutus* in the centers of patches for song and calling perches, find concealment in the piles of dead stems, and forage on the bare surface of the mud between the stems and along the slough margins at low tide. They do not forage between stems that are only 2.5 to five centimeters (one to two inches) apart, but only forage in areas with stems that are 10 to 15 centimeters (four to six inches) apart. ... Thus they are limited to the area covered by tides, where flow is unimpeded by dikes, levees or channels.”

Larsen (1989) described marginal use of upland plants along levees by the sparrows, “but their territorial headquarters are always at the slough margins.” Their avoidance of diked marsh areas with *Salicornia* and *Grindelia* with no or impeded tidal flow was mentioned, although a few birds were found in such an area, on the eastern side of Cordelia Slough, that drained well through a culvert. [As noted above for *pusillula*, small populations of that subspecies also use such areas.]

Marshall and Dedrick (1994) reported a more recent measuring of the tidal marsh areas of the Suisun to Southhampton Bay marshes, and the surveys of locations where there were still birds of this subspecies found in or near those marshes, its historic range. Of the 64,255 acres of historic tidal marsh, 8,586 acres (13.4%) remained as of 1992, with a total estimated population of 9,530 pairs. Marshall and Dedrick (1994) emphasized the prime habitat as being the fully intertidal brackish marsh, although they did find in a 1990 survey (in just parts of the North Suisun area) some 79 pairs (out of 3,803 total) occupying “non-tidal territories,” 30 of them near Roaring River. As mentioned above, Marshall (1948a) found a few of these in territories centered on a “hedge” in dry grass by a ditch with water only at the two ends.

Using sophisticated Geographic Information System (GIS) software, Scollon (1993) carried out the most thorough analysis of the remaining habitat for this subspecies. This study evaluated pertinent data for the tidal marshes, such as block size, distance from neighboring blocks, and availability of suitable habitat for dispersal between blocks, and rated the blocks and to some extent, the corridors, as to numbers of Suisun song spar-

rows they could support. The rating was based on the pairs-per-acre ranges for five “strata” of habitat quality as given in an unpublished 1992 document by Joshua Collins - the field data in support of which I have not seen. Scollon himself apparently did no field work with the sparrows, but integrated the spatial aspects of the findings of others who have worked with song sparrows in the range of *maxillaris*. For example, in addition to using Collins’ “strata” evaluations, the dispersal distances found in one local population by Johnston in the 1950s [of *samuelis*, and cited above], plus a single comment by Larsen (1989) that these birds [*maxillaris*] “will generally not travel more than 50 meters over areas lacking protective cover, such as open water”, were the sole basis for his ratings of the suitability of dispersal corridors. Nevertheless, Scollon’s (1993) maps of the various blocks of habitats, each with its rating indicated by type of hatching, and the subsequent “linking” of habitat patches [or, alternatively, not linking them] based on the dispersal capabilities as applied to the maps, result in a set of “population patches” for the subspecies. This is the broadest scale approach to a population analysis of any of the tidal marsh subspecies yet performed. Scollon (1993) presented histograms of all the population patches by area (<30, 30-399, and 400-1200 acres) and by four ranges of population size. However, these were all apparently based on the data from quick surveys of singing birds, or possibly in part on data from Johnston’s and Collins’ separate reports from *samuelis* populations. What is really needed, of course, is to carry out a number of field checks with actual censuses of *maxillaris* population blocks to see whether the basic assumptions underlying all these “What if?” manipulations in the GIS system are borne out. Such field checks should be done with blocks of several different sizes and several different degrees of isolation.

Every ecologically oriented investigation of this subspecies has indicated that its prime habitat is tall brackish marsh with full tidal flows. However, the rating system of habitat strata cited (from Collins) by Scollon indicates considerable difference of populations to be expected even within the intertidal brackish category. In addition, although several authors have stressed that birds of this subspecies “avoid” or “do not use” diked marshlands of various sorts, Larsen (1989), Marshall and Dedrick (1994), and Scollon (1993) all cite instances where smaller populations or limited numbers of *maxillaris* sparrows were indeed using such habitat. It is possible that most or all of such birds in diked (and therefore marginal?) habitat are those excluded by intraspecific competitors already on territory within more optimum habitat, and that their attempts to breed in the marginal situations are doomed to failure or sharply reduced productivity. Field studies are needed to address this critical ecological question, and to determine whether diked marsh could be managed in such a way

as to provide good dispersal corridors, even if not breeding habitat. In the meantime, there is undoubtedly optimum value in fully intertidal brackish marsh with tall *Scirpus* vegetation along channels or sloughs with mud banks not too steep for low-tide foraging, and not too far from overhanging vegetation for protection from predators.

Recommendations for Conservation and Management

This section provides suggested goals for wetlands occurring in the range of each of the three subspecies of salt marsh song sparrow. These goals would be highly beneficial to population success of the target subspecies, while not overly detrimental to the populations of other important wetlands species in these same areas. The proposed goals are listed in order of priority for each subspecies/range.

Range of *M. m. pusillula* (South to Central San Francisco Bay) -

1. Keep inviolate all bayward and slough boundaries of the existing large blocks of intertidal marsh. In the East Bay, this should include Dumbarton Marsh and its connecting “Aqueduct” and Newark Slough marshes, the Mowry Slough marsh and bayside marsh west and south of the slough-mouth, the “Ideal Marsh” (bayfront west of Coyote Hills), and “Whale’s Tail Marsh” (south and north of the mouth of Alvarado Channel). In the West Bay, this should include Outer Bair Island plus Corkscrew Slough; Greco Island; and north and south of Cooley Landing through Palo Alto Baylands marshes (nearly contiguous now). In the far-South Bay, this should include Triangle Marsh (NNW of Alviso), Albrae Slough and nearby shores of Coyote “Creek,” outer parts of Alviso and Guadalupe sloughs, Stevens Creek, etc. (all somewhat brackish but occupied). Other parts closer to the major sewage effluent outfall in Artesian Slough east of Alviso are of too low salinity to support vegetation that is usually occupied by this subspecies, as are the parts of Coyote Creek and Mud Slough near Newby Island at present.

One recently proposed change in land use across the largest block (Dumbarton Marsh) is to upgrade the railroad right-of-way there as a part of a new high-speed rail route from the Central Valley (and Los Angeles) to San Francisco. The fill along the unused tracks has been, for over 20 years, both a high-tide refugium for sparrows, rails, etc., and an avenue for access to the marsh by red foxes and feral house cats - although this avenue has been interrupted to the west and east in recent years by keeping “open” the bridges over the Dumbarton Strait and Newark Slough.

2. Expand any of the areas listed under the first priority above, especially in directions that would either: (a) provide habitat linkage for breeding populations of *pusillula* in locations between any of these areas, or at least good habitat for dispersal between populations in the event any local population suffers a disastrous decline; or (b) enhances the overall quality of habitat available within or at the edge of the habitat block. Examples of the latter might be to provide additional high-tide refugia where not now adequate, as on Greco Island (birds that use the Pacific Gas and Electric boardwalk are very vulnerable to predators), along various sloughs where the existing marsh is only in the form of a strip between the mudflat and open salt pond levee, or next to diked or industrial development.

Also in this priority should be the enhancement of habitat values for these birds in existing or planned smaller blocks. Such areas would include: Burlingame Cove, Belmont Slough and nearby Bird Island, inner Steinberger Slough, Ravenswood Slough and shoreline through the newly acquired gun club marsh near Dumbarton Bridge, La Riviere Marsh, and Mayhews Landing Tract of the National Wildlife Refuge, "Pond 3" marsh north of new Alameda Creek, Mt. Eden Creek-Baumberg Tract -Alvarado Channel in Hayward, tidal lagoons in both south and north parts of Hayward Regional Shoreline (plus possibly the adjacent H.A.R.D. marsh), newly tidal south part of San Leandro shore area, Arrowhead Marsh and other smaller marsh bits in the vicinity of San Leandro Bay and Oakland Airport, Emeryville Crescent Marsh, Albany Cove and Hoffman Marsh (in se. Richmond) - the last being very close to the original northernmost point where this subspecies was found.

3. As the opportunities arise, establish new habitat for this subspecies in areas where it does not now exist. This effort should target areas that would add marsh corridors or patches along likely dispersal routes between major blocks of existing good to optimum habitat. Even small blocks would be worthwhile if spaced relatively closely in such areas. Major gaps in habitat acceptable to this form currently occur from the Bay Bridge through the Oakland Estuary/Alameda (except the far eastern part of the south shore), salt pond levees not bordered by marsh though much of Hayward and Fremont, and the shoreline near developed areas through Foster City and San Mateo. It seems unlikely much opportunity will arise to create tidal marshes north of San Francisco Airport, but a 20-acre "marsh" (some to be open tidal flat) is a part of the Golden Gate National Reserve Area Plan for

Crissy Field in the Presidio [implementation began in late 1999]. If birds of *pusillula* parentage are to reach it, they would probably have to be introduced there, at what was likely the northwestern-most limit of the range of this subspecies.

4. Restore, to the extent possible, a "natural" range of salt marsh habitats in the location of the operating salt evaporators or diked former salt ponds (e.g., on Bair Island), should any of these areas become available. This would not only greatly benefit the song sparrows of this subspecies, but also the clapper rail, salt marsh harvest mouse, and several other species. The slow development of marsh vegetation on the "scraped" parts of the former salt ponds in the Hayward Regional Shoreline tidal lagoons, and the silting of a number of the too-straight (engineered) channels excavated there, should be compared with the rapid development of salt marsh vegetation on reopened parts of Bair Island when choosing methods for restoration of the desired habitat.

Range of *M. m. samuelis* (North San Francisco Bay through San Pablo Bay) -

1. Keep the present large blocks of high quality habitat in that condition. This includes not ditching the parts that already have adequate small channels with the diverse vegetation the sparrows prefer. The "keeping" also applies to the marsh corridors or small blocks that are spaced to provide dispersal opportunities among the larger blocks.
2. Restore sufficient intervening tidal marsh blocks or strips where there are currently the longest gaps in such. For example, suitable tidal marsh should be restored along the eastern side of the lower Napa River, and wherever possible along the entire Contra Costa County shore from Selby to San Pablo Point (the probable southeastern limit of the original range), as well as from San Rafael through San Quentin Cove. Topography prevents any suitable marsh corridor to Richardson Bay, which has some marsh remaining, but none of these sparrows in it according to Marshall (1948a,b).
3. Expand the tidal marsh area by opening to tide action some of the now disused salt evaporator ponds in the area between Napa River and Sonoma Creek. Since all or most of these ponds are now owned by the State, a truly major addition to the habitat for *samuelis* song sparrows (as well as clapper rails and other tidal marsh inhabitants) could be realized. Since this area adjoins an existing brackish marsh at Fly Bay and fronts on grassy uplands to the north (as does the existing tidal marsh east of the Napa River near Bull's Island), other species requiring the transitional sort of habitat, such as savannah sparrow and black rail, would also be benefited. This tidal marsh to

upland zone is now all but absent in San Francisco Bay proper, so the goals for San Pablo Bay should certainly include a major provision to preserve and extend it.

Range of *M. m. maxillaris* (Suisun Bay marshes and vicinity, west through Southhampton Bay) -

1. Preserve the acreage and quality of existing habitat blocks used by all significant numbers of birds. To preserve quality, prevent further salinity intrusion into the Suisun marsh areas caused by greater diversions of freshwater flow in or above the Delta. With increased salinity, the tall brackish marsh to which this race is adapted would likely be replaced by shorter, more salt-tolerant vegetation, more like that in the range of *samuelis*. Birds of that race would, however, be unlikely to disperse eastward into the Suisun area because of lack of habitat along the Carquinez Strait.

Scollon (1993) modeled two levels of salinity intrusion, based in turn on salinity levels for May 1965 and February 1971, as mapped by Rumboltz (1979). Rumboltz' (1979) 1971 map shows a level of 2,500 micromohos along a line extending across the middle of Honker Bay, and also Joice Island. According to Scollon (1993), this is nearly equivalent to the salinity standard of 2 ppt recommended by the San Francisco Estuary Project [for the continued health of the Suisun Marsh?]. At that salinity level, the vegetation, and hence the sparrows, of the marshes along the southern side of Suisun and Honker bays (totaling approximately 1,900 acres) have already suffered heightened salinity impact. However, there is insufficient recent data on *maxillaris* sparrow populations in this area with which to test this hypothesis. If that level of salinity intrusion holds, Scollon's model (case A) predicts that the major populations in the northern part of the Suisun Marsh complex would escape severe impacts. These include the population in the largest block of marsh (1,394 acres) in the Rush Ranch-First Mallard Branch area, as well as that in Hill Slough and vicinity (468 acres). In spring 1990, Marshall found 159 pairs of *maxillaris* in the western 154 acres of the former block and 58 pairs in 130 acres in the latter one (Marshall and Dedrick 1994).

If, however, salt intrusion above the threshold level of major vegetation change extends to east of Chipps Island and includes most of Montezuma Slough (Scollon's 1993 case B), there would be a major reduction of *maxillaris* populations in these last strongholds of the subspecies, and in all other smaller blocks in the northern Suisun Marsh. Without knowing whether Marshall's 1990 censuses were conducted in average quality habitat within the blocks of marsh he sampled, and

without census data from other blocks, no firm prediction can be made as to the future survival of this critically restricted form. It seems quite possible, however, that this one factor alone could eliminate it.

2. Improve the contiguity of tidal marsh blocks throughout the Suisun complex. Although still retaining a higher percentage of its original extent of such marsh than the range of *pusillula*, the separation of major blocks is more widespread. On the southern side of Suisun Bay, this is due primarily to industrial and small harbor developments along the shore, but also in some locations to old filling alone. North of eastern Suisun Bay and Honker Bay, and particularly throughout the area from near Benicia and Cordelia east to Nurse Slough and Denverton, the whole wetland area is nearly all behind dikes and managed. Most impediments to dispersal of the sparrows between larger blocks of tidal marsh are interruptions in the narrow bands of tidal marsh along the numerous sloughs. Scollon (1993) assumed that the birds would tend to spread more toward their optimum lower salinity, with increasingly saline conditions in the western part of the Bay, and his recommendations of key areas to provide the best routes for such shift of range are:
 - Along the shoreline of Joice Island (both sides) to "provide a critical link between populations along the shoreline of Grizzly Bay and those in the northern reaches of Suisun Marsh;"
 - Along the northern shore of Honker Bay and southern shore of Suisun Bay, to link populations west and east; and
 - Along the eastern reach of Montezuma Slough, to connect the northern populations with those in the eastern Suisun Bay area. Scollon (1993) indicated that a 1991 proposal would have increased tidal marsh in this area, but it was apparently not accomplished, at least by the time of his writing.
3. Evaluate the management practices in the extensive gun club and wildlife agency lands throughout the western and northern parts of the range of *maxillaris*, with a focus on alternative types of vegetation control. Management practices should be sought that would provide corridors of brackish marsh across strategic areas that now act as barriers to these birds. At a minimum, provide reasonably continuous marsh-mud interfaces (even if freshwater) that might also provide for dispersal when it occurs during the late summer period. Such manipulations could be done in different locations (rotated) in different years. The area is noted for its provision of habitat for waterfowl. The recommendation made here is not intended to diminish that

value, and might even be found to enhance it as well as habitat for the sparrows.

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Response of Birds to Managed Water Levels at Charleston Slough - A Case Study

William G. Bousman

Introduction

Charleston Slough is a former tidal estuary at the boundary of Palo Alto and Mountain View. A dike was placed across the outer slough in the 1920s, but a 60-inch pipe in that dike allowed tidal exchange up through the early 1970s, and a healthy salt marsh community of about 40 to 60 acres existed under the muted tidal regime of that period. In the mid-1970s, the 60-inch pipe was replaced with a 48-inch pipe placed higher in the dike, with the result that the tidal flow became highly muted (or non-existent), and the mean water level in the slough increased sufficiently that the salt marsh was inundated and lost.

Based on the destruction of the salt marsh in Charleston Slough, the San Francisco Bay Conservation and Development Commission (BCDC) prepared a Cease and Desist Order for Leslie Salt Company (now Cargill Salt). The company then transferred ownership to Mountain View, leaving that city to comply with the BCDC requirements. These requirements included the development of a new outlet structure in the outer dike that would provide a tidal fluctuation in the slough of 1.0 feet. At this time, the Santa Clara Valley Audubon Society (SCVAS) started a series of weekly censuses of the slough, and these continued through 1995, although the frequency of the censuses was reduced to every two weeks in the early 1980s.

The present case study is based upon a comparison of census data from the fall periods of 1980 and

1981. This comparison shows species composition and abundance changes that resulted from managed changes of water levels in Charleston Slough.

Methods

In the period from October 1980 through the end of 1981, Charleston Slough was censused on a weekly basis by four to five volunteers. Volunteers were given a one-week window in which to perform their censuses, but otherwise were allowed to select both the day of the census and the time of day. No attempt was made to census the birds in relationship to the tidal cycle. The census was made either on foot or by car using the public levee between Charleston Slough and the Palo Alto Flood Control Basin. Birds were censused within or above the slough to the centerlines of surrounding levees. As essentially all portions of the 109-acre slough were visible from the public levee, the census recorded all birds present. Each census required about two hours. Observers were encouraged to count certain species as groups because of identification difficulties. These groups included greater and lesser scaup and short-billed and long-billed dowitchers. In some censuses, when large numbers of gulls were using the private levees for roosting, not all were identified to species.

Results

Census data show the lowest number of birds and species to occur in the summer, with the greatest number observed during fall, winter, and spring. The initial two years of the census were a time of substantial transition as construction for the new outlet structure was completed in February 1981, substantially changing the water levels in the slough. Prior to the removal of the cofferdam around the outlet structure, the water level was approximately 4.6 feet above Mean Lower Low Water (MLLW) and the entire slough was inundated. With the removal of the cofferdam, the water level dropped by approximately 1.8 feet, and 50 to 60 acres of mudflats were exposed. Very little tidal flow occurred in the slough because of siltation outside of the outer levee.

The water level in the slough started to increase in the winter of 1981-82, and this increase continued in later years so that as of 1996, the slough is largely inundated once again.

A comparison of the census data collected in October and November of 1980 (n=7) and October and November of 1981 (n=6) are shown here as representative of two different water regimes. The 1980 data are for the slough at its maximum water level, with essentially no exposure of mudflats. The 1981 data are for the slough at its minimum water level, with 60-80 acres of mudflats. The census data for the two periods are com-



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Species	October-November				Table 7.9 Census Data from 1980 and 1981 for Charleston Slough
	1980 (n=7)		1981 (n=6)		
	Birds/Cen	Rank	Birds/Cen	Rank	
Pied-billed grebe	45.9	10	17.8	18	
American white pelican	78.8	7	6.3	20	Santa Clara Valley Audubon Society data.
Double-crested cormorant	8.3	17	0.3	34	
Great egret	1.5	28	2.5	30	
Snowy egret	5.7	18	2.8	28	1980 data were collected when the slough was at its maximum water level, with essentially no exposure of mudflats.
Mallard	0.7	30	3.2	26	
Northern pintail	224.0	3	24.8	16	
Northern shoveler	80.6	6	7.5	19	
Gadwall	18.6	15	1.7	31	
American wigeon	111.0	4	0.0	35	1981 data were collected when the slough was at its minimum water level, with 60-80 acres of mudflats.
Canvasback	0.1	32	3.0	27	
Bufflehead	10.9	16	0.3	33	
Scaup spp.	2.4	26	1.0	32	
Ruddy duck	1,221.0	1	103.0	6	
American coot	1,066.0	2	26.0	14	
Black-billed plover	2.0	27	75.2	8	
American avocet	63.3	8	267.7	4	
Greater yellowlegs	4.3	20	5.3	22	
Willet	2.7	25	25.2	15	
Marbled godwit	3.3	23	23.5	17	
Western sandpiper	0.0	35	53.8	9	
Least sandpiper	3.4	22	48.5	11	
Dunlin	0.4	31	53.2	10	
Dowitcher spp.	25.7	12	400.0	2	
Ring-billed gull	19.4	14	165.0	5	
California gull	28.6	11	1,720.0	1	
Herring gull	57.9	9	343.0	3	
Western gull	99.6	5	41.3	13	
Glaucous-winged gull	3.3	24	0.0	36	
Forster's tern	21.2	13	75.5	7	
European starling	0.1	33	2.8	29	
Savannah sparrow	5.2	19	5.8	21	
White-crowned sparrow	0.0	36	3.7	24	
House finch	4.0	21	4.5	23	
Total Birds	3,220.8		3,559.0		

pared in **Table 7.9** for the 36 species counted and, included with the mean number of birds within each period, is the rank of that species relative to the others censused. **Table 7.9** shows that 33 species were tallied in 1980 and 34 in 1981, while the mean species total for each census in 1980 was 3,221 birds and in 1981 was 3,559 birds.

The species list from **Table 7.9** was sorted by the rank obtained in 1980 and the fifteen most common species in that year are shown in **Table 7.10** in rank order. The species totals and ranks for 1981 are also included in this table, but not in rank order. The percent of the total number of birds for 1980 is shown in the

table as the final column and the cutoff at fifteen species is based on reaching 98% of the total number of birds recorded in all censuses.

The species list from **Table 7.9** was sorted by the rank obtained in 1981 and the eighteen most common species are included in **Table 7.11** by the 1981 rank order where, again, the inclusion of common species is based on reaching 98% of the total number of birds.

Discussion

The total number of birds counted in October and November of 1981 were approximately 10% greater than

Table 7.10 Fifteen Most Common Species Censused at Charleston Slough in 1980 – sorted by 1980 rank order

Species	October-November Birds/Census				% 1980 pop.
	1980		1981		
	n=7	Rank	n=6	Rank	
Ruddy duck	1,221.0	1	103.0	6	0.38
American coot	1,066.0	2	26.0	14	0.71
Northern pintail	224.0	3	24.8	16	0.78
American wigeon	111.0	4	0.0	35	0.81
Western gull	99.6	5	41.3	13	0.85
Northern shoveler	80.6	6	7.5	19	0.87
American white pelican	78.8	7	6.3	20	0.89
American avocet	63.3	8	267.7	4	0.91
Herring gull	57.9	9	343.0	3	0.93
Pied-billed grebe	45.9	10	17.8	18	0.95
California gull	28.6	11	1,720.0	1	0.96
Dowitcher spp.	25.7	12	400.0	2	0.96
Forster's tern	21.2	13	75.5	7	0.97
Ring-billed gull	19.4	14	165.0	5	0.98
Gadwall	<u>18.6</u>	15	<u>1.7</u>	31	0.98
Total Birds	3,161.6		2,856.6		

Santa Clara Valley Audubon Society data.

Data were collected when the slough was at its maximum water level, with essentially no exposure of mudflats.

Table 7.11 Eighteen Most Common Species Censused at Charleston Slough in 1981 – sorted by 1981 rank order

Species	October-November Birds/Census				% 1981 pop
	1980		1981		
	n=7	Rank	n=6	Rank	
California gull	28.6	11	1,720.0	1	0.48
Dowitcher spp.	25.7	12	400.0	2	0.60
Herring gull	57.9	9	343.0	3	0.69
American avocet	63.3	8	267.7	4	0.77
Ring-billed gull	19.4	14	165.0	5	0.81
Ruddy duck	1,221.0	1	103.0	6	0.84
Forster's tern	21.2	13	75.5	7	0.86
Black-bellied plover	2.0	27	75.2	8	0.88
Western sandpiper	0.0	35	53.8	9	0.90
Dunlin	0.4	31	53.2	10	0.91
Least sandpiper	3.4	22	48.5	11	0.93
Black-necked stilt	0.9	29	41.5	12	0.94
Western gull	99.6	5	41.3	13	0.95
American coot	1,066.0	2	26.0	14	0.96
Willet	2.7	25	25.2	15	0.97
Northern pintail	224.0	3	24.8	16	0.97
Marbled godwit	3.3	23	23.5	17	0.98
Pied-billed grebe	<u>45.9</u>	10	<u>17.8</u>	18	0.98
Total Birds	2,885.3		3,505.0		

Santa Clara Valley Audubon Society data.

Data were collected when the slough was at its minimum water level, with 60-80 acres of mudflats.

observed in 1980. Although the variance of the data has not been examined, a 10% change in abundance is unlikely to be significant. Similarly, the number of species comprising 98% of the entire bird population increased from 15 to 18 between 1980 to 1981 and, again, changes of this size are not believed to be significant. Thus abundance and diversity, as measured here, did not change substantially between the two different managed water regimes.

The changes that did occur between 1980 and 1981, however, were in species composition. In 1980 just five species comprised 81% of the population: ruddy duck, American coot, northern pintail, American wigeon, and western gull. The first four of these are species that clearly benefit from ponding and inundation. In 1981 censuses, however, these five species represented only 5% of the total population. Similarly, in 1981, a

different five species comprised 81% of the population: California gull, dowitcher species, herring gull, American avocet, and ring-billed gull. The gull species appear to have responded to the extensive mudflats as areas secure for loafing, while the two shorebirds species used the slough for foraging, as well as resting. These five species that were most common under the high water regime accounted for only 6% of the local population in the prior year's census data.

The first point from this case study is that the two managed regimes used for this 109-acre former slough resulted in equal numbers of birds and species diversity. The water level between the two years was very different. In 1980, the water level was sufficiently high to inundate the entire slough such that no mudflats were available for foraging or secure roosts. In 1981, the water level had been lowered such that about half the slough's area was available as mudflat for foraging or roosting. The species composition changed drastically between the two managed water levels - but these sort of changes are not quantified by simple ecological measures, such as total abundance (unchanged) or species diversity (unchanged).

A second point to consider is that the potential of Charleston Slough to be productive in terms of species abundance and diversity under two water management regimes is related to its scale compared to the entire estuarine system. Its size, 109 acres, is small compared to the overall South Bay system, and the variety and number of birds that can opportunistically take advantage of changes in such a small area are quite large. Although this case study probably applies to any similarly sized area within the estuarine system, it is not clear that it applies to areas that are substantially larger.

A third point, and one directly related to the first, is that if simple measures of ecological health such as

abundance and diversity cannot be used to distinguish between two managed regimes, than what metrics can be used? As a community of individuals, we all may see and voice the need for some sort of balance in our management of estuarine systems. In particular, when we obtain stewardship responsibilities for a new component of the system, we all see the wisdom of studying this component to allow us to make wise and informed decisions. However, in the end, as in this Charleston Slough example, there may be no sound or rational basis for selecting a "correct" management regime. In the absence of sound ecological principals to be used for management, how do we make our choices? Do we use community values? Do we allow some portion of the electorate a vote? Or do we rely upon leaders of the scientifically-informed community to govern our choices?

Epilogue

This case study is concluded by reporting the "final" solution for the management of Charleston Slough, which was achieved recently, twenty years after the original Cease and Desist Order. It was agreed that the former non-functional outlet structure would be replaced with multiple pipes with sufficient tidal capacity, so that with time, a new tidal prism would be established and the blocked outer channel would be opened through scouring. This construction was accomplished during the 1998 summer season. Although there is an increased tidal range in the slough under this new regime, it does not meet the original requirements. The next step will be to assist tidal scouring by removing some of the Bay mud outside the new outlet structure. There is no prediction, presently, as to when a functioning salt-water marsh is likely to be restored.



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The Use of Salt Ponds by Some Selected Birds Other than Shorebirds and Waterfowl

Howard L. Cogswell

The term “salt ponds” is traditionally used to cover any or all of the saltwater impoundments around the San Francisco Bay that are used in the various evaporation stages leading to final crystallization in the salt company plant-sites (now only one company, Cargill Inc., Salt Division). A number of salt ponds have been taken out of such use by this company and the last other company to operate (Oliver Brothers of Hayward), but many of these remain mostly barren of vegetation. The accumulated salts in their bottoms make the rainwater ponded in them in the winter ecologically somewhat similar to regular evaporators even though the salinity changes over the year are probably greater than in any one pond in the ponds currently in use. I would recommend that all such inoperative saline areas be included in the salt pond habitat category by the Focus Team, as long as they are mostly barren of vegetation, even though they may be completely dry for half or more of the year. I also recommend that they be placed in the “diked seasonal wetlands” habitat category when there has been sufficient growth of vascular plants that birds and such mammals as voles and the salt marsh harvest mouse typical of such “marshes” can be expected to be present in significant number.

South Bay examples of places where such former salt ponds are still mostly barren are on parts of Bair Island, the southernmost and northwestern-most ponds of the sequence west of Alviso Slough (the northwest ponds are the “Knapp Tract,” and part of the National Wildlife Refuge (NWR)), parts of the Hickory Tract just west of the head of Newark Slough, and parts of the Baumberg Tract in Hayward. Other parts of Bair Island, and the Hickory and Baumberg tracts have already succeeded to more seasonal marsh than salt pond characteristics. Presumably, the large area of former salt ponds between the lower Napa River and Sonoma Creek also have portions that would fit in each category as well.

As thus restricted, the majority of the salt pond system is heavily used by birds. A large percentage of that use depends on the shoreline of the ponds, as well as the water, and a special value is easily traced to islands and the remote or undisturbed parts of the dikes between the ponds. Such habitat aspects seem inseparable from the ponds themselves for many species, including some of those mentioned below (but especially, of course, the shorebirds - to be addressed by another focus team). For species that nest or roost on these dry land inclusions in the salt ponds, it is the isolated placement of such land within the surrounding water that makes it valuable. A

tenth-acre island in a salt pond is far more valuable as bird habitat than an acre of barren ground in an upland situation! In addition, some “Other Birds,” such as herons, often use the shoreline or shallower water adjacent to dikes and islands for foraging. Hence, this report in no way avoids consideration of the dry land parts of the system.

Salt Pond Operations

It is important in defining wetlands goals for salt ponds to understand the basics of operation of those ponds still used in the salt-extraction process. Details seem inappropriate here, except that: 1) the ponds are functionally connected into salinity gradient sequences as a result of systematic transfers of water among them; 2) each evaporator pond can thus be classified as a low, medium, or high-salinity pond, these categories having marked differences in forage value for birds; 3) some ponds are occasionally pumped nearly dry, and when this happens, their function in “isolation” from predators of roosts or, in the breeding season, of nests is sharply reduced; 4) the most highly saline ponds (crystallizers and the “pickle” ponds just before them in the sequence) have essentially no organisms suitable as food for birds, but in some locations still provide roosting protection; and 5) the “bittern ponds” (currently large ones at Newark and small ones at Redwood City) are filled with the brine remaining after sodium chloride crystallizes, and seem to provide essentially no wildlife value at all, but are a necessary part of the system since water quality restrictions now prohibit the disposal of that brine in the Bay.

Salt Pond Numbering Systems

Leslie Salt Company (which was bought by Cargill in the late 1980s) assigned numbers to each evaporator in the sequence of the water movement at each of their separate plants: Newark (plants 1 and 2), Mowry, Alviso, Redwood City, Baumberg (in west Hayward), and Napa. In several areas, additional ponds were added to the system at either the beginning or somewhere in the middle of the water-movement sequence, these ponds being distinguished by additional letters usually in suffix position. Except for the San Pablo Bay-Napa unit (sold to the State in the early 1990s), all these pond numbers continue in use by Cargill, even though the Alviso plant was closed long ago, and the Baumberg and Redwood City plants in 1972 (Redwood City being reopened a few years later). Water is no longer moved in sequence of the pond numbers, and old systems are combined with converging flows at several salinity levels.

Because duplicate numbers existed for many ponds in different areas, I came up with prefix letters making all the ponds in the NWR distinctively numbered. These are shown on the map in **Figure 7.7**. I have used “K”

instead of “N” as prefix for the Newark system because N could be confused with the abbreviation for “north” when parts of the ponds are to be referenced. For the system of ponds in Hayward (the old Baumberg plant ponds) currently outside the NWR limits, I use the prefix “H” to avoid confusion with ponds B1 and B2 (Leslie’s designations) in Mountain View - a part of the old Alviso system.

Current Studies of Salt Pond Ecology

A few studies have analyzed ecological or ornithological aspects of groups of salt evaporators with consideration of the differences among the ponds. The chief ones are:

1. Carpelan (1957), who studied a sequence of ponds in the Alviso area and reported primarily on the water chemistry, algae (including microscopic forms), and invertebrates, but mentioned some birds.
2. Anderson (1970), who studied five ponds south of Mowry Slough east to the Southern Pacific Railroad with respect to their use by birds in relation to different salinities and seasons of the year. However, his study omitted three ponds that were involved in the water-movement sequence from intake to three or four ponds short of the crystallizers, as the system then operated.
3. Gill (1977), essentially a summary of his 1971 survey of all breeding species found in bay-related habitats south of San Mateo Bridge (his M.A. thesis at San Jose State), with updates through 1975 from scattered later observations by him and others. Does mention salt ponds and their dikes as habitat features for many species.
4. Swarth (1981), who reported waterbird numbers pond by pond on the 11 ponds lying west of Coyote Hills between the new Alameda Creek Channel (which obliterated the former Coyote Hills Slough) and the east approach to Dumbarton Bridge.
5. Swarth, Akagi and Metropulos (1982), who incorporated the results from Swarth (1981) and extended counts of birds on the same set of ponds. The bird numbers were also analyzed for correlation with the biomass of major invertebrate populations (chiefly brine shrimp and water boatmen) as determined by hundreds of plankton hauls in the upper ¼ meter of water within three meters of a canoe, as well as to variations in water temperature, salinity, pH and depth and to wind direction and location about the periphery of each pond.

The last is by far the most thorough study of bird use of salt ponds and should be reviewed for information about each species to be considered in developing wetlands goals for this habitat type. Yet both that study



Howard L. Cogswell

Eared Grebes between foraging dives on salt pond K3, January 12, 1989

and the earlier one by Swarth (1981) counted birds only during the four to six hours spanning the high tide point on the adjacent Bay, ostensibly to be able to report the “maximum use” of the ponds by birds. They reported in general terms only, e.g., that most shorebird species were essentially absent from the salt ponds when the nearby tidal flats were exposed. Cogswell (1981) found that exposed tidal flats at the lower tide-levels had a drawing power for shorebirds that even exceeded that of higher level tidal mudflats (that had been created by opening dikes of long-abandoned salt ponds at Hayward). This study included data from all tide levels, but of course none from existing salt ponds.

Another limitation of the studies west of Coyote Hills which was not mentioned by Swarth et al. (1982), is that some or all of the ponds they studied had been receiving water since 1972 from the approximately 20 evaporators that lie to the north of new Alameda Creek. That area is the former Baumberg Unit of the Leslie Salt operation, water from which since that year has been sent by siphon under the new creek channel to merge with that in ponds south of it. So, the Swarth et al. classification of ponds into “low, medium, and high” salinity apparently did not include any that were strictly the lowest or “intake only” salinity. In addition, under the Leslie operation since 1972, ponds K3, K2, and K1 south of the Dumbarton Bridge approach have been the final evaporators in this sequence before the water is pumped to the pickle pond and crystallizers. So Swarth et al. also had no bird data from these highest salinity evaporators, although they did sample invertebrates in the western part of Pond K3 (their Pond 14) and two small “pump donut” ponds close to the bridge.

In 1992-93, I did semi-monthly counts of shorebirds and ardeids, and noted general numbers of other birds on Pond K1 and adjacent Newark Slough as a part of the San Francisco Bay Bird Observatory (SFBBO) Shorebird High-tide Habitat Use Study. Other observers did the same in many units around the South Bay in the same periods. The SFBBO has also implemented (for some 17 years) a Colonial Waterbird Breeding Monitor-

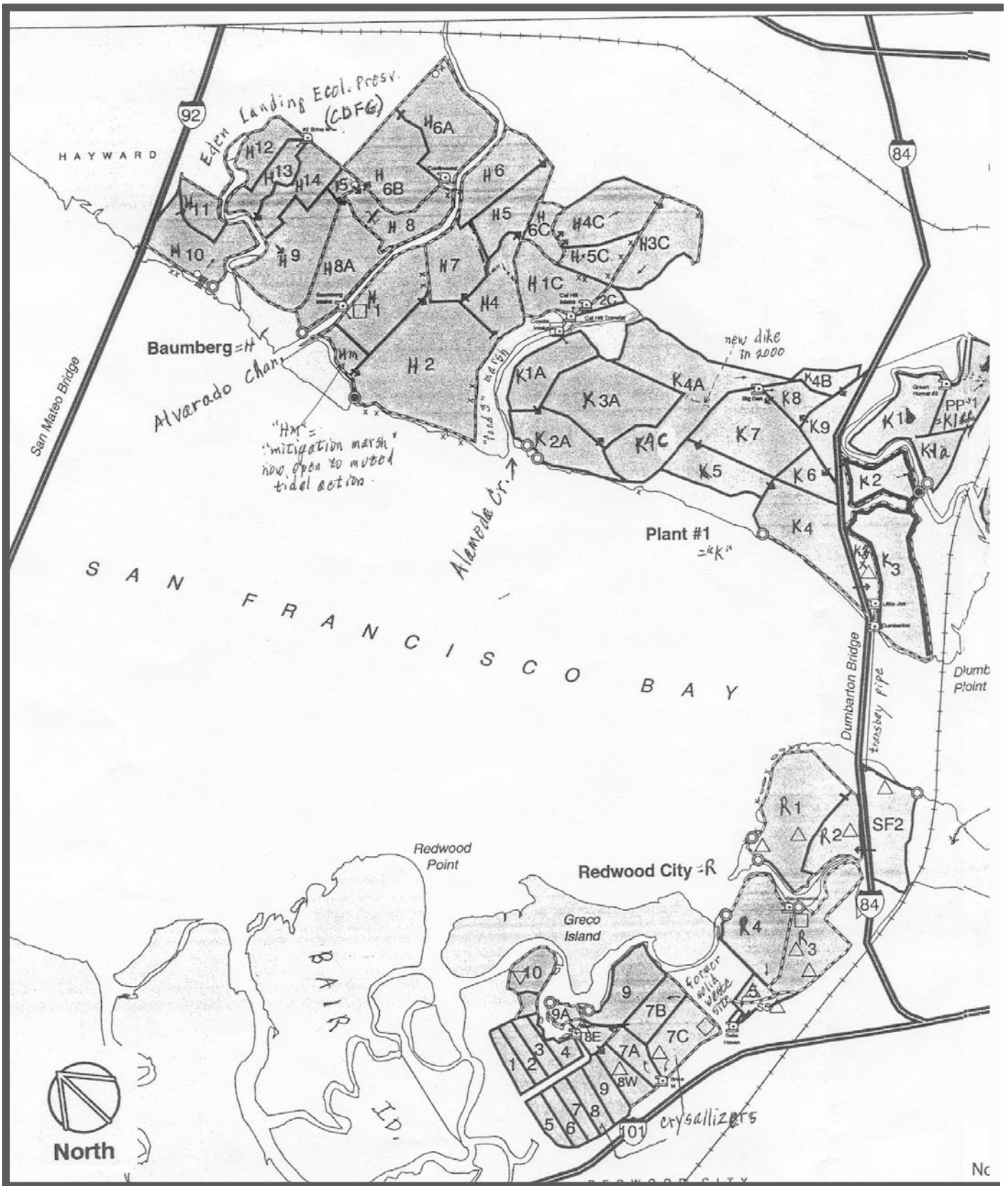
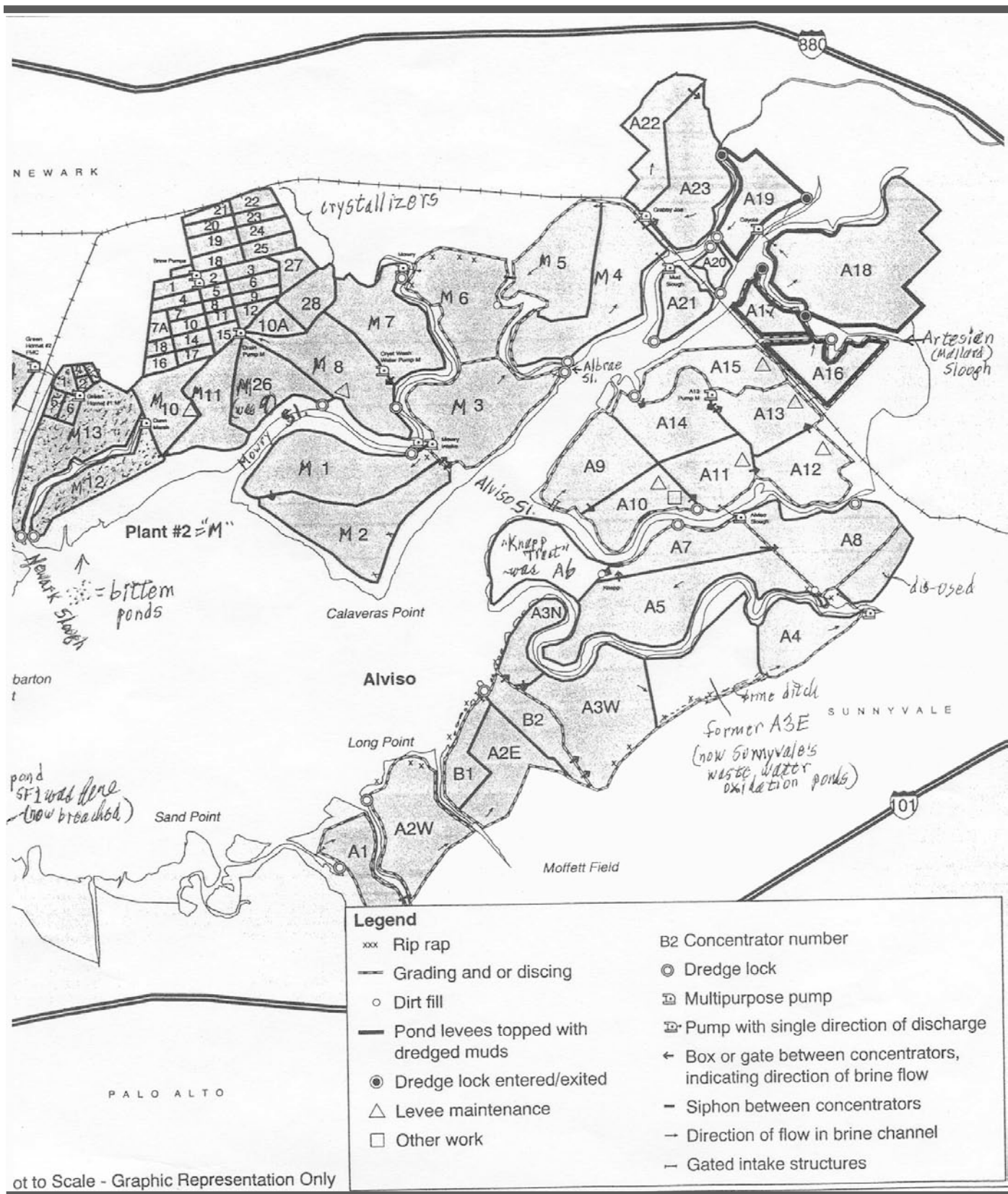


Figure 7.7 Numbering System for the Salt Ponds of South San Francisco Bay. Developed by H.L. Cogswell



based on a map from the Cargill Salt 1998-1999 Completion Report.

ing Program. This program encompasses areas around the Bay south of the San Mateo Bridge, and includes all of the nesting herons and egrets (and a few white-faced ibises) and all of the gulls and terns. Yearly reports (e.g., Layne 1995) are made to the NWR as to the locations and numbers of nests or birds in each colony and for some years some data regarding success. Trends in total numbers and some colonies of herons and egrets for the first 15 years were analyzed by Ryan (1998) for all habitats, including the few in salt ponds.

Use of Salt Ponds by Some Key Bird Species

The following sections summarize information on the use of salt ponds by 16 of the 24 bird species that were selected by the "Other Birds" Focus Team as representative of our group of species. The summaries are based on information from each of the above-mentioned reports, plus from my own memory based on over 30 years of experience with birds on salt ponds (mostly in the Hayward to Fremont area). The literature makes frequent reference to "low," "medium," and "high-salinity" evaporators or salt ponds. Herein, I use the terms "salt ponds" and "evaporators" interchangeably, unless specific reference is made to crystallizers or pickle ponds, and I omit bittern ponds entirely because of their exceedingly low habitat value for any birds.

My "low salinity" pond category includes ponds with apparently higher fish populations than any west of Coyote Hills, and thus also encompasses high-fish ponds (intake ponds or the next few in long strings of evaporators), such as those sampled for fish by Lonzarich (1989). The "high-salinity" category also is extended at least by several ponds from what was considered to be that category by Swarth et al. (1982); but my "medium-salinity" ponds encompass the same range as theirs and a bit more on each end. In the future, a thorough analysis of data over the whole range of salinities might justify recognizing as many as five salinity categories rather than three.

Eared Grebe (*Podiceps nigricollis*) - Abundant on medium or medium-high saline evaporators from October through April, and present in lesser numbers in late August through September and in May. Anderson (1970) reported a maximum count of 6,330 in November on his "ponds with high-salinity". Swarth et al. (1982) reported their maximum of 5,565 in April 1980, but numbers the following spring were below 3,200. They had average counts of 500 and about 1,950 in November of the two successive years, and a very few were found through the summer. Correlation of eared grebe November-April numbers per 10 hectares in each of the 11 ponds in the same study was strongly correlated (at $p < 0.02$ level) with the grams dry weight of invertebrate biomass sampled in the same ponds. The brine shrimp and water boatmen that constituted nearly all of these biomass samples are apparently the prime food for this

species during its stay here. Brine fly larvae and pupae, spending most of the time on or near the bottom of the salt ponds, may also be important foods, but were mostly missed in the surface plankton hauls.

There have been an estimated one to several thousand eared grebes on each of several different evaporators in the medium-salinity range in southwest Hayward in the fall of different years, and the same is probably true for each set of salinity-sequence ponds around the South Bay. In some areas, the numbers are higher in the April migration period. The total number may thus be 50,000 to 100,000 or more birds - a significant portion of the species population, although minor by comparison with its concentration in late summer at Mono Lake and the winter numbers on Salton Sea.

In 1983, a nesting colony of 70+ adult eared grebes on abandoned sewage ponds in Pleasanton, eastern Alameda County, produced at least nearly the same number of young before abandoning them still in flightless condition as the pond was drained in July. A smaller colony the same year also produced young in the Crittenden Marsh (brackish?) near Mountain View (W. Bousman, pers. comm.), and some persisted for several years in a nearby area. Swimming invertebrate or fish food resources, plus at least some emergent or submerged vegetation to which floating nests can be anchored, are required for grebe nesting. The salt ponds that supply the former very rarely have any of the latter, so their value as a breeding habitat for this species is very limited.

American White Pelican (*Pelecanus erythrorhynchos*) - Present as non-breeding visitors (most probably post-breeding) to the several lowest salinity salt evaporators in most of the intake sequences around the Bay from July through October in considerable numbers. Some 900 or so were regularly in the South Bay from 1965 through about 1980, then somewhat fewer. Numbers diminish through the winter at rates that vary among years (to zero in some years), followed by resurgence in some years in April and early May. There are a few records also through June.

Even in their peak period, local surveys of only one set of low-saline ponds may often reveal no white pelicans, while a few days later (or even later the same day) scores or hundreds may be present. The 900 total estimated above was supported by numerous flights by small airplane which I made in the 1970s and early 1980s, covering most of the salt ponds from Hayward, south to Alviso, and north through Mountain View, and occasionally on through Redwood City. Salt ponds in which white pelicans were seen feeding and/or resting (both activities in many cases) were: H10 and H11 [H10 has been an intake pond since 1973], and H1 and H2 (and sometimes the adjacent H4 and H7) in Hayward, K1A and K2A in northwestern Fremont, M1 and M2 south of Mowry Slough in southwestern Fremont, A9 in Alviso, and A1 and A2W in Mountain View. Flocks

have been observed flying on nearly straight-line routes between some of these locations.

Pond K1 south of upper Newark Slough, but visible from the Dumbarton Bridge approach, was for years a major gathering point - and most of the white pelicans in the old "Dumbarton Bridge" records noted in Audubon Field Notes and other publications were probably there. After the closing of the Baumberg Salt Plant, however, and the re-ordering of the water flow in late 1972, this pond became a highly saline pond and has held no white pelicans that I know of, even though it still has the numerous small islands on which they formerly rested. In the fall of 1964 and 1965, the full 900 were estimated on ponds H4 through H7 near Turk Island hill, which should have been medium-salinity ponds in those years. Several color-dyed birds were observed there that had come from marking programs at Great Salt Lake, Utah, and Malheur Lake, Oregon, and as I remember, one from Yellowstone Lake. Small flocks have continued to use the H3C, H4C, and H5C ponds and rest on adjacent dikes in at least some winters since 1985, perhaps only when extended rainy weather dilutes those ponds or when the salt company moves water into them in particularly accelerated fashion so that many fish are included.

The presence of large numbers of small to medium-sized fish in water less than a meter deep, where they are susceptible to ready capture (by the swim-and-scoop method often used in concert by flocks of this species), is undoubtedly the chief factor that controls just which ponds are used by them. Barren islands or remote dikes seldom traveled by any human or large predator are augmenting favorable factors - but such features are sometimes reached by flights from the feeding areas if need be. For example, up to 100 or so white pelicans often come to sit on the dikes between effluent ponds in a fenced-off area of the Hayward Regional Shoreline, where they preen, sleep, and fly away again without (at

least much of the time) swimming on those ponds or attempting to forage. For an account of the variety of fishes [and their relative numbers?] in salt ponds, the research work of David Lonzarich (1989) in the mid-1980s should be reviewed. A short commentary about his findings and enthusiasm for the study appeared in the San Francisco Bay Bird Observatory Newsletter 5(no.8, Sep.1986).

The question of whether white pelicans would ever breed on any islands in the salt pond system if they were located near a favorable food supply should be considered. Perhaps such a situation could be developed at the Napa-Solano County ponds now owned by the State. There were modest size flocks that used the low-salinity ponds there at least at times; but the fish-bearing ponds would have to be maintained as such, which presents an expense and management problem for public agencies not engaged in salt production. There might even be some possibility for a nesting island in a portion of the Baumberg Tract, purchase of which by the Wildlife Conservation Board has just been authorized. This would require maintenance of the site's island characteristic (water all around it wide and deep enough to deter most predators) and continued presence of good fishing nearby - probably depending on Cargill Salt continuing Pond H10 as an intake.

Brown Pelican (*Pelecanus occidentalis*) - This species has been said (in the December 12, 1995 meeting notice for this Focus Team) to be "restricted to Central Bay." This is not completely true. Small numbers frequently reach areas on the open Bay south to Dumbarton Bridge, and occasionally even farther. I recall seeing in late summer or fall up to 30 or 40 on Pond H1, an intake pond in Hayward, where they sat with the white pelicans or fished in their midst. Sometimes these birds would use the same surface-feeding technique as the white pelican, but sometimes it would plunge-dive at a shallow angle obviously designed to avoid striking



White pelicans and ducks on a salt pond west of old Alvarado, September 17, 1964.

Howard L. Cogswell

the bottom in such shallow water. There is probably little that could be done in operating salt ponds to enhance their value to this species, beyond the provision of some islands in or near the fish-bearing ponds, which would be done for the white pelican or for various terns (see accounts for those species). The northernmost nesting ground for this species, at Point Lobos, Monterey County, has long been abandoned, and there seems little likelihood of any area north of that being chosen. Alcatraz or Red Rock Islands in the Central Bay would be more like their traditional sites, and have been "available" for many years.

Double-Crested Cormorant (*Phalacrocorax auritus*) - Birds of this species use the fish-bearing low-salinity salt ponds all year, but in considerable numbers primarily in the fall. Swarth et al. (1982) found a maximum of 82 (on Pond K2A) in their study area in December 1979 and 79 in late September 1981, although mean numbers were less than half of these figures. Numbers sometimes reach well over 100 in the fish-rich ponds H1 through H4 in southwest Hayward, where they rest on the dikes with pelicans, or on the numerous wooden posts in some of the ponds. In the Central Bay, they have roosted at night on power lines or power-line towers for years, e.g., over 5,000 on the line to Brooks Island in the early 1940s (Bartholomew 1942, 1943a,b) and late 1940s (Cogswell, pers. obs.). That power-line has since been removed.

Gill (1977) did not find double-crested cormorants breeding in the South Bay during his 1971 survey. However, in more recent years, they have increasingly taken to nesting on the platforms or sometimes at junctions of legs and braces of powerline towers, e.g., many such south of the western part of San Mateo Bridge. In the salt ponds west of the Napa River, a few nested for a number of years in eucalyptus trees that had died when one salt pond was formed around them; and in the same general pond system, small numbers nested at least in the early 1980s on powerline towers over some of the salt ponds. I know of no such nesting yet in the South Bay, but there are many places where it might take place. However, the numbers of double-crested cormorants using salt ponds either for foraging and daytime resting or for nesting on structures within the ponds is probably rather small compared to the total number in or near the deeper parts of the Bay.

Snowy Egret (*Egretta thula*) - Although Swarth et al. (1982) reported a maximum count of 16 in their 11-pond study area, there are times in late summer or fall when just ponds H1 and H2, and H4 through H7 in southwest Hayward (at least H1, H2, and H4 having high fish populations) are utilized by over 100 snowy egrets at a time [and at least half to 2/3 that number of great egrets and many great blue herons as well]. There are probably similar large numbers on the low- to medium-salinity salt ponds near the largest nesting colony.

This is in tule marsh within Artesian (Mallard) Slough, east of Alviso, where the tremendous flow of San Jose-northern Santa Clara County sewage effluent has converted the tidal marsh to that type. Snowy egrets formerly nested on outer Bair Island in the upper part of *Salicornia* marsh on and next to the outer levee and later in coyote-bushes (*Baccharis*). Gill (1977) counted 340 and 362 active nests in these areas in 1971 and 1973, respectively. The salt ponds next to this site were taken out of use in the early 1970s, and the colony was decimated by predators (probably red foxes) in subsequent years.

Non-breeding snowy egrets will probably continue to use the low-salinity salt ponds for feeding and resting as long as they continue to have fish within their reach. The numbers foraging during the breeding season does drop in those ponds that are far from the colonies, which could perhaps be improved by providing other tall marsh areas in sloughs or freshwater ponds near those salt ponds. The only example of that known to me is the presence in 1995 of over 100 pairs of snowy egrets nesting (many young being produced successfully) in tall tules planted in effluent ponds at the Hayward Shoreline just three years earlier. A fair number of these birds flew south a mile or so to active salt ponds H10 and H11 and perhaps farther to forage. This colony has continued active at least to 1999.

Black-Crowned Night Heron (*Nycticorax nycticorax*) - Birds of this species use the low-salinity, fish-bearing salt ponds for foraging, but it seems in more localized fashion than the snowy egret. They seem to prefer places where water moves past their still-watch perch, such as gates or siphon-flows between ponds. Partly because they do much of their feeding at night, less is known about all the situations they use. Daytime roosting is usually in trees or within marsh growth, in small to fairly large flocks in the non-breeding season, e.g., in the primarily pickleweed marsh south of the outermost part of Alvarado Channel (old Alameda Creek). This marsh is being expanded eastward by 34 acres by Cargill Salt as mitigation for the impact on tidal marshes around the Bay by their levee-maintenance dredge (terms of the permit issued by the U.S. Corps of Engineers and San Francisco Bay Conservation and Development Commission). Several islands have or will be constructed in that vicinity also, and the attraction of all the diverse habitat may increase for this species.

Nesting colonies of night herons are established in very diverse types of vegetation: tall marsh (as in Artesian Slough, east of Alviso); on the ground or in coyote-bushes as on outer Bair Island [609 nests in 1973 (Gill 1977) but colony later abandoned]; dense-foliaged shrubs and low trees (as on Alcatraz Island); and dense-canopied cypress trees even in urban areas (as for years in the City of Alameda). For this species, and potentially other herons as well, a grove of such trees, or even densely-growing eucalyptus, might be planted on Turk

Island hill, which is surrounded by salt ponds in southwest Hayward. Some type of predator-proof (or strongly deterrent) structure would have to be placed across each of the several levees that tie into the island. Perhaps the species most likely to respond to such trees, however, would be the great blue heron which already nests in salt ponds in that general vicinity on the scattered old duck blinds, Archimedes' screw pumps, and one old gun club building.

Northern Harrier (*Circus cyaneus*) - This species nests in some salt marshes (upper portions, that are not flooded by tides in April or May), as well as in or near freshwater marshes or grassy flats inland. In the non-breeding season around the entire South Bay, and in the breeding period within a probable several-mile radius from their nest sites, they forage frequently over various marshes, fields, roadsides, dikes, and also those salt ponds that have numerous birds. The passage of a harrier in its typical low-level flight is sufficient to cause massed fly-ups of sandpipers and even ducks, and to send sparrows and other songbirds diving into cover. A persistent harrier on the Hayward Shore successfully captured a red phalarope that only flew short distances from the surface of a pond on the predator's first three or four swoops at it. The actual impact on the population of birds using the salt ponds from predation by harriers is unknown, but is probably small for healthy and alert fully grown individuals which see the harrier coming. There might be some serious impact on downy to partly grown young on the open dikes or islands, but I know of no studies addressing this question.

On the other hand, the population levels of the northern harrier itself (and of several other avian predators) are of concern, and should be watched. With reduction of their natural habitats, especially those required for successful nesting, the harrier may be in some trouble where its chief hunting opportunities are over salt ponds. In 1971, Gill (1977) found five nests near the Bay south of San Mateo Bridge, three of them in pickleweed. In 1979 and 1980, a pair nested in "Ideal Marsh" west of the salt pond series studied by Swarth et al. (1982), and in 1985, a pair nested (but doubtfully successfully) in pickleweed marsh of upper Newark Slough close to Coyote Hills. A pair (or two?) nests fairly regularly in or near Coyote Hills Regional Park. North of there, in summer 1999, one female was seen hunting low over a large colony of Forster's terns, from which many young were found (partly to nearly fully eaten) on nearby levees. All of these birds probably foraged for considerable periods over nearby salt ponds. A study of the nesting success of the species in such situations compared to the more extensive habitat combinations of marshy ponds and fields of the Suisun area would be valuable.

Peregrine Falcon (*Falco peregrinus*) [and by implication also the wintering Merlin (*Falco colum*

barius)] - Birds of these species forage over any of the salt ponds that harbor many birds of their normally preferred types. Individual peregrines sometimes become specialists and pursue and capture primarily or only ducks, others work on shorebirds, others take readily to rock or mourning doves, etc. Their hunting covers large areas, yet individuals or pairs take up quarters for the winter where there are elevated perches (e.g., powerline towers) to which they return regularly to rest, pluck, and consume their prey, etc. The merlin is from this standpoint a smaller edition of the peregrine, feeding on smaller birds and normally selecting lower perches. Both species forage over salt ponds frequently, but only the peregrine seems susceptible to having its habitat enhanced in the area. This is because more and more of them are now adapting to human structures for nesting (Bay Bridge, high-rise buildings, etc.). Where this is encouraged and protected within the several-mile forage distance from salt ponds having many birds of suitable size, the salt pond resource would contribute to the breeding success of the peregrines.

California Clapper Rail (*Rallus longirostris obsoletus*) - This highly endangered subspecies depends almost entirely on tidal salt marsh for its foraging, retreat from danger, and for nesting. The impact on that habitat by salt-pond maintenance operations, now detailed and avoided or mitigated by the terms of the permit recently issued to Cargill Salt, will require ongoing watch to make sure that such damage does not resume. Clapper rails do occasionally step out into the open on a salt pond dike - but normally only when a super-high tide floods the adjacent marsh. This behavior is more prevalent around the dredge locks that the company builds to move the dredge between the outer ponds and the Bay. The low dikes of these locks soon become covered with pickleweed and other high-marsh plants; are they then a part of the salt marsh habitat, rather than the salt pond?

California Gull (*Larus californicus*) - Traditionally this species was only a non-breeding migrant and winter resident in coastal California, with large numbers beginning to arrive from inland and/or northern breeding areas in late July. Total populations reached 40,000 or more by September or October, the majority gathered for much of each day at or near the numerous solid-waste disposal sites near the Bay (Cogswell 1970, 1974). Numbers of California gulls dwindle somewhat near those sites (except in the Suisun Bay area), as winter numbers of larger gulls (western, and particularly the herring and glaucous-winged) increase; but spring migration of California gulls makes them again the most numerous species in March and early April. Especially in late summer and fall, but to some extent at other seasons also, many California gulls are seen foraging on the surface of medium to medium-high saline salt ponds - pecking here and there at the surface and apparently

obtaining brine shrimp as food in the same fashion as they do, for example, on Mono Lake where thousands of these gulls nest. This species, like other medium- to large-size gulls, also forages on open tidal flats, or aerially over many different habitats, including the salt ponds. Gulls of all species (except the smallest, Bonaparte's) also use the salt pond dikes and islands for nighttime roosting or just as a protected place for daytime resting. Some flocks in the 1968-71 period even roosted at night standing in the saturated brine of crystallizers at Newark.

In 1982, about 30 pairs of California gulls were discovered nesting on small islands (old, partly submerged, dikes) in the salt ponds of the Knapp Tract, four miles northwest of Alviso. This was the first known breeding by this species in a coastal situation and the first documented record of nesting west of the Sierra Nevada-Cascade mountain ranges. By 1994, that colony had expanded to nearly 4,000 pairs (Layne 1995). Several smaller "satellite" colonies have also arisen - one on a dike in the crystallizer area in Newark, two others south and north of Mowry Slough (the latter with the Caspian Terns) with a total 471 nests in early June 1994, and a fourth on a salt pond dike near Triangle Marsh north of Alviso, with 490 birds (but only 43 nests in 1994) (Layne 1995). The last-mentioned colony was for several prior years much larger. Some of these satellite colonies have been decimated in some years by red foxes; but the three largest colonies have persisted at least through 1995, and the one south of Mowry Slough through 1999.

For several years (1983-1988), hundreds of the young California gulls were banded by SFBBO teams, mostly at the original Knapp Tract colony, as part of a detailed study of the increase in numbers and production of young within a small part of that colony (Jones 1986). For the past few years, the Knapp area has been cut out of the saltwater movement in the Cargill system, so it largely dries up by mid-summer. Large numbers of gulls have continued to nest there, but nests were disrupted apparently by red foxes in 1994 [and 1995?]. It is obvious that the breeding range expansion by this species now includes San Francisco Bay - in fact, a few pairs have even bred at the Alameda Naval Air Station (NAS).

Elsewhere, nesting gulls have been noted as having negative impacts on the nesting of other waterbirds in their vicinity. Their possible impact through predation on eggs or young of herons, egrets, and terns should be evaluated here - particularly for the Forster's and least terns. If it is decided that management of habitat should be directed toward maintaining the gull populations, as well as the other waterbirds, some decisions on just which areas can be provided or enhanced for the gulls will probably be necessary.

A major paper on the present range and status of California and ring-billed gulls throughout California is

in preparation by W. David Shuford of Point Reyes Bird Observatory and Valerie Layne of San Francisco Bay Bird Observatory. A poster summarizing the growth of the California gull colonies around southern San Francisco Bay was presented by Hanson and Ryan, SFBBO staff, at the 1997 meeting of the American Ornithologists' Union.

Western Gull (*Larus occidentalis*) - This is the most "marine" in habits of all the large gulls in the Bay Area. It successfully maintains a more-or-less equal-numbers status through the mid-winter period in the Central Bay, even when large wintering numbers of glaucous-winged and herring gulls are present. Particularly in late summer and fall, considerable numbers of western gulls also spread to the inner reaches of the Bay - south to Alviso and east to at least Antioch. They are always in the minority among gulls in these areas, using the disposal sites, bay and shores, salt ponds, and marsh sloughs as forage areas.

The traditional major nesting grounds of this species, the Farallon Islands, continues to hold by far the largest number of breeding birds, over 10,000 pairs. Some of these nesting birds commute to Bay Area disposal sites for food, as evidenced by market-prepared chop and steak bones regurgitated on the nesting grounds. Nesting colonies existed on several islands in the Central Bay by at least the late 1960s, and on top of Pier 45 in San Francisco by 1971. A few pairs of western gulls also were found nesting amid the California gulls on the Knapp Tract, northwest of Alviso, in the 1980s by SFBBO teams, who banded a few of their young. One nesting pair was there in 1994 (Layne 1995). Thus, the salt pond habitat is at least marginally a breeding habitat for this species, and the remarks pertaining to the California gull (above) also apply to the western gulls, although in lesser degree.

Caspian Tern (*Sterna caspia*) - This largest tern has nested on dikes between or on barren islands within salt evaporators in the South Bay since at least 1922 in a colony that had 287 active nests in 1931 (DeGroot 1931). This colony apparently shifted exact location over the years, but was always near the eastern approach to Dumbarton Bridge. The colony was observed to have 378 nests on 21 May 1943 (Miller 1943), 188 nests plus 202 young out of nests on 21 June 1952 (C. Sather, oral report in my field notes), and 499 active nests (most with eggs, few with young) on 14 May 1954 (personal field notes). At least on these later dates, the colony was on the dike separating salt ponds K5 and K7, north of the bridge approach, and persisted there until at least the mid-1960s.

Anderson (1970) discovered a thriving colony of Caspian terns on the southern part of the curving dike between ponds M4 and M5, east of Albrae Slough. This site continued in use, at least intermittently, to 1996, when it was decimated by red fox predation a second time.



Avocets, Willets, and Marbled Godwits on Oliver Brothers' Salt Ponds During High-tide Period on the Adjacent Bay, December, 1967.

Walt Halland

Large numbers of this species have also nested in the 1970s and 1980s (at each site for a few years only) on the dike between ponds H10 and H11 (and low islands in H10), on the western end of a long peninsular dike between ponds H4 and H7, and on a still barren area of a former salt evaporator on outer Bair Island, Redwood City (estimated 500-600 pairs in July 1975 per Gill 1977). The H10/H11 colony (1969-74) was plagued by salt foam blowing across the nesting birds and was abandoned abruptly. The H4/H7 colony (1976-86?) was perhaps the new location of these same birds and continued expansion to over 100 pairs, including some on the still drivable levee between H4 and H2 - until all the levees in this area were retopped with dredge spoils. The SFBBO observers checking the colony in 1986 (or 1987?) recorded the mostly failed efforts of the terns to nest on the deeply cracked drying mud. Swarth et al. (1982) recorded a maximum of 9 Caspian terns in the salt ponds west of Coyote Hills in 1980 and 1981 - at which time the colony was only a mile or two to the north. The Bair Island colony suffered from probable red fox predation, but some birds continued to gather at the site for several years after any successful nesting. Caspian terns were also regularly seen in the San Pablo Bay-NapaRiver Unit of salt ponds (at least along Highway 37), and probably nested somewhere in that system.

Foraging by birds of this species is wide-ranging, but a majority apparently seeks fish in the open Bay. Certainly, compared to the Forster's terns, relatively few are seen diving over salt ponds, even the fish-rich low-salinity ones. Small numbers of Caspians also appear during the nesting season over reservoirs in the hills quite far from the Bay, and are known to carry fish from such locations back to the colonies (e.g., tags from fish stocked at Del Valle Reservoir have been found on the major South Bay colonies). Hence, the nesting and roosting

safety of islands and remote dikes in the salt pond system are the prime ways in which this species is benefited by this habitat.

Forster's Tern (*Sterna forsteri*) - This species is found mostly from May through September in or near salt pond habitats, when it is nesting or the fledged young are still under intensive care by the adults. A few are present through the winter in favored locations around the Bay, but are seldom seen on salt ponds then. Nesting takes place at numerous locations, mostly on small islands within the low- to medium-low salinity ponds (where fish are abundant, and where the newly fledged young may first try their own plunge-dives). Some colonies, however, are on islands within medium-high to high-salinity ponds, e.g., K1, K2 and K3 just south of the eastern approach to Dumbarton Bridge and Newark Slough. There are no fish in those ponds, and foraging is entirely in the slough or the open Bay. The total number of active nests tallied south of San Mateo Bridge in 1971 by Gill (1977) was 935, while in 1994 somewhat over 1,000 were in 27 colonies there (Layne 1995), nearly all of them on islands or remote dikes in salt ponds. Hence, there is no obvious increase or decrease in the total population in recent years.

Colonies of Forster's terns sometimes persist for many years at the same sites, but in other cases shift to new locations in the same general region. The species seems more able to succeed with smaller colonies than the Caspian, and is thus able to use even quite small islands. However, where these are in salt ponds subject to spring or early summer draw-down by the pond operators, their success is jeopardized by the relatively much easier access to the sites by predators. This took place, for example, in at least two years between the middle and end of May in Pond H8A and a colony of over 100 pairs disappeared. A goal for optimal habitats for this species

would certainly include some careful planning and co-operation to keep higher water levels in ponds with nesting islands until the young terns were flying.

California Least Tern (*Sterna antillarum browni*) -

This endangered subspecies has its northernmost ongoing breeding colony at Alameda NAS, where they are normally present from May to August. Some pairs with the earlier fledglings apparently move from this colony by mid-August to other sites with abundant small fish and nearby resting sites barren of vegetation and free of most disruption by predators or humans. These post-breeding assembly areas are considered important for the successful maturing of the young birds, including their development of adequate foraging skills. In the salt pond system, the areas most regularly used for this sort of activity are ponds H10 and H11 (resting on the dike between them or on islands), and H1 and H2 in southwest Hayward.

A few late nests of this species, probably by pairs that had nests interrupted at Alameda, have been found (June - August) in both of these areas; but I believe none persisted through hatching of the eggs. For several years small numbers of least terns gathered in summer on barren islands in the experimental ponds (treated sewage effluent) on the Hayward shore; and in 1990 one pair nested there successfully (young fledged) on the one island to which crushed oyster-shells had been added to attract them. There has not been any subsequent nesting there through 1999, however. In 1972-75 (Gill 1977), a small colony with at least 14 active scrapes in 1975 did nest successfully on the barren flat (former salt pond) near the Caspian tern colony on outer Bair Island—the least terns perhaps depending on the vigorous defense by the larger species against predator intrusion into the area. A few pairs also have nested near Pittsburg, on or near industrial wastewater ponds in the marsh zone.

The question of whether some parts of the salt pond system could be managed to provide enhanced habitat for this species is made more difficult to answer by the varying success of the “outliers” from the main Bay Area colony itemized above. The only procedure likely to succeed would be the provision of low, barren islands in or very close to low-salinity (intake) salt ponds and/or large channel-mouths at the bayshore. Elsewhere in its range, the least tern is known to take advantage of new dredge spoil islands (but of sandy spoils), and has done so to some extent in the Alameda- Oakland Airport area. The pervasively muddy nature of the substrate in the salt pond areas, and the vigorous growth of marsh or other halophytic vegetation on islands that are just above the waterline would have to be overcome, since these are ecological features which this species tends to avoid.

Coast Savannah Sparrow (*Passerculus sandwichensis alaudinus*) - Formerly known (at least in part) as the Bryant’s marsh sparrow (*P. s. bryanti*), this is the form

of the continent-wide savannah sparrow that breeds in the coastal strip (especially the summer fog belt) of California from Humboldt County south to the vicinity of Morro Bay in San Luis Obispo County. It is somewhat more “marsh-adapted” than most subspecies of savannah sparrows, but notably less so than *beldingi* of southern California. Savannah sparrows of several other subspecies occur in migration or winter in grasslands and weed fields and to some extent in the marshes around the Bay. Many of these are essentially impossible to distinguish from *alaudinus* in the field, so habitat-use differences are very poorly known for these seasons.

The nesting habitat of *bryanti* [now *alaudinus*] was originally described as “tidal marshes” around San Francisco Bay, but gradually the form was found to occupy also the more moist grasslands of nearby valleys and outer Coast Range hills. Johnston (1968) provides the best summary - “It maintains populations in two main types of habitat in coastal California: the *Salicornia* association of tidal marshes and the grassland associations of the coastal fog belt.” He gives some details from his own research on San Pablo Marsh and from earlier work elsewhere by Marshall (1948), and further compares the habitat niche of this form with the overlapping salt marsh form of song sparrow: “... on salt marshes [it] is nearly limited to the broad expanses of low-lying salicornia (*Salicornia ambigua*) on the older and higher parts of marshes... [that] lie back of that salt marsh vegetation (cordgrass, *Spartina foliosa*) best suited to frequent submergence by tidal flooding.” The song sparrow’s favorite forage area is the mud banks of the small channels within the latter type of marsh, but Johnston (1968) does mention that savannah sparrows are occasionally seen in that habitat in the higher marsh.

Eight nests were found in 1971 by Gill (1977) in his intensive survey of breeding birds south of San Mateo Bridge, where he cited the preferred nesting habitat as “levee tops grown to annual grasses and high pickleweed growing on the levee banks.” Gill (1977) further estimated the overall nesting population of the area at 800 to 1,000 pairs. How many of these would be within the salt pond zone is unclear.

With respect to the salt pond habitats, savannah sparrows are often seen in winter and migration periods along those dikes that have at least frequent patches of herbaceous vegetation or *salicornia*, sometimes well away from marshes or herblands of greater width. The numbers that use such linear habitat zones are much greater, however, where there is upper-zone tidal marsh or seasonal wetland adjacent across the dike from the salt pond. Presumably, some of these birds are of the breeding form *alaudinus*, but this should be verified by in-hand identification. Where there is as much as an acre or two of mixed herbs and *salicornia*, such as along the Dumbarton Bridge highway fill through the salt pond zones, scattered individual savannah sparrows sing on territory (and

are thus presumably *alaudinus*) through May and June. Elsewhere, in my experience, singing savannah sparrows are found in the diked-off "seasonal wetland" habitat as well as in the upper parts of the tidal marshes, and the species appears to be a marginal one with respect to use of even the "upland" bits included in the salt-pond complex.

Alameda Song Sparrow (*Melospiza melodia pusillula*) and Samuel's Song Sparrow (*M. m. samuelis*) - These are two of the three subspecies of song sparrows endemic to the tidal marshes and immediate vicinity in the San Francisco Bay system. The third one is *M. m. maxillaris* of the Suisun Bay area, where there are no salt ponds. All three forms were studied in detail from the standpoint of validity as subspecies, distribution, and habitats by Marshall (1948), and have been further updated with respect to ties to the remaining tidal marshes by Marshall and Dedrick (1994). Only *samuelis*, found in the marshes about San Pablo Bay and the Marin County side of San Francisco Bay, has been studied with respect to its breeding cycle, territory, and foraging habits (Johnston 1956). This involved three years of intensive work with banded birds on the San Pablo Marsh, Contra Costa County, and illuminated several ways, other than morphology, in which birds of that subspecies differ from their upland neighbors: 1) their territories are smaller and usually linearly arranged along the small curving channels in the marsh; 2) birds use the *Grindelia* or other higher plants of the marsh for nesting and/or high-tide refuge, or even leave their territories for nearby upland edges during the higher high-tides; 3) the peak period of first brood egg-laying is March-April and re-nesting laying peaks in May, thus most nests avoid being flooded during the extra-high tides of June, whereas the upland song sparrows usually have eggs or nestlings from April to early July; and 4) dispersal of the young birds is much more limited than in the upland song sparrows, averaging only 185 meters from their hatching place. Presumably similar adaptations to the intertidal habitat exist in *pusillula* and *maxillaris*.

In the South Bay, Gill (1977) found 17 nests of *pusillula* in 1971, all between 12 March and 7 May, and estimated the total population south of San Mateo Bridge at 1,800 pairs. Birds of that race are commonly seen using the levees and dikes adjacent to its normal marsh habitats, and presumably *samuelis* in the San Pablo Bay-Napa River salt pond system does the same. No special study of the use of such habitats has been done, so the comments that follow are rather random recollections from my own experience with *pusillula*.

During the higher high tides of spring tide periods, when all the small channels in the tidal salt marsh are flooded, and even much of the *salicornia* zone is underwater, song sparrows that live or forage in such areas at other times of tide move to any nearby "above-water" refugium available. Where that is a salt pond dike, the birds gather and forage in and near the uppermost

bits of vegetation - a few sometimes crossing the dike to forage on brine flies, e.g., at the edge of the salt pond itself. Occupancy that is more permanent at all tide levels, even singing on territory, occurs spottily along the bayfront levees of the outermost salt evaporators, even up to a half-mile or so from any real salt marsh. The few birds I have seen in such places forage amid rip-rap and the wisps of *salicornia* and ruderal herbs that grow in such places. This sort of habitat is also occupied where the habitat landward of the levee is seasonal wetland, with at least some "marsh" vegetation. I have also noted several song sparrows (presumably *pusillula*) on the dike with no rip-rap between Pond K1 (or PP1 of Leslie's system) and the former salt ponds of the Hickory Tract in Newark. This dike is now partly covered by *salicornia* and cuts off bits of the original head of Newark Slough, where there is always some residual water. Elsewhere, *pusillula* sparrows (or presumably such) are sometimes seen taking refuge or foraging on small walkways, pump structures, or associated fences within the edges of salt ponds themselves. All of these instances are, however, marginal to the main habitat occupied by these forms - the tidal salt marshes - and these salt marsh song sparrows actually are more restricted to the vicinity of such marshes than are the savannah sparrows. Hence, conservation goals should emphasize that type of habitat for all three endemic salt marsh adapted subspecies of the song sparrow.

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Saltmarsh harvest mouse, US Fish and Wildlife Service

Snowy egret, US Fish and Wildlife Service



Teams of scientists have developed habitat goals for the baylands ecosystem of San Francisco Bay. In creating this long-term vision, they assembled and synthesized information on more than 100 species of fish and wildlife; they also described the habitats that support these species. This report summarizes this information and is suited for anyone interested in learning more about the Bay's plants and animals.

