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State of California
The Resources Agency
Department of Fish & Game

SOUTH SAN FRANCISCO BAY BREEDING BIRD SURVEY, 1971 1/

by

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ABSTRACT

Little is known of the importance of South San Francisco Bay as a nesting area. Much valuable nesting habitat has been reclaimed or filled in the past. Base line information is urgently needed for future assessment of habitat alterations. A study was conducted from March to December, 1971 to document the nesting status of water-associated birds of South San Francisco Bay. Forty species, representing 8 orders and 16 families, were studied. Breeding bird population indices were obtained on the great blue heron, snowy egret, black-crowned night heron, Caspian tern, Forster's tern, California least tern, California clapper rail, American avocet, black-necked stilt, snowy plover, ring-necked pheasant, short-eared owl, burrowing owl, barn swallow, cliff swallow, long-billed marsh wren, yellowthroat, Brewer's blackbird, tricolored blackbird, red-winged blackbird, Savannah sparrow, and salt marsh song sparrow. Total habitat in the study area was approximately 47,000 acres: Salt ponds, 21,744 acres (46%); tidal flats, 13,530 acres (29%); open water, 6,500 acres (14%); salt marsh, 4,250 acres (9%); grasslands, 700 acres (1%); fresh water marsh, 200 acres (0.5%); and dikes and levees, 200 miles (0.5%). Nesting was studied from March to July with over 4,000 nesting attempts documented. Earliest nesting dates were in March for great blue herons. Peak nesting for most species occurred May-June. Data were recorded on nesting dates, location, nest type, and clutch size when possible, for all species. Nesting success data were recorded for the great blue heron, Caspian tern and Forster's tern. Population indices were derived from nest counts, rope drag and direct observation.

1/ Wildlife Management Branch Administrative Report No. 72-6 (June 1972). Supported by Federal Aid in Wildlife Restoration Project W-54-R "Special Wildlife Investigations."

RECOMMEDATIONS

The following are recommendations resulting from this study:

1. Encourage acquisition of marsh lands throughout South San Francisco Bay to preserve the salt marsh ecosystem.

2. Acquire approximately 500 acres of the northeast corner of Bair Island, San Mateo County (not already included in the proposed South San Francisco Bay National Wildlife Refuge) to act as a buffer zone and protect nesting areas of California least tern, Caspian tern, great blue heron, black-crowned night heron, snowy egret and California clapper rail.

3. Initiate management practices within the study area to enhance California least tern nesting habitat.

4. Program a follow-up breeding bird survey, on a 3-5 year basis, to evaluate the changes in avifauna composition and distribution in South San Francisco Bay.

5. Initiate annual or semi-annual clapper rail census in South San Francisco Bay.

6. Encourage continuation of salt production by solar evaporation in South San Francisco Bay to provide nesting and feeding habitat.

7. Enhance Forster's and Caspian tern nesting areas by creating insular nesting sites throughout the salt ponds.

8. Continue banding program for Caspian and Forster's terns, great blue herons and black-crowned night herons and snowy egrets to gain additional information on juvenile dispersal, movements and wintering areas.

TABLE OF CONTENTS

TABLES

FIGURES

INTRODUCTION

San Francisco Bay constitutes one of the largest estuaries on the Pacific Coast. Its open waters, mudflats, tidal marshes, uplands and land configurations provide an important habitat for migratory and resident birds. The destruction of much of this habitat went unchecked until the last ten years. Still, due to the ever increasing demands for urban and industrial development, much of the remaining bay lands are destined for such uses. Previous attempts to ascertain the value of San Francisco Bay to nesting and resident birds have been centered around individual species with little work directed towards the avifauna as a whole. Works by Grinnell and Wythe (1927), Grinnell and Miller (1944), and Sibley (1952) are the only comprehensive studies done on San Francisco Bay avifauna. The majority of bay lands development has occurred since these studies. The present status of many resident and/or highly endemic forms of San Francisco Bay wildlife such as the salt marsh song sparrow and California clapper rail is largely unknown. Many species exhibit an extension of the breeding range. Little work has been done to understand these range extensions or assess the current nesting status. Recent evidence has also been gathered that shows fish-eating birds are experiencing reproduction failure and points to the need to document breeding status of water-associated birds of South San Francisco Bay.

SCOPE OF STUDY

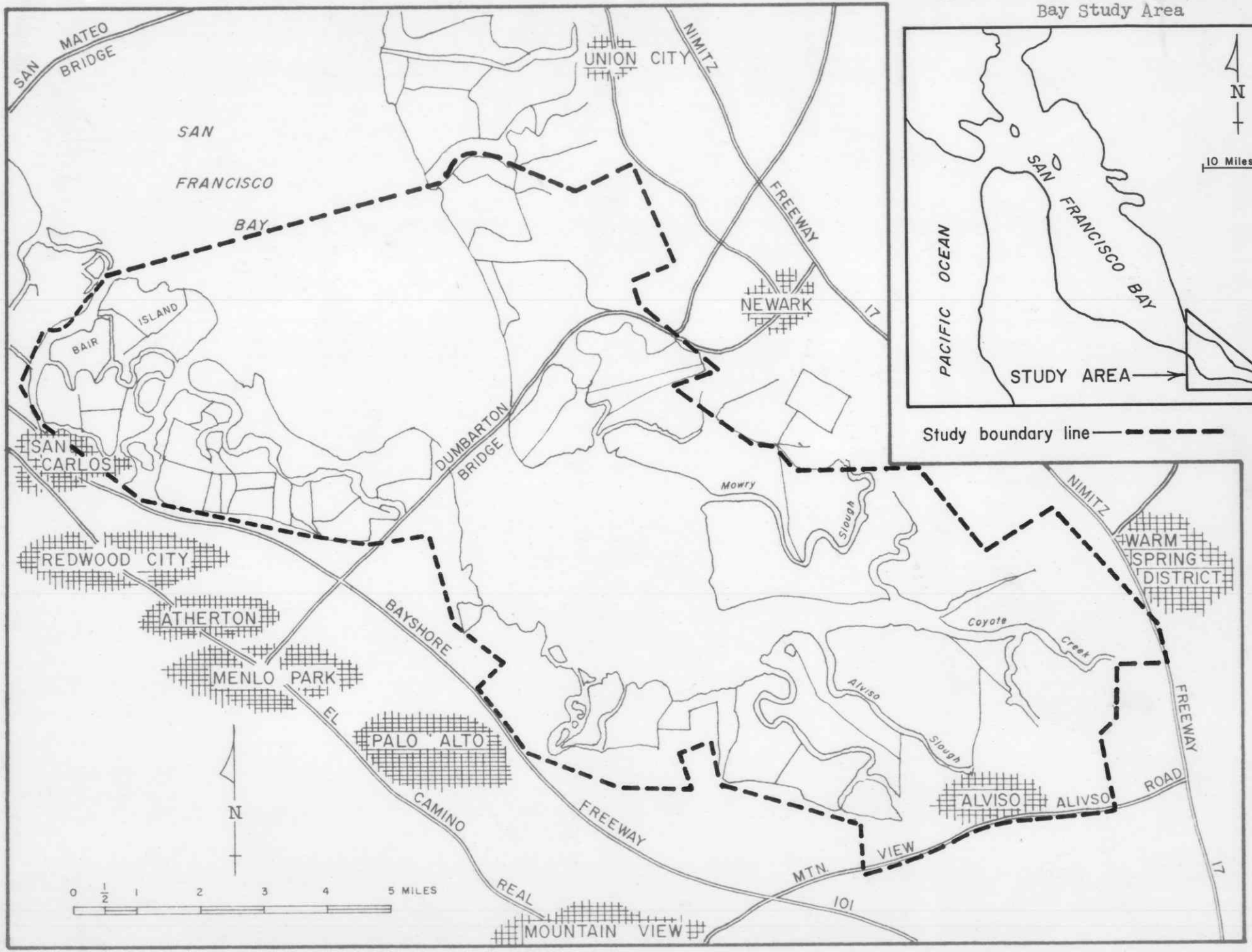
Objectives of this study include the following:

1. Determine the number and species of birds nesting in South San Francisco Bay.
2. Delineate habitat types and acreage.
3. Determine wildlife values of various habitat types within the study area.

STUDY AREA

Study was conducted over approximately 47,000 acres (74 square miles) of South San Francisco Bay (Figure 1). San Francisco Bay is one of the largest esturine systems along the west coast of North America. It is influenced in the north from the drainage of the Sacramento and San Joaquin Rivers and in the south from Coyote Creek and numerous smaller drainages of the the Santa Cruz and Mt. Hamilton Ranges. Much salt and freshwater marsh habitat have been reclaimed or filled so that only approximately 20 percent of the original marsh remains today. The entire San Francisco Bay estuary is surrounded by a large megalopolis of over seven million people. The south portion of San Francisco Bay is influenced by the Mediterranean climate characteristic of central California. Air temperature varies moderately with the January average about 48° and the July average 68°F. Precipitation is moderate, averaging 13 inches in the southernmost part of the bay (U.S.D.A. 1941). Study area terrain is at or slightly above sea level. Highest point is Coyote Hills at 300 feet in Alameda County. Seven habitat types were delineated in study area; salt ponds, tidal or mud flats, open water, salt marsh, grasslands, fresh water marsh and dikes and levees (Figure 2).

Figure 1. South San Francisco Bay Study Area



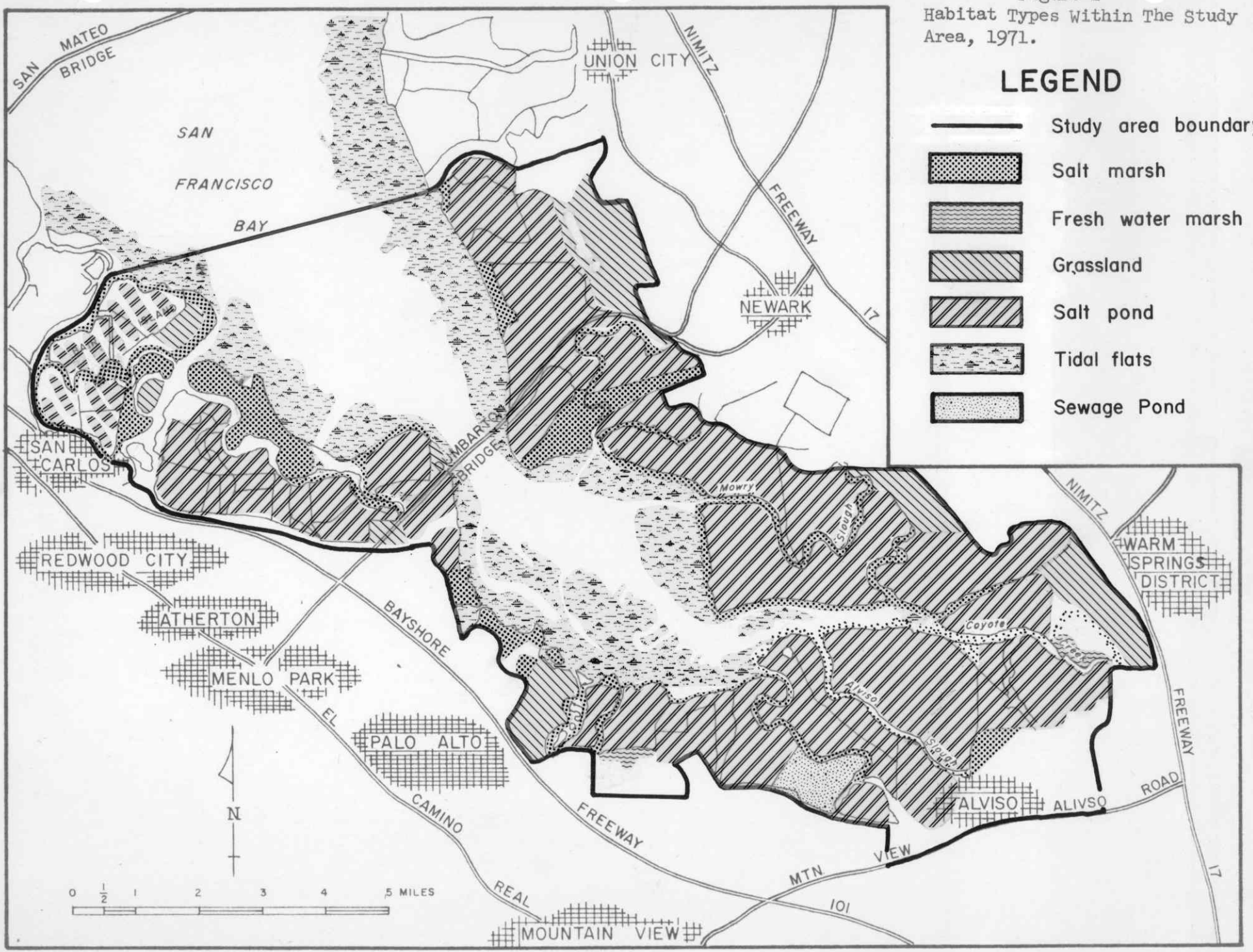


Figure 2
Habitat Types Within The Study Area, 1971.

Habitat Types

Salt Ponds

Salt evaporator ponds accounted for 21,744 acres (46%) of the total study area. Process of obtaining salt by solar evaporation from these ponds involves a series of ponds with sea water passing through the outer or concentration ponds where water is evaporated to concentrate sodium chloride, with less soluble salts being precipitated. In the final pond of saturated brine, evaporation has reduced the volume of brine to about 10 percent of its original volume. Brine is next transferred into separate groups of ponds called crystalizing pond where continued evaporation precipitates the salts (Ver Planck, 1958). Average size of the salt ponds within the study area was 400 acres and varied in size from 85 to 850 acres. A tremendous range in salinity exists in the various ponds, ranging from 22,000-170,000 ppm. Wildlife values are directly affected by salinity and pond water. Waterfowl, pelicans and terns prefer the ponds with less saline water while shorebirds and grebes are almost always found in association with the more saline ponds (Anderson, 1970). Levees around the ponds have high wildlife values and will be discussed under dikes and levees habitat type.

Tidal Flats

This habitat type accounted for 13,530 acres (29%) of the total study area acreage. Tidal or mud flats are an extensive feature of San Francisco Bay and particularly South San Francisco Bay. This habitat type was not directly related to the breeding biology of the avifauna but provides an important food chain link. Numerous forms of blue-green algae, diatoms and nematodes are found on the surface of the bay mud with large invertebrates, gastropods and annelid worms living in the mud itself. Numerous species of fish, shorebirds and waterfowl feed on these.

Open Water

Open water comprised 6,500 acres (14%) of the total study area. Because of the extensive mud flats found in the study area the volume of open water habitat fluctuates tremendously during any one tidal cycle. During a minus tide the surface water of the south bay is reduced to that of a small river with exposed mud flats extending as much as one mile from shore. Many of the organisms found in association with mud flats are also common to the open waters.

Salt Marshes

Salt marshes represented 4,250 acres (9%) of the total study area acreage. The most extensive areas of undisturbed salt marsh are found near Plummer Creek, Mowry Slough and Coyote Creek in Alameda County, and near Redwood Creek in San Mateo County. Salt marshes represent the most productive type of natural habitat found in the United States. Within San Francisco Bay, salt marshes are characterized by two plant associations: (1) Spartina zone, found on low ground subject to daily tidal coverage and is characterized by pure stands of cord grass (Spartina foliosa); (2) Salicornia zone found on higher ground, is dominated by

pickleweed (Salicornia ambigua) with other vegetative forms such as (Grindelia sp.) and (Distichlis sp.) often occurring in equal abundance. Many other important plants are found in association with this zone (Appendix 1).

Salt marshes on both the east and west sides of San Francisco Bay are found on extensive alluvial deposits from numerous streams draining Santa Cruz and Mt. Hamilton Mountains. The marshes are drained by an intricate network of creeks of various size, the smaller converging to form several major creeks or drains which empty into the bay at the marshes edge.

Salt marshes of San Francisco Bay provide extremely important habitat for wildlife. California clapper rail, an endangered species, and the salt marsh song sparrow, are restricted to the salt marsh ecosystem. In addition, numerous other animal forms are supported by salt marsh habitat.

Grasslands

Grasslands accounted for approximately 700 acres (1%) of the study area habitat. Coyote Hills, Alameda County, comprised 300 acres of this. Similar acreages were located approximately one mile north of Drawbridge, Alameda County. Smaller areas were found within the Palo Alto Flood Basin, Santa Clara County, and on Bair Island, San Mateo County. This habitat is characterized by a large variety of plant species. In contrast, few animal species were found in association with or depending upon this habitat type.

Fresh Water Marsh

Approximately 200 acres (0.5%) of fresh water marsh was included in the study area. Eighty-five acres were located in Coyote Hills, Alameda County. Additional fresh water marshes were located between Mt. View and Charleston Sloughs, and at the head of Coyote Creek, Santa Clara County. Flood basin near Palo Alto also contains a fresh water marsh. Brackish waters tending to fresh water marsh habitat, were found toward the headwaters of Alviso, Guadalupe, Charleston and Mowry Sloughs.

Fresh water marsh vegetation is dominated by cattails (Typha spp.) and tules (Scirpus spp.) with bulrushes, spike-rush and sedges in subdominant roles. These plants provide valuable food for wintering waterfowl and nesting cover for numerous species of birds.

Dikes and Levees

Approximately 200 miles of levees (0.5%) were found in the study area. Of these, 120 miles were classified as driveable and 80 miles were either too narrow or irregular to allow vehicular travel. All levees included in this habitat type were found in association with salt evaporator ponds and were most often used to enclose salt ponds. These levees were found to be extremely important to nesting Forster's terns, Caspian terns, avocets, black-necked stilts, snowy plovers, killdeer and limited numbers of waterfowl. Most nesting was found on those levees which had no vehicular travel and/or having an insular effect within salt evaporator ponds.

ACCOUNT OF NESTING SPECIES

Breeding bird survey was conducted from March to December, 1971 in South San Francisco Bay in portions of San Mateo, Santa Clara and Alameda Counties. Historical information, study methods and results are summarized in each of the following sections on species or groups of species. Nesting sites, habitat types and habitat values are also reported. Recommendations regarding methods, future studies and enhancement of nesting habitat within South San Francisco Bay are also included.

Great Blue Heron

Background

Great blue heron (Ardea herodias) was at one time a cosmopolitan breeding species in South San Francisco Bay. Colonies formerly existed at Alvarado, Alameda County; Alviso, Santa Clara County; and Redwood City, San Mateo County. Presently, the only active colony in the study area is located on Bair Island, San Mateo County. This colony is probably a product of the original colony near Redwood City. The original colony was reported to have nested in a eucalyptus grove for "a good many years" prior to 1900 (Carriger, et.al., 1908). This site was abandoned in 1900 and relocated north of Redwood City along a small slough. It became a ground nesting colony at this time with nests being build in pickleweed (Salicornia virginica) along the edge of the slough. Colony consisted of 49 active nests in 1907 (ibid.). This same colony was found to contain 30-40 nests on March 25, 1936 (Moffitt, 1939). No reference has been found since concerning this colony. The original site, as described in 1908, no longer exists. When the herons moved to the present site is not known. Thirty pair of herons were found nesting at the Bair Island colony in 1967 and 1969 (Anderson, 1970). This survey is the first to record reproduction in this colony.

Description of Colony

Bair Island great blue heron colony is located on the north side of Bair Island, 2 miles north of the Port of Redwood City, San Mateo County, California (Figure 3). The island, approximately 1,400 acres, is owned by the Leslie Salt Company.

The colony occupies one of three elevated knolls on the island formed as a result of dredging spoils deposited on the island. Active nesting is restricted to six acres of the northernmost knoll with nests placed in the tops of coyote bush (Baccharis pilalaris) which are 3-5 feet tall. Besides coyote bush, star thistle (Centaurea solstitialis), sow thistle (Sonchus oleraceus), and foxtail grass (Bromus rubens) make up the dominant ground vegetation at the colony site. The colony is bordered on the south and southwest by two 150 acre dry salt evaporator ponds and on the north and northeast by a narrow strip of pickleweed and the bay. Extensive mud flats border this to the north.

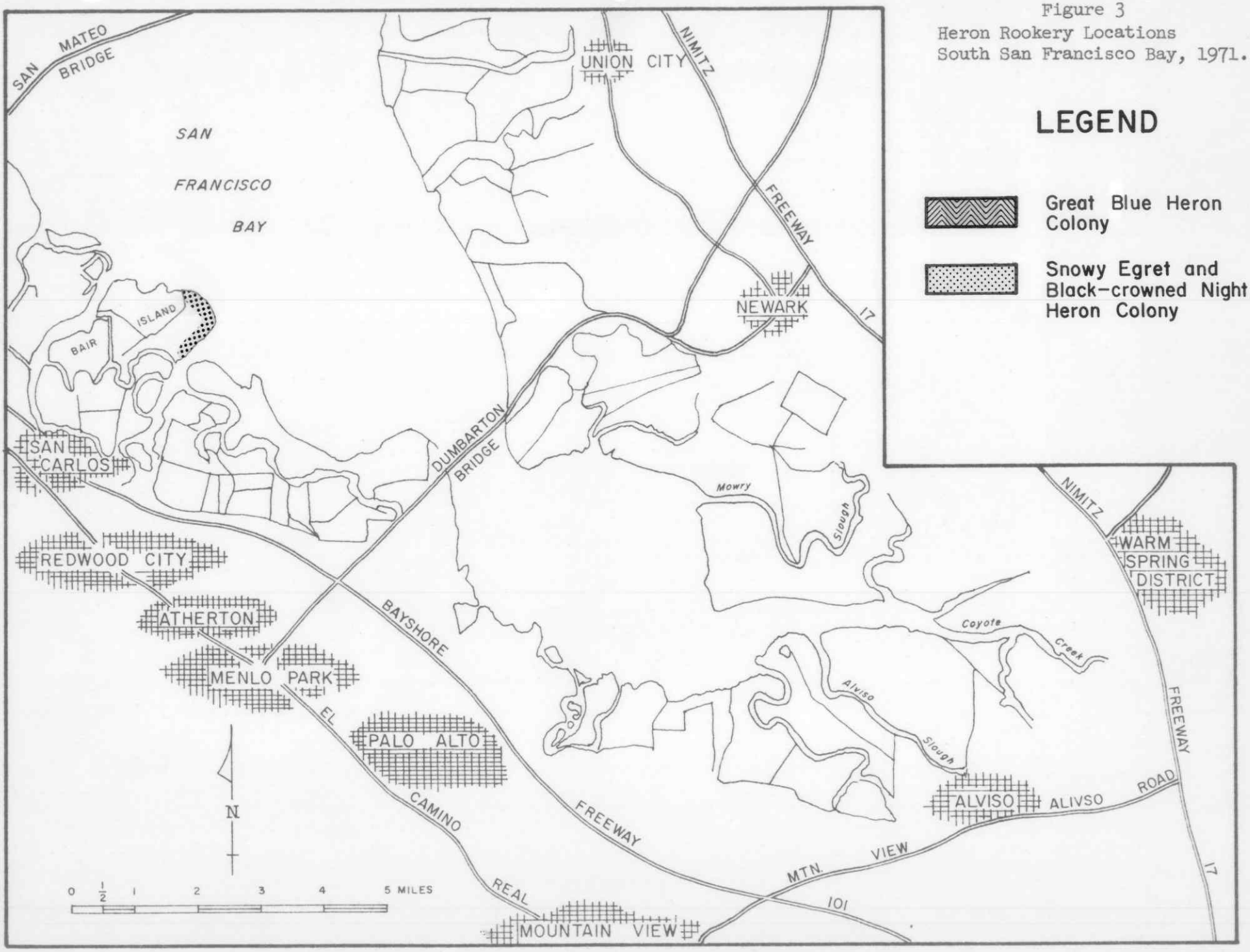


Figure 3
Heron Rookery Locations
South San Francisco Bay, 1971.

LEGEND

Great Blue Heron Colony

Snowy Egret and Black-crowned Night Heron Colony

Methods

Visits to the colony were made by boat from the Hubbard Johnson Lumber Company, Redwood City, to the PG&E maintainence catwalk at the mouth of Redwood Creek. Visits were scheduled on the average of once a week starting March, 1971 until the end of May and then once every two weeks until the middle of August. Visits were limited to between 15-45 minutes so as not to keep adults off of the nests for any length of time. Beginning April 9, all active nests were marked with a numbered stake driven into the ground near each nest. Placement of stakes was mapped for future reference. All nestlings between 2-5 weeks of age were banded. Data on nestling weight, sibling relationship and nest location were recorded during banding. Fish remains were collected at the nests for food habits analysis. Fresh eggs and shell fragments were collected for chemical analysis.

Findings

Egg laying: Observation of the Bair Island colony began on March 4, 1971 at which time five active nests were found. Eighty adult herons were counted on the salt flat south of the colony during this visit. By using an incubation period of 28 days (Palmer, 1962) and back-dating from the date of hatching, the first eggs were laid between the last week of February and the first week of March.

Clutch size: Eleven active nests were found on March 16: 3 nests contained 1 egg, 2 contained 2, 4 contained 3, and 2 contained 4 eggs each. On April 1, 30 active nests were found: 2 nests contained 1 egg, 2 with 2, 13 with 3, 10 with 4, and 3 with 5 eggs each. All active nests (49) were marked for study, seven of which were abandoned during the course of the season. Average clutch size, 3.63 eggs, was based on the greatest number of eggs and/or nestlings one week of age or less found in the 49 nests (Table 1). This is comparable to the 3.60 reported by Page (1970) and 3.63 found by Pratt (1970) for the same species.

TABLE 1

Frequency of Great Blue Heron
Clutch Size, Bair Island, 1971

Clutch Size		Number of Nests	Percent
1		0	0
2		4	8
3		14	29
4		27	55
5		4	8
	Total	49	100

Average/nest 3.63

Hatching Success: First nestling observed on April 1 was estimated to be 24-48 hours old. Of 178 eggs laid in 49 clutches, 124 (69.7%) successfully hatched (Table 2). Peak hatching occurred during the first two weeks of May (Table 3).

TABLE 2

Great Blue Heron Reproductive Success
Bair Island, 1971

Total eggs laid in 49 clutches:	178
Number Hatched:	124
Percent Hatched:	69.7%
Number Fledged:	105
Percent of Hatched Eggs:	84.7%
Percent of Eggs Laid:	59.0%

Fledging Success: Fledging began during the second week of June and continued until the middle of August (Table 3). Birds at time of fledging were 6-8 weeks old. Forty-two of the 49 nests were successful in fledging a total of 105 young, averaging 2.50 per nest (Table 4). This figure compares with 2.26 reported by Wilburn (1971) for the Lincoln, California rookery and 1.87 reported by Page (1971) for the San Joaquin River Rookery near Los Banos, California. The Lincoln and San Joaquin River colonies are located adjacent to fresh water habitat. Pratt (unpublished) reports a fledging success of 2.1, 2.3 and 1.9 (3 years, 1968-70) at Audubon Canyon Ranch Rookery adjacent to Bolinas Lagoon, Marin County.

Mortality: Mortality in this colony was low. Thirteen of 49 nests exhibited no loss during the season (Table 5). Eighteen nests had one or more eggs which failed to hatch, while 11 had one or more chicks which failed to fledge. Three nests showed both egg and chick loss. Seven nests were abandoned during the season. Three of these contained young when abandoned and the rest had what appeared to be complete clutches when abandoned. Twenty-two nestlings died during the season.

Fourteen of these were documented with cause of death determined in eight instances. Age at death ranged from one week to six weeks with the greatest number occurring between the age of one to three weeks. In nearly all cases, one or more nestlings had hatched 4-8 days before their siblings.

Table 3: Great Blue Heron Nesting Success
Bair Island, 1971

Nest No.	Clutch Size	Date of Observations: April 9 Eggs/Young		April 14 Eggs/Young		April 18 Eggs/Young		April 24 Eggs/Young		May 9 Eggs/Young		May 17 Eggs/Young		June 11 Eggs/Young		July 2 Eggs/Young		July 11 Eggs/Young		July 31 Eggs/Young		August 11 Eggs/Young		Number Hatched	Number Fledged
1	5	5	0	3	2	0	4		3		2		2		2		0		0		0		0	4	2
2	3	0	0	0	0	1	0	3	0	3	0	0	2		2		2		2		0		0	2	2
3	4	4	0	1	3	0	4		4		4		4		4		3		3		0		0	4	4
4	5	1	0	3	0	4	0			4	1	1	3	0	3				3		2		0	3	3
5	4	4	0	4	0	4	0	4	0	0	3		3		3		3		0		0		0	3	3
6	4	4	0	4	0	4	0	4	0	0	3		3		3		3		3		0		0	3	3
7	4	4	0	4	0	4	0	4	0	0	1		1		1		1		0		0		0	1	1
8	4	4	0	4	0	4	0	4	0	0	4		4		4		2		2		0		0	4	2
9	4	4	0	4	0	1	3	0	3		3		3		3		0		0		0		0	3	3
10	4	1	0	3	0	4	0	4	0		ABANDONED													0	0
11	4	4	0	1	3		3		3		3		3		3		3		0		0		0	3	3
12	4	4	0	3	0	3	0	1	2	0	2		2		2		2		0		0		0	2	2
13	4	4	0	4	0	4	0	3	1	2	2	2	2	2	2		2		0		0		0	2	2
14	3	2	0	3	0	2	0	2	0	2	0	2	0	2	0	2	0		ABANDONED					0	0
15	4	4	0	4	0	2	2	0	4		3		3		3		0		0		0		0	4	3
16	4	3	0	4	0	4	0	2	0	1	1	0	2		2				1		1		0	2	2
17	3	3	0	3	0	1	1	1	1	0	1		1		1		1		0		0		0	1	1
18	4	4	0	4	0	4	0	4	0	2	2	0	2		2		2		0		0		0	2	2
19	3	2	0	3	0	3	0	3	0		ABANDONED													0	0
20	4	2	2	1	2	1	2	1	2	0	2		2		0		0		0		0		0	2	2
21	4	1	3	0	4		4		4		4		3		0		0		0		0		0	4	3
22	4	4	0	1	3	0	4		4		4		3		3		0		0		0		0	4	3
23	4	4	0	2	2	0	4		4		4		4				3		0		0		0	4	4
24	5	5	0	4	1	1	3	0	3		3		3		3		1		0		0		0	3	3
25	4	4	0	4	0	4	0	4	0	1	3	1	1	1	1	1	1	1	1		0		0	3	1
26	5	5	0	5	0	5	0	5	0	5	0	2	1	2	1				ABANDONED					1	0
27	3	3	0	0	3		3		3		3		3		3		0		0		0		0	3	3
28	3	3	0	0	3		3		3		3		3		0		0		0		0		0	3	3
29	3	2	1	0	1		1		1		1		1		ABANDONED									1	0
30	3	0	3		3		3		3		2		2		0		0		0		0		0	3	2
31	2	0	1		2		2		2		2		0		0		0		0		0		0	2	2
32	4	4	0	4	0	4	0	0	4		2		2		2		2		0		0		0	4	2
33	4	4	0	4	0	4	0	4	0	1	3		3		3		0		0		0		0	3	3
34	4	4	0	4	0	4	0	3	1	1	3		3		2		2		0		0		0	3	2
35	3	1	2	0	3		3		3		3		2		0		0		0		0		0	3	3
36	4	4	0	4	0	4	0	0	4		4		4		4		0		0		0		0	4	4
37	4	4	0	1	0	1	0			0	1		1		1		0		0		0		0	1	1
38	3	1	0	3	0	3	0	3	0	2	1	0	3		3				2		0		0	3	3
39	3	3	0	3	0	2	0	2	0	2	0	2	0	2	0	2	0		ABANDONED					0	0
40	4	4	0	2	2	2	2	2	2	0	2		2		0		0		0		0		0	2	2
41	4	4	0	4	0	4	0	4	0	0	4		4		3		3		3		0		0	4	3
42	3	3	0	1	1	0	2								ABANDONED									2	0
43	3	1	0	3	0	3	0	3	0	3	0	0	3		3		3		3		0		0	3	3
44	2	1	0	1	0	2	0	2	0	1	1		2		2		2		2		0		0	2	2
45	2	2	0	1	1	0	2				2		2		1		0		0		0		0	2	2
46	3			3	0	3	0	3	0	3	0	0	3		3		3		0		0		0	3	3
47	2	1	1			1	1	0	2		2		2		1		0		0		0		0	2	2
48	4					4	0	4	0	4	0	0	3		3		0		3		0		0	3	3
49	4									4	0	4	0	0	4		4		4		4		3	4	3
TOTAL:		178	135	13	114	39	101	56	79	66	41	94	14	105	9	86	5	48	1	32	0	9	0	3	124	105

TABLE 4

Great Blue Heron Fledging
Success, Bair Island, 1971

Fledglings per nest	Number of nests	Percent
1	4	10
2	16	38
3	19	45
4	3	7
Total	42	100

Average/successful nest 2.50

TABLE 5

Great Blue Heron Mortality
Bair Island, 1971

Nest studied:	49
Nests abandoned during the season:	7 (14.3%)
Successful nests fledging one or more young:	42 (85.7%)
Nests without loss:	13 (26.5%)
Nests losing one or more eggs:	18 (36.8%)
Nests losing one or more chicks:	8 (16.3%)
Nests losing both eggs and chicks:	3 (6.1%)

Predation: No predation was in evidence at this colony in 1971. Two to three short-eared owls (Asio flammeus) were seen in the immediate area during each visit to the colony but were never observed feeding near the colony. Analysis of short-eared owl pellets collected at roosts failed to reveal any heron remains. Norway rats (Rattus norvegicus) are also present in the colony area, but apparently pose no threat to herons.

Banding

All banding was done during regularly scheduled visits to the colony. Prior to banding this year, only one great blue heron had been banded in the San Francisco Bay area. A total of 107 great blue heron chicks were banded. Four banded dead chicks were found in the colony. One three week old bird was found hung in the branches of the nest; another six weeks old, was found 30 yards from its nest with a broken ankle; and 2 four weeks old birds were found dead below their nest. Mortality caused by investigator banding nestlings was encouragingly small.

A banded juvenile heron was observed at the mouth of Mowry Slough, Alameda County, on August 8, 1971 and is presumed to be from the Bair Island Colony.

Black-crowned Night Heron, Snowy Egret and Common Egret

Background

Black-crowned night heron (Nycticorax nycticorax) has been breeding in South San Francisco Bay since 1900. Finley (1906) reported a large colony, 700 pairs, near Alvarado, Alameda County in 1906. A colony of 60 nests was found near Alameda, Alameda County in 1900 (Cohen, 1904). By 1927 both colonies were inactive (Grinnell and Wythe, 1927). Sibley (1952) states that in 1952 no active colonies of black-crowned night herons were known in the south bay. Reference to any nesting by this species in South San Francisco Bay was not found until 1967. Black-crowned night heron nesting is now restricted to the Bair Island Rookery, San Mateo County (Figure 3). First survey of the Bair Island Rookery was conducted in 1967 when 200 night heron nests were found. By 1969 this rookery had increased to 400 nests.

Snowy egret (Leucophoyx thula) represents a much more recent breeding species in South San Francisco Bay. Nesting was first reported on Bair Island in 1969 when 150 snowy egret nests were found (Anderson, 1968).

Common egret (Casmerodius albus) formerly nested approximately one mile southeast of Agnew, Santa Clara County (Sibley, 1952). Nesting was also reported on Bair Island in 1967 when the first survey was made of the rookery, 75 nests were found. No common egret nesting was found in 1969 or 1971.

This report summarized the 1971 nesting season for black-crowned night herons and snowy egrets.

Description of Rookery

Bair Island Rookery is located on the northeast corner of the island, see great blue heron section for description and location of Bair Island (Figure 3). Active nests were found on both sides of a slough one mile long. Gum plant (Grindelia humillis), pickleweed (Salicornia virginica), and coyote bush (Baccharis pilularis) compose the major vegetative types within the rookery. A wide expanse of mixed salt marsh cord grass (Spartina foliosa) and pickleweed border the rookery on the north and northeast while a large dry salt pond borders it on the south and southwest.

Methods

Visits to the rookery were made by boat from the Hubbard Johnson Lumber Company, Redwood City, to the PG&E catwalk on the southeast corner of Bair Island. All observations were made by walking through the rookery. Visits were made on the average of one every three weeks beginning on March 4, until the end of June, 1970. Data on the number of nesting pairs and clutch size were recorded on each visit. Nestlings were banded during regularly scheduled visits to the rookery.

Findings

Black-crowned night heron nesting was in progress at the first visit of the rookery on March 4, 1971. A count of nesting pairs was not taken at that time. Snowy egrets were present at the rookery but no nesting was observed during that visit. Black-crowned night heron nests were evenly distributed throughout the rookery with the majority of nests located in gum plant or pickleweed. Coyote

bush was also utilized by a few herons as nest sites. Snowy egrets tend to colonize more than herons. Four separate groups or colonies were active along the slough. Three of these were located in gum plant or pickleweed, while the fourth was located in garden orache (Atriplex hortensis) 3-5 feet tall. Snowy egret nests were first found on April 1. Peak nesting for black-crowned night herons occurred the middle of May while the peak of snowy egret nesting was 2-3 weeks later (Table 6).

TABLE 6

Black-crowned Night Heron and
Snowy Egret Nesting
Bair Island, 1971

Survey Date	Number of nest/species	
	Black-crowned Night Heron	Snowy Egret
4-01-71	368	28
4-24-71	563	240
5-14-71	684	312
6-01-71	502	340
6-22-71	319	265

Mortality: Although no quantitative data were recorded on hatching or fledging success, general indication of the rookery success was gathered from clutch counts and banding data. At first, chick mortality appeared high but studies by Hickey (1952), Palmer (1962), Teal (1965), and Jenni (1969) suggest a 50-70 percent chick mortality for snowy egrets and black-crowned night herons. This high mortality usually occurs during the first 1-3 weeks. The Bair Island Rookery appeared to follow this same trend with a 50-60 percent estimated mortality.

Banding

All banding was conducted during scheduled visits to the rookery. Eight-hundred black-crowned night heron chicks and 405 snowy egret chicks were banded in 1971 at the Bair Island Rookery. Thirty-two banded dead chicks of both species were found in the rookery. No snowy egrets and only 61 black-crowned night herons have been banded prior to this year in the San Francisco Bay area (USF&WS, 1971).

American Bittern

Nesting by American bittern (Botaurus lentiginosus peeti) was not documented within the study area during 1971.

Sibley (1952) list the status of the American bittern in South San Francisco Bay as that of a fairly common resident in fresh water marshlands, occasionally in salt marsh. Nesting records have been reported from Irvington (small young, May 18, 1923) and Lake Merced (Grinnell and Wythe, 1927). Sibley (MS) reports seeing one with white nuptial patches in salt marsh near Alviso, May 6, 1951.

During this study, bitterns were usually flushed (March-June) during visits to the Palo Alto Flood Control Basin, the upper reaches of Coyote Creek, and the upper ends of Mowry and Plummer Sloughs. These areas appear to afford the best nesting habitat within the study area for the bittern. Nesting is characteristically restricted to dense stands of tule and rushes with nests placed close to the ground.

Waterfowl

Background

The importance of San Francisco Bay to waterfowl is primarily as a wintering area. Prior to the reclamation of almost all fresh water marshlands surrounding the bay, this area offered some of the best nesting habitat available. The bay area, study area in particular, is presently characterized by having very little suitable habitat for nesting waterfowl. Those areas which do attract nesting waterfowl are limited in size or are on private duck clubs and fresh water is drained off prior to the breeding season.

Methods

No special effort was made toward assessing waterfowl nesting within the study area (Figure 4). Those nests and/or broods found were done so while investigating other species. All nests were located while walking through nesting cover by flushing hens. Broods were located by aerial survey, observations from automobiles, and by flushing them from cover while walking through marsh or water-associated habitat.

Findings

Six waterfowl species were found nesting within 200 acres of fresh water marshes in the study area in 1971. Pintail (Anas acuta) was found most frequently with 21 nests and/or broods followed by gadwall (Anas strepera) 19, mallard (Anas platyrhynchos) 8, ruddy duck (Oxyura jamaicensis) 5, cinnamon teal (Anas cyanoptera) 4 and shoveler (Spatula clypeata) 1 (Table 7).

Twelve nests, representing three species were found. Seven of these were later found destroyed. Forty-six broods, representing six species were observed in addition to the nests found. Duplication of brood counts occur because of the overlap in areas and follow up censusing of the same area. In most cases, however, censusing was directed towards a different part of the area than previously censused.

Areas in which the most successful nesting occurred were Coyote Hills Slough and Alameda Creek, Alameda County; Mt. View, Charleston Sloughs and Coyote Creek, Santa Clara County and Palo Alto Marsh, San Mateo County (Figure 4). Nesting failure was most evident in areas isolated from fresh water. No successful broods were observed on Bair and Greco Islands, San Mateo County or on numerous other small islands or salt dikes within salt ponds. Numerous nesting attempts were made in these areas (Table 7). Absence of suitable fresh water in these areas accounted for the lack of successful broods. Predation by Norway rats was also a factor in nesting failure and occurred most frequently in areas where there was waste disposal or human disturbance.

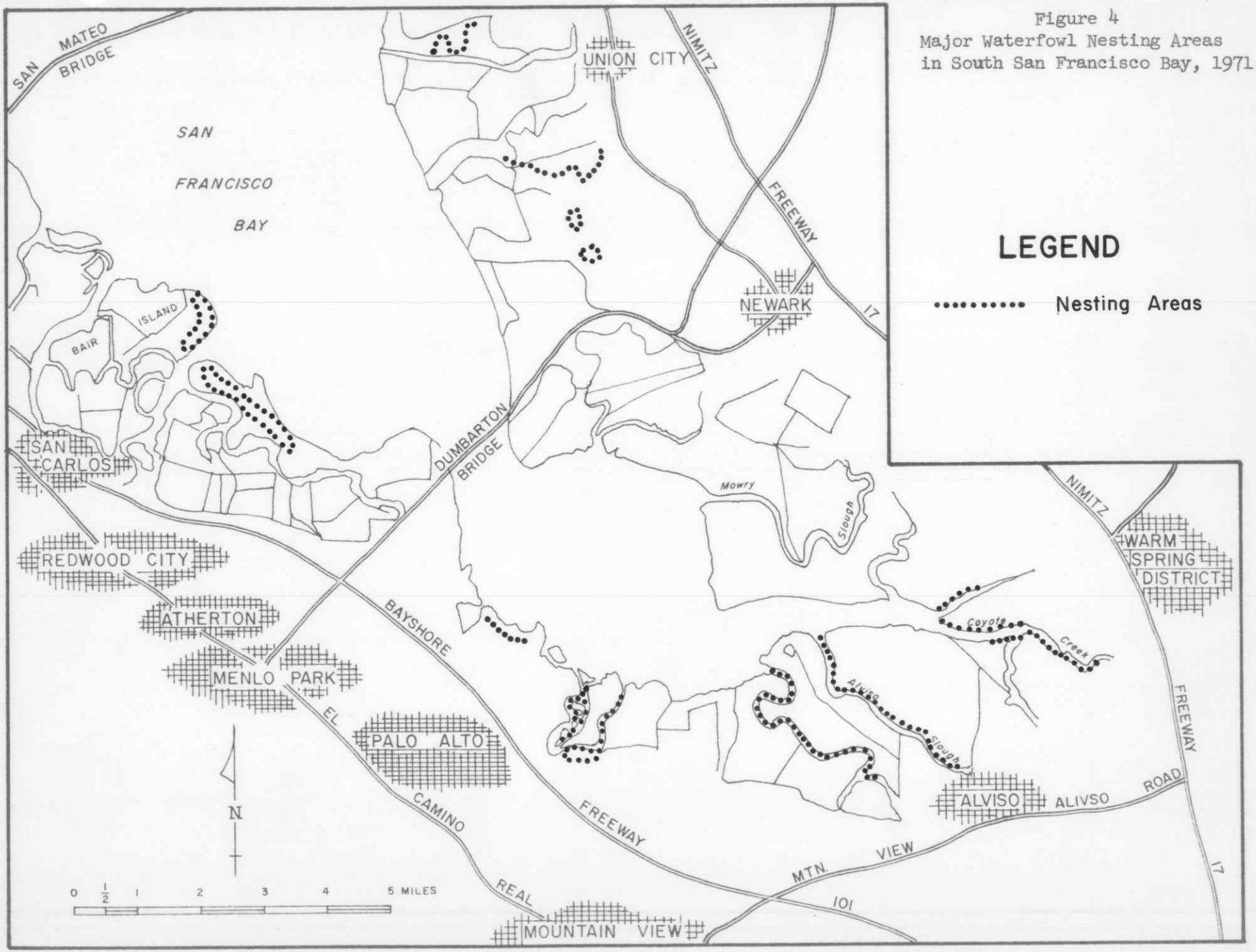


Figure 4
Major Waterfowl Nesting Areas
in South San Francisco Bay, 1971.

TABLE 7
Waterfowl Nesting Summary
South San Francisco Bay, 1971

Species	Date	Location	Number of hens	Brood size/sizes	Clutch size
Gadwall	6-23-71	Charleston Slough	1	5	
"	"	" "	2	6,8	
"	7-16-71	Guadalupe Slough	1	6	
"	7-23-71	Charleston Slough	7	2,4,4,6,6,9,11	
"	7-23-71	Coyote Hills Slough	8	5,6,9,9,10,10,11,12	
Mallard	3-23-71	Bair Island	1		13 2/
"	4-14-71	Greco Island	1		8
"	4-18-71	Bair Island	1		9 1/
"	4-23-71	Knapp Property	1		7 7/
"	6-23-71	Charleston Slough	1	15	
"	6-23-71	" "	2	6,10	
"	7-10-71	Coyote Hills	1	9	
Pintail	4-14-71	Greco Island	1		8 3/
"	4-21-71	Knapp Property	2		8,9 6/
"	4-24-71	Bair Island	1		8 5/
"	5-05-71	Palo Alto	1		9
"	5-05-71	E. Dumbarton Bridge	1		8
"	6-03-71	Knapp Property	1		7 4/
"	6-23-71	Charleston Slough	1	6	
"	"	" "	1	9	
"	"	" "	1	6	
"	"	" "	4	5,7,7,8	
"	7-14-71	Palo Alto	3	9,9,11	
"	7-16-71	Guadalupe Slough	1	4	
"	7-23-71	Charleston Slough	3	4,5,6	
Cinnamon Teal	5-05-71	Palo Alto	1		9
"	6-23-71	Mt. View Slough	1	6	
"	6-23-71	Charleston Slough	1	4	
"	7-23-71	" "	1	8	
Shoveler	7-23-71	Charleston Slough	1	5	
Ruddy Duck	6-23-71	Mt. View Slough	1	6	
" "	7-16-71	Guadalupe Slough	1	4	
" "	7-16-71	" "	1	4	
" "	"	" "	1	5	
" "	7-23-71	Charleston Slough	1	2	

Note: 1/ Found destroyed 5-23-71
2/ Found destroyed 4-17-71
3/ Found destroyed 4-29-71
4/ Found destroyed 6-20-71 (Rats)
5/ Found destroyed 5-05-71
6/ Found destroyed 5-05-71 (Rats)
7/ Found destroyed 5-05-71 (Rats)

White-tailed Kite

Background

White-tailed kite (Elanus leucurus) is a resident in South San Francisco Bay. The population has fluctuated greatly in the last 75 years. Prior to 1895 it was common and widespread in the state (Grinnell and Miller, 1944). Taylor (1889) found 11 nests in Santa Clara County in 1889. Numbers then began to decline in Santa Clara County. Grinnell and Wythe (1927) reported the kite as being "rather rare" in the San Francisco Bay Region. Pickwell (1932) felt the white-tailed kite was restricted to 2-3 individuals in that year. Numbers remained low through the 1930's (Martin, 1939). An increase in kite activity in the south bay was noted in the early 1940's and apparently continued to improve. Sibley (1952) estimated a population of 100 individuals in south bay region in 1952. This comeback in numbers in the bay area was paralleled throughout former kite range in California (Waian and Stendall, 1970)

Today, white-tailed kites are a common sight in the bay where they can usually be seen foraging in large open fields or marshes especially west of Fremont and Coyote Hills, Alameda County and near Milpitas and Palo Alto, Santa Clara County. Results of white-tailed kite nesting in the South San Francisco Bay area during the 1971 season are presented in this section.

Methods

Kite nests were located by aerial reconnaissance and ground survey. Nests located by ground survey were done so by flushing a bird off the nest or by observing foraging kites and following them to nesting sites. Once located, the nests were recorded and plotted on a map of the study area. Data on clutch size, nest construction, and hatching and fledging success was recorded. Eyas were banded at 3-4 weeks of age.

Findings

Seven white-tailed kite nests were located within the study area this year (Figure 5). Nesting dates ranged from April 4, 1971 to August 18, 1971. The one nest located on August 18 must be considered unusually late in the nesting season for this species. Bent (1937) lists 120 nesting records from California to Texas between February 12 and June 21. Dixon (1957) list July 10 as the latest laying date for 124 records of white-tailed kite nesting in San Diego County, California.

Nesting Habits

Nest construction and sites varied considerably. Three nests found on Bair Island, San Mateo County were constructed in coyote bush 4-8 feet in height. One nest was located in a eucalyptus tree east of the town of Alviso, Santa Clara County. The remaining three nests were constructed in willow and sycamore trees east of Coyote Hills, Alameda County. These nests were inaccessible.

Nesting

Only two nests were followed to fledging (Table 8). In these, all eggs hatched and all young fledged. The nest located on August 18 contained two fresh eggs and was judged to be 1-2 days old but was not revisited. One of the nests near Coyote Hills

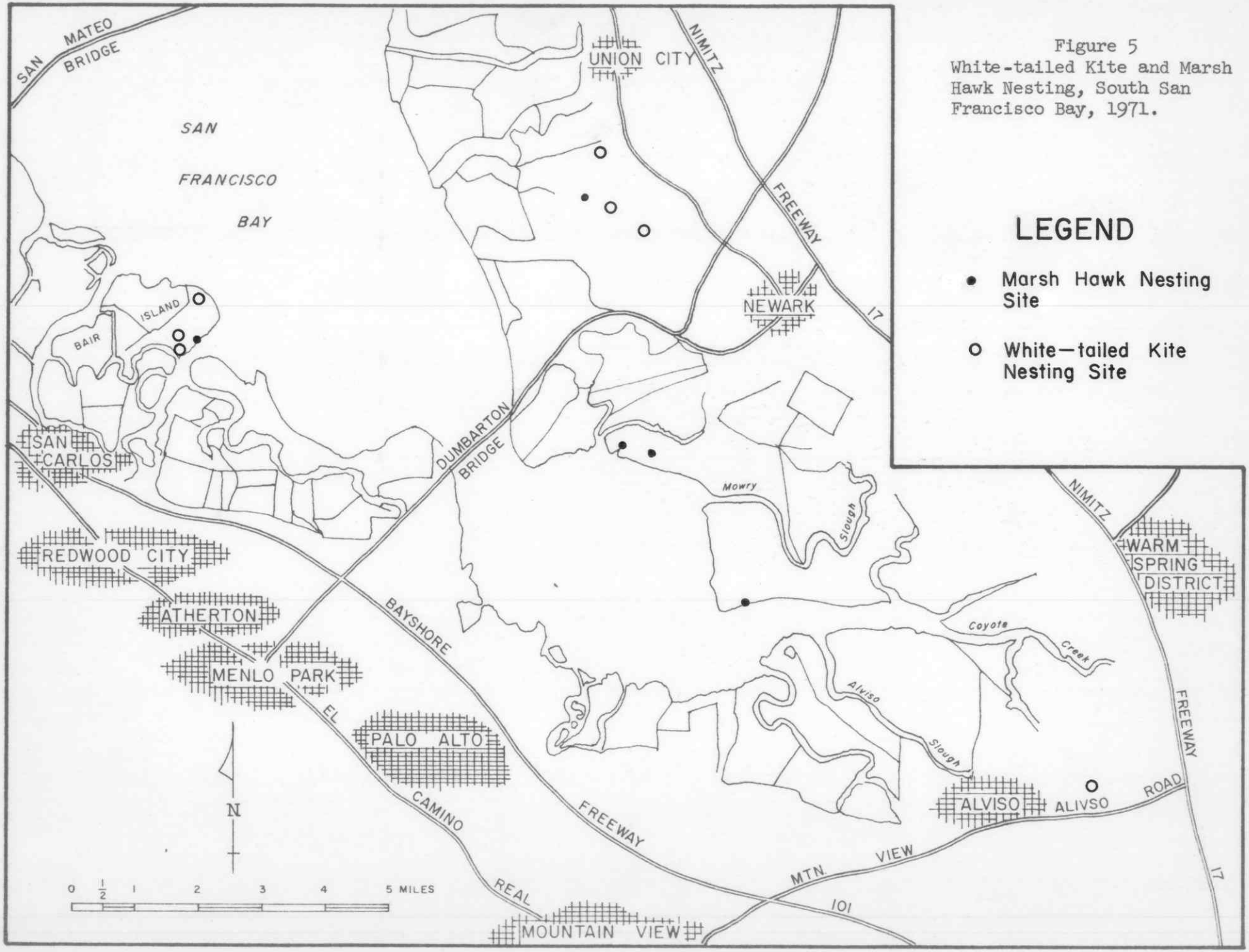


Figure 5
White-tailed Kite and Marsh Hawk Nesting, South San Francisco Bay, 1971.

was observed to have two adults and three volant young near it, approximately one month after discovery. Detailed information was not obtained on other nests because of inaccessibility.

TABLE 8

White-tailed Kite Nesting
South San Francisco Bay, 1971

Date	Location	Number Eggs	Number Fledged	Number Banded
4-04-71	Bair Island	5	5	5
4-18-71	" "	3	3	3
4-27-71	Coyote Hills	-	*	0
5-06-71	Alviso	-	**	0
5-17-71	Coyote Hills	-	***	0
6-18-71	Coyote Hills	4	-	0
8-18-71	Bair Island	2	-	0

* 2 adult-3 young seen on July 18, 1971
** young never observed at nest - adults seen on 2 aerial surveys
*** young not observed at nest

Population projections were not made on this species within the study area. Nesting densities seem to be a function of food availability and not territory size.

Marsh Hawk

Background

Marsh hawk (Circus cyaneus) is generally considered to be a winter visitor in the San Francisco Bay area. Reports of nesting in the bay area are limited. Barlow (1900) reported a nest with eggs near Alviso, Santa Clara County prior to 1900. Sibley (1952) and Grinnell and Miller (1944) make reference to the same nest as being the only reported nesting in the south bay up to that date. Reference has been made to this species nesting near Point Reyes, Marin County and Pescadero, San Mateo County.

Nesting was documented on five separate occasions during this study with numerous additional sightings of foraging birds (Figure 5). A detailed report of this species nesting within the south bay is presented in this section.

Methods

All nests were located by flushing adult birds from the nest while walking through nesting habitat. All nests were marked with directional land marks placed on the nearest elevated ground. Follow up visits to nests were carried on in conjunction with other field work in that area. Data were recorded on nest location and construction, clutch size and fledging and hatching success. Young marsh hawks were banded at one nest.

Findings

No information was found regarding laying dates for California marsh hawks. Bent (1938) lists 34 records from Colorado, Utah, and Washington between March 16 and July 18. Five nests were located within the study area (Figure 5). Eggs were first located on April 18, 1971. One nest contained five eggs, three contained six eggs and one contained four eggs. Nests containing five or more eggs were considered complete. Hammond and Henry (1949) list 5.23 eggs as being the mean clutch size for 13 marsh hawk nests studied in North Dakota in 1939.

All nests were built on the ground which is characteristic of the species. Three nests were constructed in stands of pickleweed subject to tidal action. One additional nest located in pickleweed was situated on dry dredging spoils. The fifth nest was located in a cord grass marsh subject to tidal action. All nests were constructed of dried grasses and/or small twigs. Nests averaged 18 inches to 24 inches in diameter. Those nests subject to tidal action were considerably thicker than the one located on dry ground.

Four of the five nests provided sufficient data to determine hatching and fledging success (Table 9). One nest not included was not revisited for 40 days at which time no signs of adult or young were found.

TABLE 9

Marsh Hawk Nesting Success
South San Francisco Bay, 1971

Date	Location	Number Eggs	Number Hatched	Number Fledged	Number Banded
4-18-71	Bair Island	5	5	5	5
5-07-71	Plummer Creek	6	6	5	0
5-07-71	" "	6	5	4	0
5-19-71	Coyote Hills	6	4	4	0
6-01-71	Coyote Creek	4	Incomplete data		
	Total	27	20	18	5

Hatching Success

Twenty-three eggs were laid in the four nests considered. Twenty eggs (86%) successfully hatched. Fate of unhatched eggs was not determined. Because of the sample size these figures should not be considered as representative of the hatching success for this species in the study area.

Fledging Success

Eighteen young (90%) were successfully fledged from 20 eggs that hatched. Exact dates of fledging are not known. Young in 3 of 4 nests were able to fly at 4-5 weeks of age. Some were found in the nest as much as six weeks after the discovery of the nest.

Banding

Five young were banded during the study. All were banded at 3-4 weeks of age at the Bair Island nest site. Weights at banding ranged from 380-575 grams, average 470 grams.

No effort was made to estimate marsh hawk populations within the study area. Five nests located represent the minimum breeding population present. Considering the acreage of nesting habitat available (4,200 acres) additional nesting probably occurred. Marsh hawks were commonly seen on Greco Island, San Mateo County and over the marshes near Mowry Slough, Alameda County.

Ring-necked Pheasant

Nesting was restricted to fields, adjoining levees, and agricultural lands bordering marshlands in the extreme south bay. Active nesting was recorded within the Palo Alto Flood Control Basin and two miles northeast of Alviso, both in Santa Clara County. Two nests were found in each locality. First nesting was found on April 12, 1971. Young were seen on several occasions (7) east of Coyote Hills, Alameda County.

Suitable nesting habitat within the study area was limited to approximately 400 acres. Coyote Hills Regional Park and the grasslands between Charleston and Mayfield Sloughs, Santa Clara County accounted for most of the habitat (300 acres).

The adult pheasant population in the study area, based on direct observations, is between 40 to 50 birds.

American Coot

Nesting by the American coot (Fulica americana) within the study area was documented on four occasions during 1971. First evidence of nesting was found on June 5 near Coyote Hills Regional Park, Alameda County. One adult with one chick was seen then. Two additional broods were found on June 18 near Coyote Hills, with 3 and 5 chicks respectively. A fourth brood of 5 chicks was observed near Charleston Slough, Santa Clara County on July 23. All broods observed were in areas of cattails and rushes influenced by fresh water.

Additional sightings of adults (approximately 40) were made between April-August 1971 within the study area. Most of these occurred near Coyote Hills, Coyote Creek, Alviso Slough and the Palo Alto Flood Control Basin; all areas influenced by fresh water. These sightings probably represented additional nesting in the study area during 1971.

California Clapper Rail

Background

In spite of its reported secret habits, the California clapper rail (Rallus longirostris obsoletus) has been the object of numerous studies throughout its range. Majority of the work has been centered in the South San Francisco Bay marshes and dates back to when the clapper rail was hunted as a game bird.

Studies in the 1890's have described the nesting habits of this bird in the San Francisco Bay (Taylor, 1894 and Adams, 1900). Other nesting studies were reported by Bryant (1915), DeGroot (1927), Applegarth (1938) and Zucca (1954). Behavior and feeding studies have been reported by Williams (1929) and Moffitt (1941). Population studies were reported on by Applegarth (1938) and Zucca (1954).

Major clapper rail populations in San Francisco Bay are centered in the salt marshes bordering the south arm of the bay in Alameda, Santa Clara and San Mateo Counties. Small populations exist in and around the salt marshes of San Pablo Bay in Sonoma and Marin Counties, Elkhorn Slough in Monterey County, Tomales Bay and Bolinas Lagoon in Marin County. Grinnell and Miller (1944) lists three records from Humboldt Bay, California; however, it is doubtful that any resident populations exist north of Tomales Bay.

Study Area

Clapper rail investigations were restricted to 4,250 acres of salt marshes. Approximately 1/10 (425 acres) is bare surface in the form of sloughs, creeks and mudflats. Considering this, 1,950 acres were classified as primary rail habitat and 1,120 acres as secondary rail habitat. The remaining 746 acres, which comprised most of the brackish headwaters of the numerous sloughs in the study area, was considered poor clapper rail habitat. The most extensive areas of undisturbed salt marshes are found near Plummer Creek, Mowry Slough and Coyote Creek in Alameda County and near Redwood City and Greco Island, San Mateo County (Figure 6).

The salt marshes on both the east and west sides of San Francisco Bay are built on extensive alluvial deposits from the numerous streams draining the Santa Cruz and Mt. Diablo mountains. The marshes themselves are drained by an intricate network of small sloughs or tidal meanders with the smaller sloughs converging to form several major ones which empty into the bay at the marshes' edge. Most of a clapper rail's life is centered around these tidal meanders.

Methods

Field investigations were conducted between March and December, 1971. Nesting studies were concentrated from March to July. Nests were located by walking tidal meanders as described by DeGroot (1927) and by a modified rope drag method. In both cases, incubating birds were flushed and nests were located and described. Population indices were arrived at by rope drag, nest counts, call counts and direct observation during flood tides. In both nesting and population studies rope drags were conducted using a 100 yard length of #10, single ply nylon twine, marked with 3 foot lengths of red and yellow surveyors tape alternately attached to the tape at 12 foot intervals. Transect widths averaged 75 yards. Transects covered approximately 20 square acres and were run both parallel and perpendicular to the drainage pattern of the marsh. Transect acreage figures were computed from aerial photographs and topographic maps of the study area. Flushed rails were marked with reference to the colored tape on the rope and followed in flight so as to reduce duplicate counts. The area was searched for nests within a 15 foot diameter of the flushing site. Data were recorded on nest location, habitat type where nest was found, nest construction and clutch size. Rails were also censused during flood tides (6.7'+) as described by Zucca (1954). On large sections of marsh (100+ acres) a flat bottomed boat was used to run transects through flooded marsh. Observation under flood tides was limited to between one hour before and one hour after slack tide. A recorded tape of clapper rail calls was used to induce calls for census purposes.

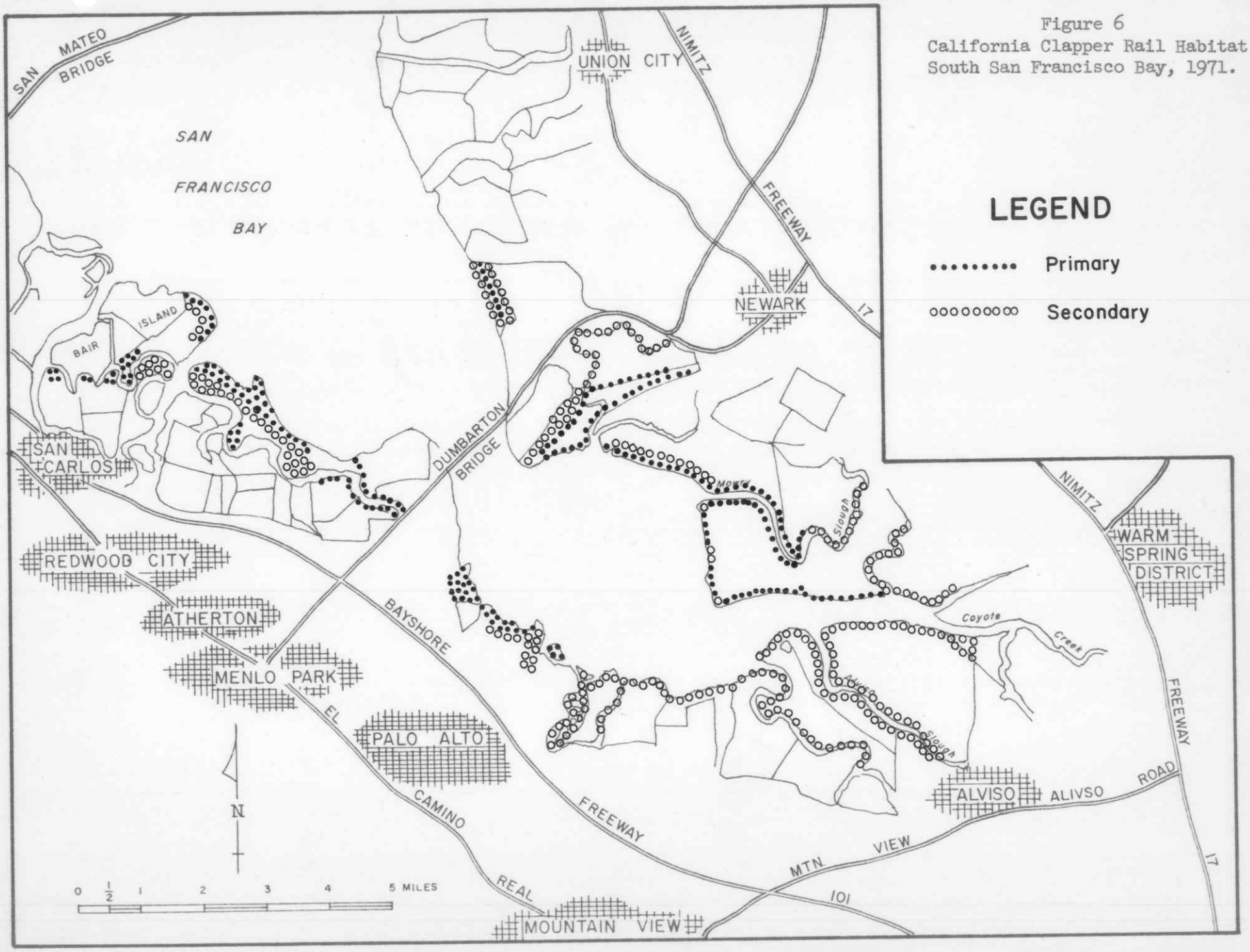


Figure 6
California Clapper Rail Habitat
South San Francisco Bay, 1971.

Findings

Nesting: Eighty-seven nests were located during the 1971 season (73 by rope drag and 14 by walking tidal meanders). Active nesting was recorded between the middle of April to the middle of July. Peak nesting occurred during the first two weeks of May (Figure 7). When necessary, dates of first laying were determined by back-dating, allowing one day for each egg in the nest at the time of discovery (for clutches of less than six eggs). Grinnell et. al. (1918) report egg laying dates from the middle of March to the end of June. Applegarth (1938) and Zucca (1954) reported the first nest in April with peak of nesting in May. Of the 87 nests, 58 were active when discovered. Five nests appeared new but without eggs (DeGroot (1927) and Steward (1953) found rails to build as many as six duplicate or dummy nests for every one actually used), 19 additional nests were classified as old nests without eggs or old duplicate nests, and five nests with eggs were found destroyed. DeGroot (1927) reports a second nesting period between June 25 and July 15 for the California clapper rail. Zucca (1954) also found a second nesting but attributes this to renesting attempts after first attempts were destroyed by high spring tides. Similar studies on the northern clapper rail (Rallus longirostris crepitans) of the east coast by Schmidt and McLain (1951) report a definite second nesting. A second nesting peak did occur this year between June 15 and July 15 but was of a smaller magnitude than the peak nesting period in May. A series of high tides on May 22-25 and June 19-21 of this year was sufficient to disrupt nesting at that time and probably accounted for the late peak in July. Reasons for the apparent second nesting attempts need further clarification.

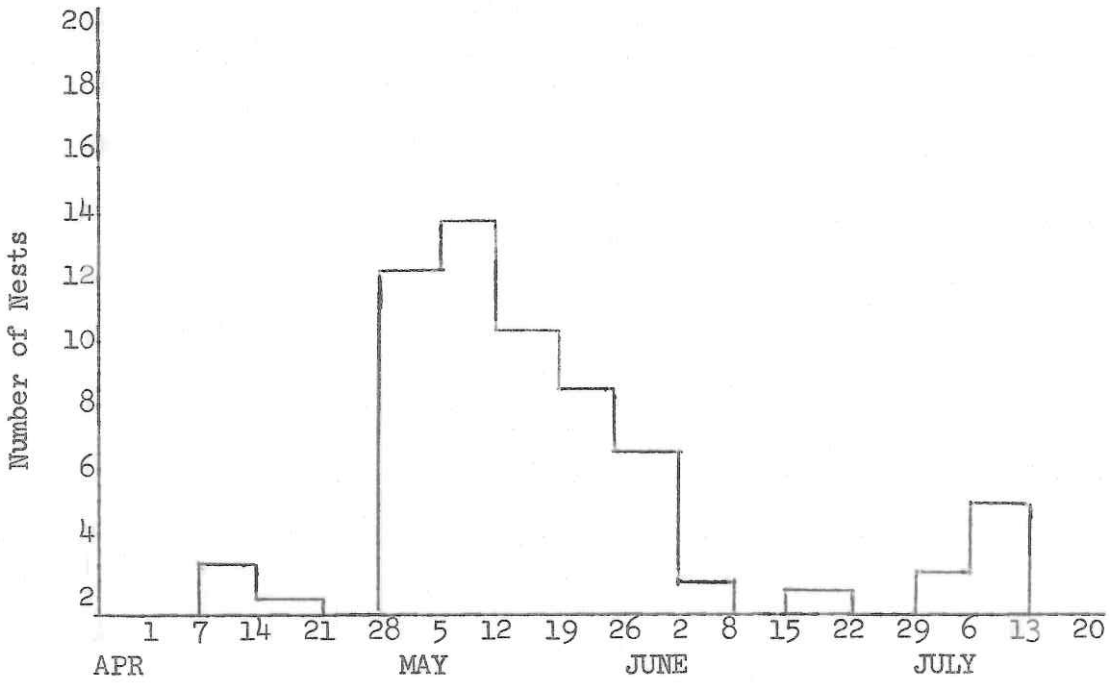


Fig. 7 California Clapper Rail Nests Found By Weeks
South San Francisco Bay, 1971

Clutch Size

Fifty-eight active nests, containing 396 eggs, were found in 1971. Clutch size ranged from 3-11 eggs. A distribution of clutch sizes is presented in Figure 8.

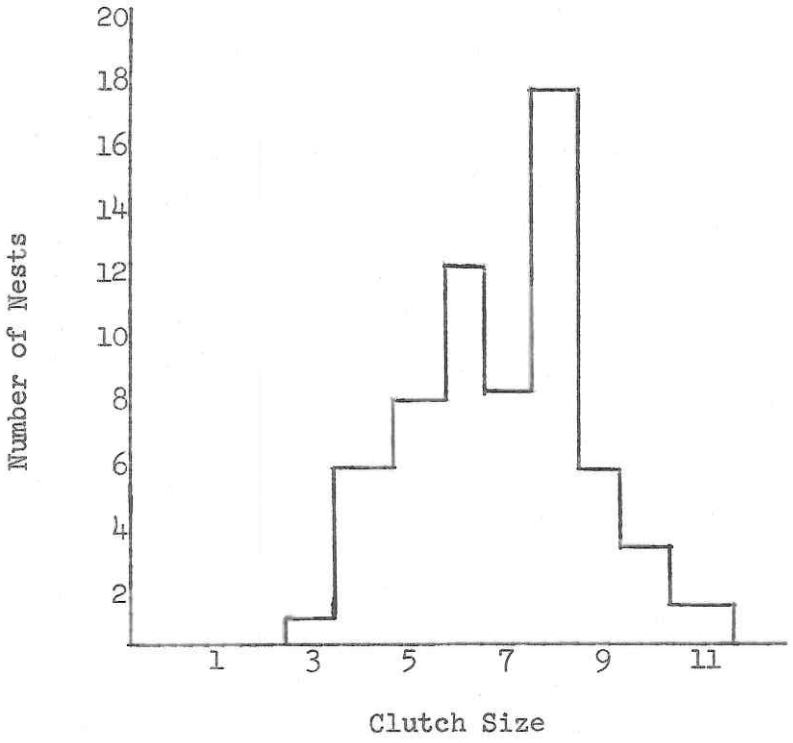


Fig. 8 California Clapper Rail Clutch Sizes, South San Francisco Bay, 1971

Nests which contained eggs but appeared abandoned or destroyed were not considered. Mean number of eggs per clutch, based on data taken from 58 nests was 6.83. A comparison of three other studies of the California clapper rail in South San Francisco Bay shows a somewhat higher mean clutch size (Table 10).

TABLE 10

Comparison of Clutch Sizes from California Clapper Rail Nesting Studies, South San Francisco Bay

	DeGroot 1926	Applegarth 1938	Zucca 1951	Gill 1971
Number of nests	74	27	27	58
Total number of eggs	611	214	195	396
Mean number of eggs	8.51	7.92	7.22	6.83
Range of clutch size	5-14	6-9	5-9	3-11

Because nests were not followed to hatching during this study, mean clutch size was based on the number of eggs recorded at time of discovery, with many of these containing 3-5 eggs and obviously incomplete clutches. This would lower mean clutch size from that which probably occurred.

Structure of Nests

Five nesting habitats within salt marsh were recorded. These were classified as cord grass, gum plant, pickleweed, salt grass and mixed cord grass and pickleweed, based on the predominant marsh vegetation in which the nests were located. Zucca (1954) gives detailed descriptions of each type of nesting habitat. All nests were constructed of dried cord grass with the exception of one made of dried salt grass. Sixty-nine of the 87 nests (79%) were located in pure stands of cord grass 2-3 feet tall. Ten were built in the bases of gum plant bushes, six in pickleweed,

and two in mixed cord grass and pickleweed. Schmidt and McLain (1951) found 192 of 234 (825) clapper rail nests located in tall stands of East Coast cord grass (Spartina alterniflora) during a two-year study of clapper rails in New Jersey.

Hatching and Fledging Success

Because of the limited time available to observe each species during the survey no data were taken on hatching or fledging success. Breeding success has previously been reported on by DeGroot (1927) and Zucca (1954) for the California clapper rail and by Adams and Quay (1958), Kozicky and Schmidt (1949), Schmidt and McLain (1951), and Stewart (1953 and 1954) for clapper rails on the east coast.

Population Studies

Rope Drag: Thirteen transects were run on 11 different sections of marsh (Table 11). All transects were run during the nesting season (April-July). No difference was

TABLE 11

Summary of California Clapper Rail Transect
South San Francisco Bay, April-July, 1971

Date	Location	Habitat type	Acres	Tide height in feet	No. rails flushed	Rails/ acre
4-09-71	Greco Is., s.e. corner	Primary	32.60	2.5	14	0.43
4-14-71	Greco Is., middle	Secondary	22.30	0.0	11	0.48
4-16-71	Mouth, Coyote Crk., n. side	Secondary	25.80	-0.3	8	0.31
4-19-71	Marsh, 1 mi. w. Coyote Hills	Primary	47.20	-0.3	21	0.45
4-23-71	" "	Primary	38.00	4.3	41	1.08
5-07-71	n. Mouth Mowry Sl.	Primary	7.60	4.2	8	1.05
"	" "	"	13.20	4.2	14	1.06
"	" "	"	8.30	4.2	7	0.84
5-10-71	Greco Is., s.e. corner	Primary	30.00	-0.6	13	0.43
5-11-71	Palo Alto marsh	Primary	10.10	2.9	7	0.69
5-14-71	Mouth, Coyote Crk., n. side	Secondary	41.60	5.0	29	0.70
6-06-71	Greco Is., n. corner	Primary	15.90	4.1	17	1.07
6-11-71	Mowry Sl. mouth s.	Primary	27.80	4.6	28	1.01

found between transects run parallel or perpendicular to the drainage pattern of the marsh. Tidal conditions were found to affect transect results. Low tides exposed the overhanging banks of the tidal meanders and afforded rails excellent escape cover. Flushed rails showed a marked preference to fly opposite the direction of the drag. Of 218 rails flushed by this method, only four flew into the path of the drag. Salt marsh habitat was classified as either primary or secondary according to vegetative type. Primary was composed of pure stands of cord grass while secondary was often pure stands of pickleweed or mixtures of cord grass, pickleweed and other marsh vegetation. Transects run on primary habitat during medium high tides produced denisities ranging from 0.84 to 1.08 rails per acre. Those run on primary habitat during low tides ranged from 0.43 to 0.84 rails per acre. Transects run on secondary habitat during medium high tides produced a density of 0.70 rails per acre while those run during low tides on secondary habitat ranged from 0.31 to 0.43 rails per acre. Average densities for all transects run during high and low tides on both primary and secondary habitat are summarized in Table 12.

TABLE 12

Average Densities for Primary and Secondary California Clapper Rail Habitat During High and Low Tide Conditions

Habitat type; tide cond.	Number of transects run	Number of Rails/acre	Average Density of Rails/acre
Primary; medium high	6	0.84-1.08	1.02
Primary; low tide	4	0.43-0.69	0.50
Secondary; medium high	1	0.70	0.70
Secondary; low tide	2	0.31-0.48	0.39

Call counts: Censusing rails by call counts proved unsuccessful this year. Rails tended to stimulate calls from other rails creating a chorus effect making it hard to distinguish individual rails. This same problem was encountered by Adams and Quay (1958) and Bateman (1965). Rails were found to respond to recorded calls, but once a chorus effect was created, it was impossible to get an accurate count. This method would be very effective in establishing the presence or absence of rails on a section of questionable marsh.

Visual census at flood tides: This method was limited during the nesting season due to lack of sufficient high tides during daylight hours. It did prove successful during November and December of 1971 when several excellent tides of 6.8'+ occurred during the day. Census efforts were directed to a 90 acre section of marsh west of Coyote Hills, Alameda County. Rails were easily censused between one hour before and after slack tide when they were forced up out of the marsh onto floating debris. Censusing was done from a 12 ft. flat-bottomed boat moving through the flooded marsh. A density of 1.42 rails per acre was found for a 35 acre section of marsh on December 24. Zucca (1954) using similar methods reports densities of 1.22 and 1.21 rails per acre during a two day census on a 63 acre section of primary salt marsh near the west end of the Dumbarton Bridge, San Mateo County. Censusing was done during high winter tides (6.9', 6.8') under "favorable conditions" with good visibility.

Population Estimates: Population projections based on the average densities found during medium high tides, on both primary and secondary habitat from rope drag techniques, put the number of rails within the study area in South San Francisco Bay at 2,750 with a range of 2,420-2,880. These figures represent the minimum rail populations in the study area since it is not probable that all rails were flushed during transect operations.

Establishing population indices from direct observation during flood tide conditions needs further investigation. Population investigations using this method produced densities inversely proportional to those obtained from rope drag, i.e., higher densities in pickleweed than cord grass. This, I feel, is the result of more floating debris being trapped in pickleweed than cord grass. Rails would tend to congregate in these areas of dense flotsam as the tide forced them up out of the marsh.

Virginia Rail

Virginia rails (Rallus limicola) are similiar to soras in seasonal distribution, with wintering populations commonly found in salt marshes and nesting confined to fresh water marsh or areas with fresh water influence. Sibley (1952) makes several references to Virginia rail nests near Lake Merced and Alvarado, both north of the study area. Nesting records for this species in South San Francisco Bay were unavailable. Extensive nesting studies of the California clapper rail and fresh water marsh nesting species failed to produce evidence of Virginia rail nesting in the study area. Numerous winter records of this species in the south bay are available (Audubon Field Notes, 1968-71).

Suspected nesting places to be further investigated include the marshes within Coyote Hills Regional Park and the upper reaches of Coyote Creek and Mud Slough north of Alviso, Santa Clara County.

Sora

The sora (Porazan carolina) is considered a resident of San Francisco Bay with nesting restricted to fresh water. During winter, however, it is also found in salt marshes (Sibley, 1952).

No nesting by soras was found within the study area during 1971. The only suitable fresh water marshes in the study area are found near Coyote Hills, Alameda County and along Coyote Creek, Santa Clara County and the other small creeks flowing into the south bay. These areas were investigated for sora nesting (April-July) but none was found. Several nesting records exist for this species outside the study area in addition to numerous winter records within the study area (Sibley, 1952). Considering the number of winter sightings of this species in the south bay, it is probable, unless the sora migrates in spring to more suitable nesting areas in San Pablo and Suisun Bays or elsewhere, that nesting occurs in the study area. More intensive studies will be needed to document this.

Killdeer

Only one killdeer (Charadrius vociferus vociferus) nest, containing 3 eggs, was found during this study. This was located on Bair Island, San Mateo County, April 3, 1971. A second nesting was documented when three young were observed along the Southern Pacific Railroad tracks north of Alviso, Santa Clara County on June 11, 1971.

Nesting habitat is much more varied with the killdeer than with the snowy plover. Marshes, meadows, plowed fields and sandy substrate are often used by the killdeer as nesting sites. Adults were observed in all of these habitat types within the study area during 1971, probably indicative of more extensive nesting than actually found.

Snowy Plover

The snowy plover (Charadrius alexandrinus nivosus) is the smallest of the plovers frequenting San Francisco Bay and one of two which breed in the bay area. Nesting records for this species in the bay area exist prior to 1930. Kelley (1927) reports finding two nests near Baumberg south of Hayward, Alameda County. Young snowy plovers were found near Palo Alto, Santa Clara County by Martin (1939) and near Alviso, Santa Clara County in 1950-51 by Sibley (1952).

This species, as well as other Charadriiformes, has responded favorably to the presence of salt ponds in the south bay. Salt pond dikes, when accompanied by loose shell or small pebble deposits offer excellent nesting substrate for this species.

Nesting was recorded on 15 occasions during the study. First nesting was found on May 8, 1971 near the Knapp Gun Club, Alviso. Nesting continued through July. Bent (1927) lists 155 nesting dates from California ranging from April 2 to July 28. Nests were usually located by driving salt pond levees and noting flushed birds or ones exhibiting distraction displays. This did not always produce active nests because of the difficulty in locating the highly cryptic colored eggs and nests. Numerous nests were probably overlooked during the study. Of the 15 nests found, clutch size ranged from one to three eggs with the following distribution: 1 with 1 egg, 6 with 2 eggs, and 8 with 3 eggs.

Two areas within the study area accounted for all snowy plover nesting found during the study (Figure 9). Nine of 15 nests were located along a two mile section of salt pond levee, $\frac{1}{2}$ mile west of Alviso. The remaining nesting was found along a mile long section of salt pond levee immediately west of Coyote Hills, Alameda County. Both areas were rich in shell deposits and loose debris.

Although nesting was never documented as occurring there, snowy plovers were seen on three occasions along a levee on Bair Island, San Mateo County, and seven were counted along a series of insular dikes immediately north of Moffett Field Naval Air Station, Santa Clara County.

Since suitable nesting habitat was limited within the study area, those areas which did support nesting could be described as dictating a semi-colonial nesting situation. Nesting on the Knapp property was often a few feet apart with three nests occupying a 40 foot long dike of small shell deposits.

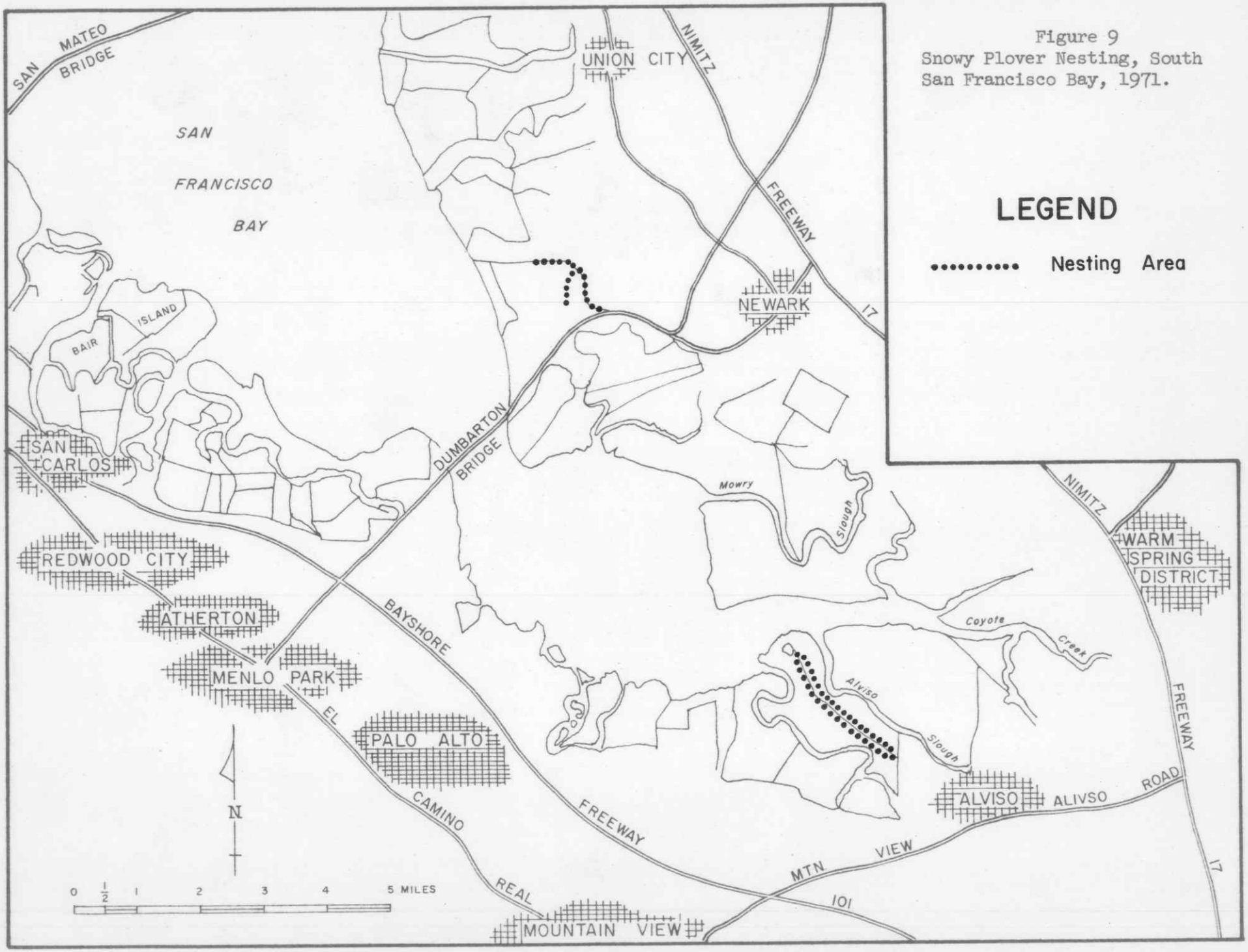


Figure 9
Snowy Plover Nesting, South San Francisco Bay, 1971.

Breeding populations of snowy plovers within the study area would approximate, I feel, close to 150 pairs. This would include nesting actually observed during 1971 plus the observation of other adult birds within the major nesting areas and the sightings of additional birds in areas with suitable nesting habitat such as Bair Island, Moffett Field and the Drawbridge-Coyote Creek areas.

American Avocet

Background

American avocet (Recurvirostra americana) is the most familiar large shorebird seen around San Francisco Bay. It is presently classified as a common resident with numbers fluctuating seasonally. Grinnell and Wythe (1927) refer to the avocet as an irregularly common visitor during autumn and winter. No mention is made of this species breeding in San Francisco Bay prior to 1937. It is now actively breeding in the bay area and represents another bird which has adapted to the salt pond environment of the bay. Almost all nesting reports are for areas associated with salt pond dikes. The first reference to avocet nesting in the south bay is by Martin (1939) who found young at Palo Alto, Santa Clara County in 1937. Young were also reported near Alvarado, Alameda County (Parameter 1937) and at the Dumbarton Bridge (Kelley 1941). Sibley (1952) reports a nesting colony of 26 pairs near Alviso in 1950. The same colony was intact a year later but contained only 5 pairs at that time.

Extensive avocet nesting was found throughout the study area in 1971.

Methods

Avocet nests were located by ground survey and aerial reconnaissance. Most nests could be located by searching an area where adult birds appeared alarmed or exhibited distraction displays. Other colonies were located by using a spotting scope and observing large concentrations of avocets during the nesting season.

All colonies were recorded and mapped. Data were gathered on scrape counts, clutch size, nesting substrate and the number of adults and young present. Limited effort was made to determine hatching and fledging success. Population projections were reported for the study area.

Findings

One hundred and sixty avocet scrapes were located during the study. Of these, 141 contained eggs when found while 19 were empty but considered active. All scrapes were constructed on salt dikes. The largest colonies were located on insular salt pond dikes and had to be reached by rubber raft (Table 13).

The insular effect appeared to enhance nesting of many species besides the avocet. Single largest colony was located in the first salt pond immediately west of the town of Alviso (Figure 10). This was actually a series of three colonies on

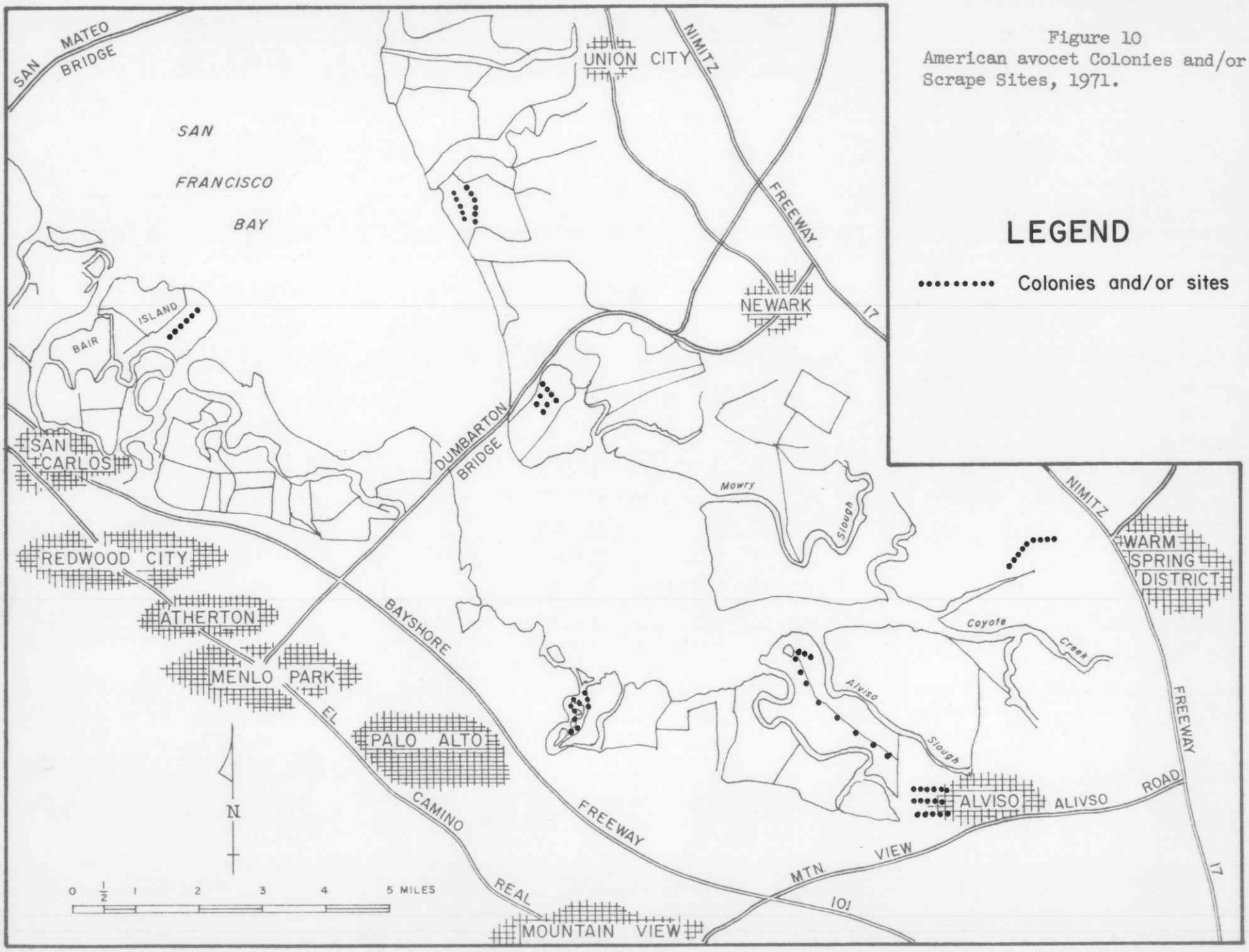


Figure 10
American avocet Colonies and/or Scrape Sites, 1971.

TABLE 13

American Avocet Nesting Data, South San Francisco Bay, 1971

Date	Location	Number of scrapes	Number Young	Clutch Number 0	1	2	3	4	5	6	7
4-23-71	Knapp Gun Club	7	0	0	1	0	2	4	0	0	0
5-05-71	½ mi. n. of Dumbarton Br.	9	0	0	0	0	0	8	1	0	0
5-06-71	¼ mi. w. Alviso series of 3 dikes	63	4	17	7	2	5	31	0	0	1
5-12-71	1 mi. n.n.e. of Drawbridge, Alameda Co.	7	0	2	1	0	0	4	0	0	0
5-20-71	¼ mi. w. Coyote Hills, Alameda Co.	36	0	0	1	2	14	18	1	0	0
6-23-71	Charleston Slough Santa Clara Co.	36	18	0	5	6	21	4	0	0	0
7-16-71	Knapp Gun Club	2	2	0	0	2	0	0	0	0	0
	TOTAL:	160	24	19	15	12	42	68	2	0	1

parallel insular salt dikes approximately 200 yards apart. Another feature which appeared to enhance nesting was the amount of debris scattered about the dikes. Nesting was observed to be of a greater magnitude on debris cluttered dikes than on similar ones without. The length and/or width of the dike did not seem to affect nesting. Height and location of dikes did, however. Dikes with a low profile and situated in relatively large salt ponds (440 acres) where wind could create large waves to wash the dike were usually free of avocet nesting, even though other desirable conditions existed.

Nesting was first observed on April 23, 1971 when seven active scrapes were located on the Knapp Gun Club, west of Alviso Slough. Nesting continued through the middle of July. Bent (1927) lists 35 records for California avocet nesting between April 22 and June 25. The majority of nesting was complete by the end of May.

Average clutch size was between 3-4 eggs (Table 13). Because follow up visits were not made to most of the colonies it was impossible to ascertain hatching or fledging success. It was assumed normal except for those scrapes found on the Knapp Gun Club. Here, extensive predation by Norway rats was found. All scrapes were destroyed when eggs were being incubated.

Population Projections

Because of the characteristic nesting site preference of this species in the South San Francisco Bay area, population projections are figured on a linear basis. Two hundred miles of dikes and levees was delineated for the study area. All dikes were uniformly constructed from dredging spoils with widths and heights varying slightly. Eighty miles were closed to vehicular travel with 15 of these being insular in nature. The remaining 120 miles was

maintained for salt production and classified as driveable. Seventy-one miles of this was defined as being relatively free of any outside disturbance and suitable as avocet nesting habitat. Scrape counts were conducted on 2.84 miles of the 15 miles of insular dikes and on 3.78 miles of the 60 miles of driveable levee suitable for nesting. Nesting was found along the frequently traveled levees but was insignificant compared to the insular or lightly traveled levees. Densities for insular nesting areas averaged one scrape per 70 linear feet while noninsular areas suitable for nesting averaged one scrape per 550 linear feet. Population projections based on scrape counts of one per 70 and 550 feet respectively for insular and noninsular nesting habitat put the number of breeding pairs of avocets within the study area at 1,800.

Black-necked Stilt

Sibley (1952) lists the black-necked stilt (Himantopus mexicanus) as an uncommon summer resident and rare winter visitor to the South San Francisco Bay Region. Nesting reports and winter sightings prior to 1952 refer to only small numbers; usually single pairs. Parameter (1936) saw single birds near Alvarado, Alameda County on April 15, 1936. Grinnell and Wythe (1927) report eggs and young found on May 3 near Niles, Alameda County. Three adults were seen near Alviso, Santa Clara County on August 20, 1948 (Plynell, 1948).

The black-necked stilt has adapted readily to the salt pond environment of South San Francisco Bay with numbers increasing steadily during the last 20 years (Audubon Field Notes, 1952-71). The stilt can now be classified as a common breeding species of, and regular winter visitor to South San Francisco Bay.

Fourteen nesting attempts were documented for the study area during 1971. First nesting was found on May 3 when nine active scrapes were found near Alviso, Santa Clara County. Three additional nests were found on June 2 and adults with young were seen on two occasions on June 23. Clutch size ranged from 1 to 4 eggs with the following distribution: 1 with 1 egg, 2 with 2 eggs, 6 with 3 eggs and 3 with 4 eggs. Unlike avocets, little if any material was used in nest construction in those nests found during 1971. All nests were constructed on loose dirt at the base of or between large dirt polygons on salt pond levees. Of the limited nesting found during the study, stilts appeared to be semi-colonial nesters. The nine nests found on May 3 were placed along a 30 yard section of salt pond levee. Other concentrations of adult stilts were frequently seen on insular areas within salt ponds from early April to July. Locating nests proved difficult as compared to avocet nests as stilts were observed to take flight quicker and exhibit distraction displays over a larger area and longer time.

Population projections of breeding stilts in South San Francisco Bay were based on impressions of adults observed throughout certain sections of the study area between April-August. Although not as numerous as the avocet, certain areas appeared to offer better nesting than others. The Alviso area south of Coyote Creek and east of Guadalupe Slough is esimtated to support approximately 150 breeding pairs. Coyote Hills area west of the hills and north of the Dumbarton Bridge provided nesting for another 100 pairs. The Palo Alto area between Guadalupe and Mayfield Sloughs supported about 100 pairs. Mowry Slough south of the Dumbarton Bridge had approximately 75 nesting pairs while the Bair Island area had another 25-50 pairs. Total estimated nesting population in the study area appeared to be between 400-500 pairs.

California Least Tern

Background

California least (Sterna albifrons browni) did not nest within the study area in 1971 but a substantial increase in its numbers in the South San Francisco Bay this year warrants a report as to its current breeding status in this area.

Prior to 1943, as reported by Grinnell and Miller (1944), the northernmost nesting colony of California least terns was located at Moss Landing, Monterey County. Paxton (1967) reported three nests of least terns at Alameda, Alameda County in June, 1967. Least terns were also observed in South San Francisco Bay during August and September 1968. The highest number reported by Anderson (1970) was 60 on September 1. A breeding colony was located by Anderson on July 2, 1969. This colony of approximately 30 pairs was located on Bay Farm Island, Alameda County. On July 8 of that same year a small breeding colony of 15 pairs was located on Bair Island, San Mateo County. It is thought that this colony was recently established from the Bay Farm Island colony. With the discovery of the Bair Island colony it was estimated that 45 pairs of least terns nested in the South San Francisco Bay area in 1969. Least terns failed to return to Bay Farm Island in 1970, but did breed on Bair Island. A count of 17 birds on June 22 apparently represented the total breeding population as subsequent visits failed to show any increase in numbers (Elliott, 1970). Predation from short-eared owls (Asio flammeus) and Norway rats (Rattus norvegicus) is thought to have accounted for the marginal success of the Bair Island colony that year. Of 14 nesting attempts that year, only four young fledged.

Methods

A concentrated effort was made to document any nesting attempts by this species, within the South San Francisco Bay in 1971. Previous colonies on Bair and Bay Farm Islands were searched on foot beginning in April, 1971. Aerial surveys and contacts from local Audubon Societies and interested bird watchers were also utilized in locating additional colonies.

Findings

On April 28, 1971, a pair of least terns was seen in courtship display over Bair Island (Elliott, pers. commun.). I saw 11 adult least terns in this same area on May 16. These birds were occupying the same large salt flat as described by Anderson (1968). No nesting activity was observed at this time or during subsequent visits. Shallow water over previous nesting areas may have discouraged any nesting attempts.

The presence of least terns on Bay Farm Island in 1971 was verified by Elliott when 50-75 birds were found nesting on June 23 (Figure 11).

A visit to Bay Farm Island on July 7 revealed 13 active scrapes and 30-40 nesting pairs. On July 22, 1971 William Anderson and I discovered a colony of between 30-40 pair of least terns $\frac{1}{2}$ mile north of Coyote Hills, Alameda County. These birds were utilizing a salt pond dike separating two salt ponds of 300 acre size. A search of the area failed to reveal any active or old scrapes. Young of the year were quite evident within the colony. A possible explanation for the absence of observed nesting in this new colony is that it went undetected and

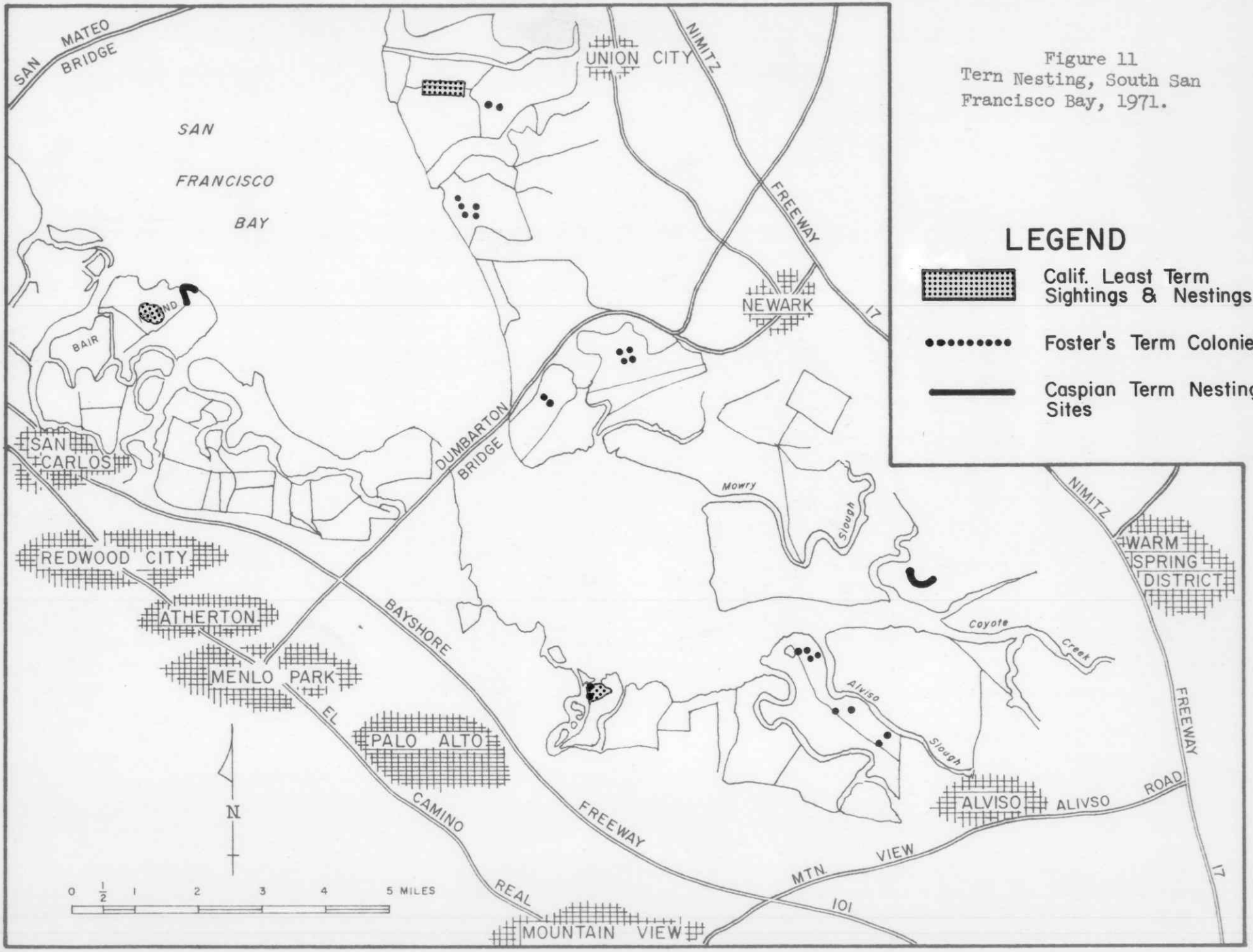


Figure 11
Tern Nesting, South San Francisco Bay, 1971.

possibly undisturbed until late in the season. The colony on Bay Farm Island was disturbed by development on the island and much of the nesting observed in July may have been renesting attempts.

To assure that this new group near Coyote Hills was not part or all of the Bay Farm Island colony a trip was made to Bay Farm Island that same day. The original colony was intact at which time we estimated between 40-50 pairs of nesting terms present. An additional colony of ten pairs was located on the northernmost edge of the island. This colony, like the other, was located on a large, relatively flat area with deposits of shells scattered throughout.

An additional group of 16 least terns was located on the west side of the bay on July 24, 1971. These birds were occupying a large hydraulic fill $\frac{1}{2}$ mile north of the west approach to the San Mateo Bridge, San Mateo County. No signs of nests were found but the adults were observed feeding five volant young. This group is probably part of the Bay Farm Island colony.

Although no actual nesting was observed in the two new colonies of least terns this year, it is significant in that there was such a large increase in numbers within south bay this year. A minimum of 85-105 pairs of least terns nested in South San Francisco Bay area this year. It is probable that more were nesting considering the late discovery and observation of the colonies.

Forster's Tern

Background

Forster's tern (Sterna forsteri) was first reported nesting in the San Francisco Bay Region in 1948 by N. W. Carriger. Prior to this the status of this bird in the San Francisco Bay area was considered to be that of a migrant and winter visitor (Grinnell and Miller, 1944). This newly discovered colony, located near the eastern approach to the San Mateo Bridge, Alameda County, was found to contain 100 active scrapes on May 28, 1948. A second colony was located on May 6, 1951 near the eastern end of the Dumbarton Bridge (Sibley, 1953). A third colony was located on June 7, 1953, two miles northwest of the town of Newark, Alameda County (Sibley, 1953). These last two colonies were situated within the boundaries of the study area. Of these original colonies, only the Dumbarton Bridge colony was found to be active in 1971.

Methods

Colonies were located through ground survey, aerial reconnaissance, and literature search. A rubber raft was required to gain access to the colonies as all were located on insular type levees within salt evaporator ponds. Scrape counts were made by walking through the colonies. Counts of adults were made with binoculars and a spotting scope. Data taken included: active scrapes, egg composition per scrape, number of chicks and number of adults. Dominant vegetative forms of each colony were noted. Nesting materials were collected and identified. Fish species and their frequency were also noted.

Findings

In addition to the Dumbarton Bridge colony, eight other colonies were found to be active within the study area during 1971. Largest colony was located $\frac{1}{4}$ mile west

of the mouth of Alviso Slough, Santa Clara County. Four small colonies were located within a 250 acre salt pond two miles northwest of the town of Alviso, Santa Clara County. A sixth colony was located $\frac{1}{4}$ mile south of the mouth of Guadalupe Slough, Santa Clara County. Additional colonies were located $\frac{1}{2}$ mile southwest of the Dumbarton Bridge Toll Plaza, $\frac{1}{2}$ mile southeast of the mouth of Coyote Creek Slough and the original colony $\frac{1}{2}$ mile south of the KGO radio transmitter tower; all in Alameda County (Table 14).

All colonies studied this year were located on small islands within salt ponds. There appeared to be no correlation between the size of the pond and the establishment of a nesting colony. All islands or discontinued dikes observed within the study area were utilized this year as nesting sites by Forster's terns. This insular type of nesting is characteristic of the species as described by Bent (1921). Unlike the Caspian tern, the Forster's tern requires some vegetative cover to nest on or with which to contruct the nest. Salicornia twigs (Salicornia virginicas), ice plant (Mesembrayanthemum nodiflorum), and sea lettuce (Ulva sp.) were utilized most frequently. Small pieces of driftwood, shells, dried fishes, bones and feathers were often used in scrape construction. Composition of materials in the scrape was dependent upon the materials in and around the colony.

Breeding activity was first observed on April 23, 1971 when 100 pairs of terns were seen in various stages of courtship and nest building near the mouth of Alviso Slough. Egg laying for most colonies commenced during the last week of April and the first week of May (Table 14). Mean clutch size as determined from data taken from the two largest colonies was 2.60 eggs per scrape. This was determined from scrape and egg composition counts taken during peak nesting at each colony. Data on clutch size seems to vary with geographic location for this species. Sibley (1953) suggests a mean clutch size of 2-3 for the colony originally discovered in 1951.

Peak egg laying occurred between the first and second week of June (Table 14). Hatching occurred for most colonies during the third week of May, based on an incubation period of 23 days for this species (Dawson, 1909). Young were first observed on June 2 (Table 14). Volant young were first seen on June 21. No effort was made to determine hatching or fledging success. Those colonies situated on low salt dikes or within large salt ponds (550 acres) apparently exhibited a higher proportion of egg and chick loss from wind and/or wave action.

Minimum number of breeding pairs of Forster's terns within the study area in 1971 was estimated to be 982 (Table 14). A projected breeding population was nearer 1200 pairs within the study area, based on the duration of egg laying, the late discovery of three colonies and the number of adult and young present in the colonies. It should be noted that I observed additional breeding colonies of Forster's terns outside of the study area (Figure 11).

Banding

Forster's terns banded during this study were the first time this species was banded in the San Francisco Bay area. Banded were 697 chicks from five different colonies. Twenty-six bands were recovered from dead chicks within the colonies. No other returns have been reported.

TABLE 14
Forster's Tern Nesting,
South San Francisco Bay, 1971

Location	Date	No. of scrapes	No. of eggs/scrape 1	2	3	4	5	No. young	No. adults
Knapp Gun Club Alviso, Santa Clara County	4-23-71	0	-	-	-	-	-	0	500
	5-03-71	18	6	7	5	-	-	0	
	6-03-71	470	45	66	355	4	-	214	
	7-16-71	49	11	25	7	5	1	198	
Small island colonies Alviso (Four)	6-03-71	61	4	8	48	1	-	31	
	6-18-71	156	33	50	73	-	-	41	
N. of E. approach Dumbarton Bridge Alameda Co.	5-05-71	9	8	1	-	-	-	0	150
	6-03-71	277	35	75	152	13	2	54	
	6-23-71	146	60	41	38	7	-		
	7-18-71	51	18	9	24	-	-		
S. of E. approach Dumbarton Bridge Alameda Co.	5-05-71	1	1	-	-	-	-		
	6-02-71	16	2	5	9	1	-	3	48
Charleston Slough Santa Clara Co.	6-23-71	2	-	2	-	-	-	31	70
Coyote Hills So. Alameda Co.	6-23-71	14	4	4	6	-	-	74	250

Caspian Tern

Background

Grinnell and Miller (1944) report eggs of Caspian terns (Hydroprogne caspia) were taken in the "general area" of San Francisco Bay in 1916. The actual discovery of a colony was not until 1922 when seven scrapes were reported by a workman for the Leslie Salt Company (DeGroot, 1931). This colony was located on a salt pond dike two miles north of the east approach to the Dumbarton Bridge. This same colony was relocated 1½ miles south of its original site in 1924. It continued to increase in size to 1930 when 296 scrapes were reported and again in 1943 when 378 scrapes were reported (Miller, 1943). The colony was still intact in 1966 when 299 scrapes were reported by Chaniot (1970). Between 1968-69 this colony was forced to move because of dredging spoils piled on the nesting levee. It is thought to have relocated out of the present study area to a small salt dike ¼ mile south of the east approach to the San Mateo Bridge, Alameda County (W. Anderson, pers. commun.).

Within the last four years two additional colonies of Caspian terns have been reported in the south bay. One colony, located on a long salt pond dike one mile northwest of the town of Drawbridge, Alameda County, contained over 100 nesting pairs in 1968 (Anderson, 1970). The inception of this colony is not known. A more recent colony (1969) of Caspian terns has established itself on a salt dike on the north side of Bair Island, San Mateo County (Anderson, 1970, California Department of Fish and Game). Both of these colonies are within the study area and were included as part of the 1971 South San Francisco Bay Breeding Bird Survey.

Methods

Colonies were located by ground and aerial survey (Figure 11). Access to the colonies was by foot and in the case of the Bair Island Colony by boat. Visits were made to the colonies on an average of once every two weeks. Time spent within each colony each visit varied from ½ to 1½ hours. Data taken on each colony included counts on the number of adults, active scrapes with eggs, young and volant young. Egg composition counts were also taken on each scrape. Adults were counted prior to my entry into the colony. All other data was obtained by walking through the colonies. Food habit studies were conducted on both colonies with fish species and their frequency being recorded. All banding within the colonies was coordinated with the regularly scheduled visits. Chicks were banded between one and six weeks of age. Some data on chick weights and color variation were recorded.

Predation

No successful predation was in evidence or observed in either of the colonies, however, both ring-billed gulls (Larus delawarensis) and California gull (Larus californicus) were observed near the colonies throughout the breeding season and appeared attracted to the colonies during my visits. Any attempt by these gulls to attack chicks or eggs resulted in their being driven off by adult terns. Black-crowned night herons were nesting in the Salicornia bordering the north side of one colony but no evidence of predation by this species on tern chicks was found.

Banding

Data obtained from the USF&WS Banding Laboratory lists only 15 recoveries from 1,020 banded Caspian terns in the San Francisco Bay area. Of these, 12 were recovered from Mexico-Central America, two from San Diego, California and one from San Luis Obispo, California. These recoveries provide useful information on the distribution and dispersal movements of San Francisco Bay Caspian terns. For this reason and to provide better information toward understanding the biology of this bird, a banding program was initiated in the two colonies studied this year.

Banded were 604 chicks in the two colonies with 15 recoveries made from dead chicks within the colony. Banding could have been done more efficiently by using some type of corral or holding device, such as described by Nelson (1924), to reduce scattering of the chicks. This would have prevented many chicks from swimming out into the salt ponds, especially at the Drawbridge colony, where I feel increased mortality resulted from such disturbance.

Drawbridge Caspian Tern Colony

In 1971, this colony occupied 100 yards of a narrow salt dike separating two large salt evaporator ponds of approximately 475 acres each. A dike was formed from dredging spoils and as a result has a very irregular surface. Except for strands of pickleweed growing along the shoreline, the dike is free of any vegetation. Nesting was concentrated in a relatively flat section of the dike. Scrapes were made on both the top and sides of the levee.

Findings:

Colony was first visited on April 16, 1971 at which time 42 active scrapes containing eggs were found (Table 15). Egg laying was initiated around the first of April from inferred parallel data from the Bair Island colony. Nesting reached a peak around the third week of May at which time 176 active scrapes were counted. Scrapes without eggs were evident in the colony beginning with the first visit but as the colony increased these scrapes became harder to recognize due to the increased amount of nesting material and dried fish scattered throughout the colonies. Chick activity also tended to obscure many of these scrapes. Considering the number of observed scrapes with eggs and those without, I would estimate that approximately 200 pairs nested in the colony in 1971.

Data gathered on scrape counts and clutch composition indicate a mean clutch size of 1.98 eggs. Bent's (1921) and Miller's (1943) figures for colonies in Louisiana and California suggest a mean clutch size of less than two. Ludwig (1965) reported a mean clutch size of 2.81 for Caspian tern colonies in the Great Lakes Region.

Young were first observed on May 7 at which time one each was found in two different scrapes (Table 15). A maximum of 113 chicks was observed on June 23. The number of chicks counted on each visit did not represent the total present in the colony at that time. These counts could be as much as 100 percent in error as many chicks were observed swimming away from the colony prior to entry. Other chicks were passed by due to their cryptic coloration and ability to hide among the large clods along the shoreline. Because of variables, no effort was made to determine hatching or fledging success.

TABLE 15
Caspian Tern Nesting
South San Francisco Bay, 1971

Date	No. of scrapes with eggs	No. of eggs/scrape 1	2	3	4	5	6	No. of young
Drawbridge Colony								
4-16-71	42	16	20	6	-	-	-	-
4-27-71	113	32	47	30	3	1	-	-
5-07-71	171	46	84	40	1	-	-	2
5-22-71	176	49	94	28	5	-	-	83
6-04-71	97	36	41	20	-	-	-	87
6-23-71	46	27	18	1	-	-	-	113
7-08-71	44	11	15	1	-	-	-	43
Bair Island Colony								
4-09-71	1	1	-	-	-	-	-	-
4-18-71	24	17	5	2	-	-	-	-
4-24-71	45	23	10	12	-	-	-	-
5-09-71	196	48	94	46	7	1	-	1
5-17-71	273	65	142	58	6	1	1	20
6-12-71	304	79	151	68	6	-	-	163
7-02-71	106	32	60	10	4	-	-	293
7-08-71	89	22	55	9	3	-	-	No count taken
7-16-71	37	22	11	4	-	-	-	27
8-01-71	14	5	7	2	1	-	-	46

An effort was made to document the feeding habits of the Drawbridge colony by noting species and frequency of fish found in the colony. Miller (1943) reports only three species of fish (staghorn sculpin, viviparous perch and top smelt) found in the old colony north of Dumbarton Bridge. Twenty-one species were identified from this colony in 1971 with jack smelt (Atherinopsis californiensis) accounting for 33 percent of all fish found, followed by shinner perch (Cymatogaster aggregatus) 16 percent and staghorn sculpin (Legtocottus armatus) 16 percent (Table 16). Fourteen of 21 species are typically marine or brackish water fishes. This distribution only represents the fish found at the colony site and not necessarily the frequency of fish consumed (Table 16). It is of interest to note that a few of the terns from this colony were feeding on trout which were tagged and released in the Arroyo del Valle Reservoir, Alameda County, a distance of almost 25 miles from the colony.

Bair Island Caspian Tern Colony

Description:

In 1971, colony was located on a salt pond dike on the north side of Bair Island. Active nests were scattered over 150 yards of the dike with the largest concentration occurring in a 50 yard section. Small patches of Australian saltbush (Atriplex semibaccata) were growing on top of the dike and were utilized as nesting sites by a few terns. The majority of the breeding birds constructed scrapes on the bare ground on top and sides on the levee. Colony is bordered on the north by a wide belt of pickleweed and on the south by a dry inactive salt pond.

Findings:

Colony was first visited on April 9, 1971. One scrape containing one egg was found at this time. Seventy adult terns were counted at the colony site (Table 15). Nesting reached a peak during the first two weeks of June during which a high of 304 scrapes with eggs were counted. This was projected to be an estimated 350 breeding pairs.

Data on this colony suggests a mean clutch size of 2.03 eggs per scrape. Hatching and fledging success was not determined. Young were first seen on May 9. A high of 293 chicks was counted on July 2 but is not to be considered the total number produced in the colony because of the chicks ability to hide. Volant young were first seen on June 22.

Short-eared Owl

To date, only one reference to short-eared owl nesting in the San Francisco Bay area is available (Grinnell & Wythe, 1927). Grinnell and Miller (1944) list it as occurring in two roles in California: (1) resident, in very small numbers, locally, and breeding; (2) winter visitant, common and widely distributed. Sibley (1952) makes no reference to short-eared owl nesting in South San Francisco Bay. Johnston (1956) states that short-eared owls may breed in the marshes bordering the bay and elsewhere in the region, however, none has been reported doing so in recent years. Mr. William Anderson (pers. commun.) found no short-eared owl nesting in the south bay between 1967-70. Most of the short-eared owls in the bay population are thought to leave the area in April for northern or interior breeding grounds and return in July to winter in the area. Breeding grounds are reported to occur intermittently the entire length of California west of the

TABLE 16

Fish Found at the Drawbridge
Caspian Tern Colony, April-July, 1971

	Number of times found during study	Percent
Jack smelt (*Atherinopsis californiensis*)	200	33
Shinner perch (*Cymatogaster aggregatus*)	100	16
Staghorn sculpin (*Leptocottus armatus*)	100	16
Long-jawed mudsucker (*Gillichthys mirabilis*)	59	09
Oriental goby (*Acanthogobius flavimanus*)	32	05
Northern anchovy (*Engraulis mordax*)	37	06
Top smelt (*Atherinops affinis*)	19	03
Northern midshipman (*Porichthys notatus*)	1	<01
Pacific herring (*Clupea harengus*)	3	<01
Pacific sanddab (*Citharichthys sordidus*)	4	<01
Starry flounder (*Platichthys stellatus*)	2	<01
Rainbow surfperch (*Hypsurus caryi*)	2	<01
Striped bass (*Morone saxatilis*)	4	<01
Brown smoothhound shark (*Mustelus henlei*)	1	<01
Threespine stickleback (*Gasterosteus aculeatus*)	12	02
Rainbow trout (*Salmo gairdnerii*)	21	04
Largemouth black bass (*Micropterus salmoides*)	2	<01
Black crappie (*Pomoxis nigromaculatus*)	2	<01
Bluegill (*Lepomis macrochirus*)	2	<01
Carp (*Cyprinus carpio*)	1	<01
Goldfish (*Carassius auratus*)	1	<01
	605	100%

deserts (Grinnell and Miller, 1944). Nesting has been documented for salt marsh areas in the State of Washington (Kitchin, 1919) and in New Jersey (Urner, 1923).

During the study, short-eared owls were frequently seen near certain areas from March to August, 1971. Two or three flushed from Bair Island, San Mateo County on all but one visit to the island, but nesting was never documented. Sightings of short-eared owls were made throughout the nesting season on Greco Island, San Mateo County; Palo Alto Flood Control Basin, Santa Clara County; and near the marshes around Coyote Creek, Mowry Slough and Coyote Hills all in Alameda County. Nesting is strongly suspected of occurring in the study area during 1971 based on the relatively constant number of owls observed throughout the study period in these areas. 1/

Population projections for short-eared owls within the study area are based on observations and sightings of foraging and flushed adults: Bair Island 2-4, Greco Island 2-3, Palo Alto Flood Basin 4-6, Alviso and Guadalupe Sloughs 4-8, Dumbarton Bridge 2 and Coyote Hills 4-6. Total estimated population for the study area is between 20-30 individuals. This projection is applicable to the period March-July, 1971 only. Immigration into the study area during fall and winter could increase the population substantially.

Burrowing Owl

Burrowing owls (Speotyto cunicularia) were noted nesting at two localities within the study area during 1971. Three pairs nested along the bank of a salt pond levee $\frac{1}{4}$ mile west of the west end of Durham Road, Alameda County immediately adjacent to a 300 acre cultivated field. Nesting was also recorded $\frac{1}{2}$ mile SSW of Alviso, Santa Clara County. Here, approximately 8-10 pairs nested during 1971. Previous studies by Shrout (unpublished) in 1968 report seven nesting pairs for this same 18 acre section of grassland. Follow-up work by Malet (unpublished) during 1970 found a two-fold increase in nesting pairs for the same area.

Since suitable nesting habitat was limited to approximately 400 acres within the study area and this area was surveyed regularly during the study with only the two nesting areas documented, I feel the nesting population of burrowing owls within the study area was between 12-16 pairs.

Because of this species' nesting habits, no effort was made to determine productivity.

1/ Short-eared owl nesting was documented on two occasions during 1972. Both cases were within the Palo Alto Flood Control Basin, Santa Clara County. A nest containing seven eggs was discovered on April 1, 1972 by Mr. Kenneth Gardner. The nest was located approximately 30 feet from a tidal slough, built on the ground with a canopy of 12-14 inch rye grass (Elymus triticoides). Follow-up visits found 5 eggs and 2 young on April 5 and 5 young on April 13. The parent bird was flushed from the nest on each visit. A second successful nesting attempt was found on April 15, 1972. This nest was approximately 50 yards from the above nest. Two volant young and one approximately one week pre-fledging stage were found.

Long-billed Marsh Wren

Nesting by the long-billed marsh wren (Telmatodytes palustris paludicola) was documented on six different occasions during 1971. Four of these were found in 2-3 foot tall stands of salt marsh cord grass and two were located in dense stands of cattails near Coyote Hills, Alameda County. All nests found were of the typical compact oval ball construction, interwoven with cattails or cord grass stalks and placed 2-5 feet above the substrate. Besides the six active nests, numerous additional nests were located but were classified as dummy or decoy nests as this species is known to build as many as 6-10 additional nests for each one actually used (Bent, 1927).

Active nesting was first found on May 5, 1971 when two nests were found containing four eggs and one egg respectively. The last active nest was found on June 5, containing three eggs.

Although 4 of 6 nests were located in salt marsh cord grass, I feel this is a result of the intensity of which this habitat type was investigated. Of the approximately 2,000 acres of cord grass marsh within the study area, 300 acres of this was investigated intensively during nesting studies of the California clapper rail. Marsh wrens were seldom encountered or often entirely absent from those sections of marsh sampled. There appeared to be about one nesting pair per 5-10 acres of cord grass or between 200-400 pairs utilizing cord grass marsh as a nesting habitat in the study area.

Fresh water marsh, though limited in size, appeared to support much higher densities than salt marsh. Total fresh water marsh suitable for nesting numbered 200 acres. Major concentrations were found in Coyote Hills Regional Park, the upper reaches of Alviso and Guadalupe Sloughs, Coyote Creek and Mud Slough, and in the Palo Alto Flood Basin. Most of this was linearly distributed along the edges of these sloughs and creeks and not in singularly large areas as was the salt marsh. Densities within fresh water marsh appeared to be around one pair per 0.25 acre or 800 nesting pairs for the study area in 1971. Total nesting pairs for both freshwater marsh and salt marsh are estimated between 1,000-1,200.

Barn and Cliff Swallow

Both the barn swallow (Hirundo rustica) and the cliff swallow (Petrochelidon pyrrhonota) will be considered under one section since their nesting requirements are essentially the same and they were usually found in association with one another throughout the study area.

Both swallows have adapted favorably to man's influence in the bay area. Nests were always found in association with such man-made structures as boat houses, pump houses, hunting clubs, railroad bridges, or almost any vertical structured surface. The cliff swallow is considered to be a colonial nesting species while the barn swallow rarely is found nesting more than 2-3 pairs to a single location (Sibley, 1952). Exceptions to this were observed this year, when 16 barn swallow nests were found under the eaves of an abandoned duck hunting shack near the town of Drawbridge, Alameda County. Pickwell (1929) also reported a similar number of barn swallows nesting in one location in South San Francisco Bay in 1928.

Nests of the two species were distinguished by their construction and shape. Barn swallow nests vary in size and shape depending on the location; on a vertical surface the nest is roughly the shape of a reversed half cone, the top being somewhat more than half a circle and the lower end pointed. If built on a flat surface the nest is more circular and much shallower than the cone-shaped nest. Cliff swallow nests are roofed over, and generally assume a flask, retort or bottle shape with a narrow entrance leading into an enlarged chamber. The eggs of the two species are also different but the shape of the nests was usually sufficient for identification.

Nesting by barn swallows was first observed on April 8, 1971. Cliff swallow nesting started approximately two weeks later. Peak nesting occurred during the second week of May and first week of June respectively. The great majority of nesting by both species was found in the town of Drawbridge, Alameda County; an assemblage of abandoned, wood frame duck hunting shacks located along Coyote Creek and Mud Slough (Figure 12). Approximately 900 nests of both barn and cliff swallows were located this year in the study area with 585 of them occurring in the Drawbridge area. Of these, only 59 (10%) were barn swallow nests. A similar group of buildings along Mowry Slough, Alameda County, provided nesting sites for 115 swallows with 35 (30%) of these being barn swallow nests. Another major nesting site, a series of pump houses west of Coyote Hills, Alameda County, accounted for 125 swallow nests; 54 being barn swallow nests. Overall, cliff swallows and barn swallows nested in a 6:1 ratio respectively for the study area.

In addition to the 900 nests or pairs found in the study area, an additional 500 pairs could safely be projected as utilizing the other numerous nesting sites in the study area in the form of cat-walks, boat houses and pump houses. Assuming the same ratio, the overall population projection of nesting swallows for the study area would be 1,200 pairs of cliff and 200 pairs of barn swallows.

Loggerhead Shrike

Loggerhead shrike (Lanius ludovicianus) nesting was documented once during the study. A nest containing five eggs was found on Bair Island, San Mateo County on April 18, 1971. The nest was located in coyote bush on the southeast corner of the island. Additional nesting by this species probably occurred within the study area but on a limited basis because of the scarcity of suitable nesting habitat in the study area. Shrikes were sighted on three occasions near the Palo Alto Nature Center from April to July, 1971. Previous nesting dates for this species in the San Francisco Bay area are listed by Sibley (1952) and for the Santa Clara Valley by Atkinson (1901).

San Francisco Bay Yellowthroat

As its name implies, the San Francisco Bay yellowthroat (Geothlypis trichas sinuosa) is chiefly restricted to the marshes of San Francisco Bay. Geographically it is confined, during the breeding season in the north to Marin County and Napa Slough, southern Sonoma County; east to Carquinez Strait and south to San Jose, Santa Clara County. During winter, it is found along the coastal marshes from San Francisco Bay south to San Diego. There are two winter records for Humboldt Bay, Humboldt County (Grinnell, 1944). Nesting is generally restricted to fresh water marshes

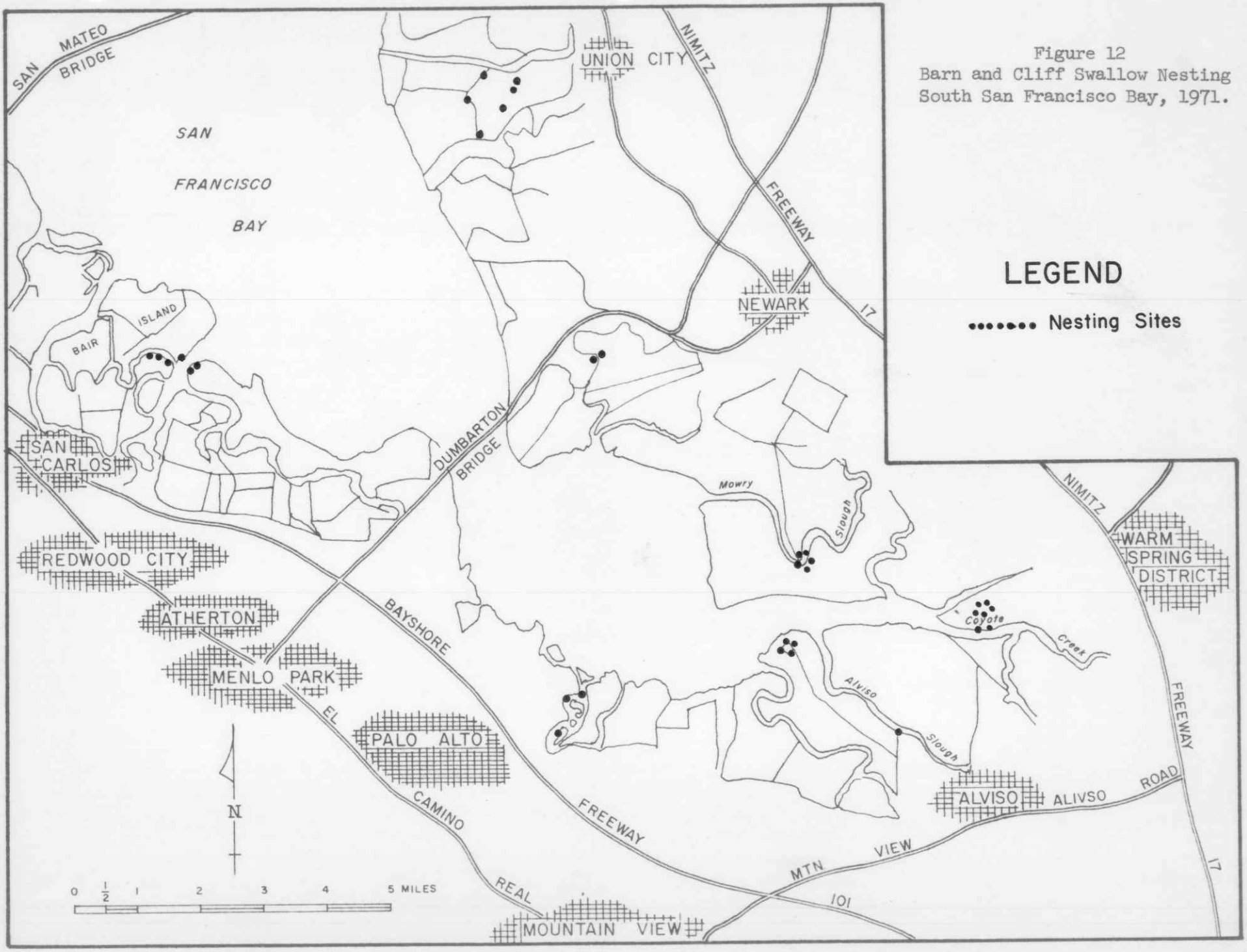


Figure 12
Barn and Cliff Swallow Nesting
South San Francisco Bay, 1971.

but has been known to occur in salt marsh (op. cit.). Ray (1919) reports finding nests located in salt marsh north of San Rafael, Marin County.

Only one nest was located during the 1971 nesting season. This was found on June 7 in the large section of fresh water marsh (85 acres) east of Coyote Hills, Alameda County. The nest was constructed 2-3 feet above the ground in a large stand of cattails. Five additional yellowthroat sightings were made during three other visits to this marsh area. Yellowthroats were also observed (8 sightings) during the five visits to the upper reaches of Coyote Creek, Santa Clara County. Nesting was not found here but is suspected. No yellowthroat nesting was found in salt marsh habitat in 1971.

A total of 200 acres of fresh water marsh was delineated within the study area. Eighty-five acres of this was located east of Coyote Hills with the remainder distributed among the upper ends of Coyote Creek, Charleston and Mountain View Sloughs and the Palo Alto Flood Basin, in Santa Clara County, and near Mowry Slough, in Alameda County. Of this 200 acres, approximately 150 acres can be classified as good nesting habitat for yellowthroats. The 13 individual sightings plus the one nest represent a minimum of 15 yellowthroats for the 40 acres of marsh sampled. All of the individual sightings were of adult males and probably represent breeding pairs. Based on this, the minimum breeding population of yellowthroats in the study, is between 25-30 pairs.

Western Meadowlark

One western meadowlark (Sturnella neglecta) nest was found during the study. This nest, containing three eggs, was found on May 4, 1971 on Bair Island, San Mateo County. Meadowlarks usually restrict nesting to grassland or weed covered areas and this type of habitat is limited to approximately 400 acres within the study area Bair Island, the Palo Alto Flood Basin, and the fields NNW of the town of Drawbridge, accounted for most grassland habitat. Meadowlarks were frequently observed in and around these areas and probably utilized them for nesting.

Meadowlarks were also observed, on occasion, to forage in the cord grass marshes of the study area.

Red winged Blackbird

San Francisco Bay is credited with having its own race of red winged blackbird (Agelaius phoeniceus mailliardorum). During spring and summer it is usually restricted to salt and fresh water marshes and wet pasture land and grasslands associated with the preceding. In winter it spreads out to adjoining fields and grasslands and is joined by several other subspecies which breed north and east of San Francisco Bay; A. P. nevadenis, A. p. caurinus and A. p. californicus.

During 1971, nesting was found in three habitat types: salt marsh, fresh water marsh and grassland. Salt marsh accounted for most of the nesting found in the study area with 13 of 22 nests confined to this habitat type. Six nests were found in coyote bush on Bair Island, San Mateo County and three in fresh water marsh in Coyote Hills Regional Park, Alameda County. Nesting was first recorded on April 11, 1971. Bent (1942) lists the period April-May as the nesting period for this species. The last nest was found on June 8, 1971. Table 17 summarizes red winged blackbird nesting found during 1971.

TABLE 17
Red winged Blackbird
Nesting South San Francisco Bay, 1971

Date	Location	Habitat	Eggs/young
4-18-71	Bair Island	Coyote Bush	0/0
"	" "	"	2/0
"	" "	"	1/0
"	" "	"	5/1
"	" "	"	2/0
"	" "	"	1/0
4-28-71	Coyote Hills	Fr. water marsh	4/0
"	" "	"	3/0
"	" "	"	0/0
5-12-71	Mowry Slough	Salt Marsh	4/0
5-14-71	Greco Island	Salt Marsh	1/3
"	" "	"	2/0
"	" "	"	0/2
5-19-71	Greco Island	Salt Marsh	no data
"	" "	"	0/1
"	" "	"	4/0
"	" "	"	0/3
6-02-71	Coyote Creek	Salt Marsh	0/2
"	" "	"	0/0
"	" "	"	old
"	" "	"	old
6-08-71	Charleston Slough	Salt Marsh	0/3

Since the red winged blackbird is such an obvious part of the San Francisco Bay avifauna, I felt it necessary to establish a baseline population projection for the study area. Three nesting habitat types were defined and delineated: salt marsh cord grass 2,000 acres, grassland 300 acres, and fresh water marsh 200 acres. In most cases, pro-rating selected population densities to the overall acreage was not applicable because territory size varied among and within each habitat type. Derived densities are, therefore, the result of overall impressions of nesting utilization and density for various areas throughout the study area. Fresh water marsh (cattails) was observed to have the highest densities, especially near Coyote Hills where an estimated 300 pairs nested in the 90 acres of marsh. The remaining fresh water marsh could have provided nesting habitat for another 200-300 pairs. Territory size in salt marsh appeared to be a function of available song perches; with most sections of marsh uniform in height with few objects rising above the surface vegetation. Of the 2,000 acres of salt marsh habitat only selected areas appeared to provide suitable nesting habitat. Greco Island is estimated to have had 150 pairs, Mowry Slough and Coyote Creek approximately 100 pairs, and Alviso, Guadalupe, Mt. View and Charleston Sloughs 100 pairs. Grassland areas such as Bair Island, the Palo Alto Flood Control Basin and the Newark area could have provided nesting area for another 300 pairs. Breeding populations for the three nesting habitat types (salt marsh, fresh water marsh, grassland) could therefore be expected to approximate 500, 350 and 300 pairs respectively or 1,000-1,400 pairs for the study area.

Brewer's Blackbird

Brewer's blackbird (Euphagus cyanocephalus) nesting was recorded on three occasions within the study area during 1971. A single nest, containing three eggs, was located near Coyote Hills, Alameda County, on May 1, 1971. A second nest occupied a window ledge in the old town of Drawbridge, Alameda County. This nest, found on May 12, 1971, contained three eggs and two young. The third nest was built among palm fronds covering a duck hunting blind. On June 3, 1971 this nest held three young that were approximately one week old.

As described by Williams (1952) the Brewer's blackbird is one of many avian species to profit from human alteration of the environment. Like the red winged blackbird, the Brewer's is a semi-colonial nesting species with nesting sites seldom exceeding 20 nests. It prefers nesting in dense vegetation, usually pine trees, eucalyptus, or hedgerows of many types. It will also utilize man-made structures as nesting sites. Nesting is rarely reported for marsh habitat although Brewer's will often forage or roost in such areas (Williams, 1952).

The Brewer's male, like the red winged, is also polygymous. The degree varies from year to year and within the individual, with some males reported as having as many as four females (op. cit.).

Since the preferred nesting habitat of this species is limited within the study area, population projections are relatively low compared to areas outside the study area. Coyote Hills afforded the best nesting habitat in the study area. Here, good stands of Monterey pine, eucalyptus, willows and box elder plus coyote bush and toyon provided nesting cover. This area could possibly support as many as 400 breeding pairs. The domestic dwellings, including duck blinds and pump houses used in salt production, might provide nesting sites for an additional 200-300 pairs. Total nesting populations of Brewer's blackbirds in the study area during 1971 appeared to be around 700 pairs.

Tricolored Blackbird

Coyote Hills Regional Park, Alameda County, represented the only documented nesting site of tricolored blackbirds (Agelaius tricolor) found during the study. Harvey (1971) reported approximately 400 pairs nesting in the fresh water marshes of the area. The east bay, and the Alameda and Newark areas in particular, have historically been the only major nesting areas for this species in the South San Francisco Bay (Sibley, 1952). Scattered nesting records for as far south as Milpitas (Neff, 1937) and Alviso (Grinnell and Miller, 1944) have been reported.

The only other sightings of tricolored blackbirds seen during the study were of a wintering flock of between 300-400 individuals seen in a cultivated field near the west end of Durham Road, Alameda County. Although not observed doing so in 1971, this flock could be utilizing the small sections of fresh water marsh to the southeast along Coyote Creek, Alameda County, as nesting sites.

Population projections for nesting tricolored blackbirds within the study area must be restricted to the Coyote Hills population (400 pairs) until other nesting habitat can be studied more thoroughly.

House Finch

The house finch or linnet (Carpodacus mexicanus) is considered a common resident and nesting species of the San Francisco Bay area and was frequently found nesting within the study area during 1971.

Thirty-one active nests were located (Table 18). First nesting was on May 4, 1971 with nesting continuing through July. Twenty-nine of 32 nests were found during May. Nesting probably began during the first week of April. Almost all nests were found in association with man-made structures. Pump houses in connection with salt production and duck blinds were utilized most frequently.

TABLE 18

House Finch Nesting
South San Francisco Bay, 1971

Date	Location	Nesting site	Eggs/young
5-03-71	Alviso	Pump house	3/1
5-04-71	Coyote Slgh.	" "	4/0
" "	" "	" "	4/0
5-06-71	Alviso	Duck blind	3/0
" "	"	" "	3/1
5-12-71	Drawbridge	" "	5/0
" "	"	" "	5/0
" "	"	" "	5/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	3/0
" "	"	" "	1/0
" "	"	" "	0/0 *
" "	"	" "	0/0 *
" "	"	" "	0/0 *
" "	"	" "	0/0 *
" "	"	" "	0/0
" "	"	" "	0/4
" "	"	" "	4/1
5-18-71	Corkscrew Slgh.	Duck shack	6/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	4/0
" "	"	" "	3/0
" "	"	" "	2/2
" "	"	" "	1/3
" "	"	" "	0/2
" "	"	" "	0/3

*Active nests - adults chased from the nest or vicinity.

Coastal Savannah Sparrow

The coastal Savannah sparrow (Passerculus sandwichensis alaudinus) is one of two fringillides found nesting in the salt marshes of San Francisco Bay. This particular subspecies of Savannah sparrow is also found inhabiting the grassland associations of the coastal fog belt. This, however, is not extensive in any one place, being found chiefly on ridges of the coastal hills. The population inhabiting the salt marshes is limited to the broad expanses of low-lying Salicornia on the higher parts of the marsh; on San Francisco Bay marshes these reaches stand about 5-10 feet above mean tide level and occur behind the broad stands of cord grass which are subject to frequent tidal submergence (Johnston, 1956). Nesting also occurs in the grassland areas adjacent to the salt marshes and on higher lands in the bay area created as a result of the deposition of dredging spoils on former marsh lands. Bair Island, San Mateo County, is the largest of such areas in the study area.

In the lower marsh regions the song sparrow (Malospiza melodia pusillula) is also a common passerine species, however, its habitat does not overlap significantly with the Savannah sparrow. There seems to be no competition between the two species for any environmental requisite (Marshall, 1948).

Nesting of the Savannah sparrow in the San Francisco Bay marshes is reported to extend from February to June. The question of a double brood in this species, first proposed by Johnston in 1954, is still in doubt. During this study nesting was first discovered on April 1, 1971. This probably does not represent the first nesting of the season for the study area as Johnston (Ibid) reports that eggs are laid between March 12 and June 15 (sample of 61 records) with peak of egg laying occurring between April 1 and April 10. Only eight clutches were found during this study. Dates ranged from April 1 to June 22. Clutch size ranged from 3-4 eggs with only 2 of the 8 clutches being composed of three eggs.

Location of nests was found to be extremely difficult, especially in Salicornia. Birds tend to flush approximately 20-40 yards ahead of the investigator or seek refuge under the dense Salicornia where they could move about freely.

Although Johnston reports Salicornia on the higher marsh areas as being the most frequently utilized nesting cover, only three nests were found in this type of cover during 1971. The remaining nests were found in grasses or combinations of grass and weeds found on the higher disturbed grounds. This, however, is probably not representative of the majority of Savannah sparrows inhabiting the study area. Observation of birds was much easier in this type of habitat and probably accounts for the larger numbers observed.

Data on population studies of this species are limited. Impressions of population densities were gained while investigating other breeding species. Bair Island, San Mateo County and the grassland area adjacent to the Fremont marshes, Alameda County were found to have the largest Savannah sparrow populations in the study area. Breeding population estimates for these two areas are 200 and 150 pairs respectively. Similar grassland-marsh associated areas near the Palo Alto Flood Basin and Coyote Hills supported approximately 75 and 150 pairs respectively. The remaining habitat suitable for nesting included the more elevated portions of slough banks and salt pond levees grown to vegetation. This type of nesting habitat probably accounted for an additional 300-400 nesting pairs. Total breeding population estimates for the study area are between 800-1,000 pairs.

Salt Marsh Song Sparrow

Background

The song sparrow (Melospiza melodia) is represented by four separate races within the greater San Francisco Bay area. All races are endemic to the bay regions, none are migratory. The grassland and uplands surrounding the three bays is occupied by M. m. gouldii, while M. M. samuelis is confined to the salt marshes bordering San Pablo Bay and M. m. pusillula being found only in South San Francisco Bay. M. m. maxillaris is restricted to the Suisun Bay area.

Because these subspecies are found within a confined geographic area, they have been the object of numerous studies. Major contributions to their literature have been provided by Grinnell (1913, 1944), Marshall (1948), and Johnston (1954, 1955, 1956).

Of the four races, only M. m. pusillula is found within the study area. Territorial relationships of pusillula are similar to those of the other bay area races (Johnston, 1956). In late winter and early spring, male singing and chasing increases. By late February and March most males have established territories. Singing decreases in late March and April with territory activity continuing throughout the remainder of the breeding season (mid-June). Territory activity ceases in July, but becomes evident again in late August and early September, after they complete their postnuptial molt. All races of bay area song sparrows are double brooded with many laying a third clutch (Johnston, 1954). First nesting by song sparrows usually occurs during the last week of February with peak nesting occurring the last week of March. Mean clutch size is reported to be 3.31 with first clutch size 3.25 and second clutch 3.40 (Johnston, 1954).

Findings

Nesting:

Seventeen nests were found during the study. First nesting was encountered on March 12, 1971 near Mowry Slough, Alameda County. Of 17 nests found, clutch size and/or number of young was recorded on 15. Distribution is as follows: 2 nests with 3 eggs, 4 with 4 eggs, 1 with 2 eggs, 1 with 1 egg, 2 with 1 egg/1 young, 2 with 3 young, 1 with 4 young, 1 with 3 broken eggs, and 1 with 2 broken eggs. The last nest was found on May 7, 1971. All nests found were built in Salicornia-Grindelia associated marsh, as well as salt marsh cord grass.

Population Projections:

As reported by Johnston (1956) determination of population densities in bay area races of song sparrows is extremely variable depending on the race and habitat types occupied. Marshall (1948) also mentions the same difficulties. Although their work was mainly with San Pablo Bay populations the same was found to apply to the South San Francisco Bay. Population projections for pusillula were determined from techniques described and used by Johnston for samuelis and from reported densities from Marshall, also for samuelis.

As described by Johnston (1954) salt marsh song sparrows live along tidal sloughs, and except in places where sloughs double back on themselves the territories of the birds are strung out one by one along the length of the sloughs. The birds then occupy effectively only a small portion of the total marsh. Song sparrows samuelis utilize both cord grass and Salicornia marshes as nesting areas. Nesting is restricted to cord grass between 2-3 feet tall and Salicornia growing more than 18 inches tall; with little if no nesting found outside these limits. This was observed to be the case during 1971 also. Because of these special requisites, Johnston was able to determine population densities for samuelis by counting the number of territorial males during the breeding season found along transects established near tidal sloughs in the San Pablo Bay.

Beginning in April a series of similar transects was set up and run (Figure 13). Transect sites were selected on a basis of areas which appeared to have good song sparrow populations and within marsh which had numerous long tidal sloughs. Transects were then run by walking the natural curve of the sloughs and counting the number of males on territory.

Population densities derived from transects run during 1971 are presented in Table 19. The areal calculation of each transect was determined by multiplying the length of each transect by 30 feet. Thirty feet was shown by Johnston to be the average width of territories along Salicornia sloughs. The resulting densities are projected as breeding pairs based on actual counts of territorial males. The lower densities obtained in 1971 as compared to Johnston are possibly the result of transects being run three weeks later than those of Johnston in 1953, or are characteristic of the overall lower densities for the South San Francisco Bay race.

TABLE 19
Salt Marsh Song Sparrow Transects
South San Francisco Bay, 1971

Transect No.	Date	Length in feet	Size in acres	Pairs	Density/acre Johnston, 1956 1/	Density/acre Gill, 1971 2/
1	4-14-71	2,000	1.4	11		7.9
2	4-14-71	2,200	1.5	13		8.7
3	4-16-71	3,000	2.0	20		10.0
4	6-06-71	2,500	1.7	7		4.0
A	1953	3,060	2.1	22	10.5	
B	"	3,575	2.5	24	9.7	
C	"	2,400	1.6	17	10.4	
H	"	4,480	3.0	25	8.2	

1/ Density in pairs/acre representing seasonal high (March) densities for M. m. samuelis (Johnston, 1956)
2/ Density in pairs/acre on that date for M. m. pusillula

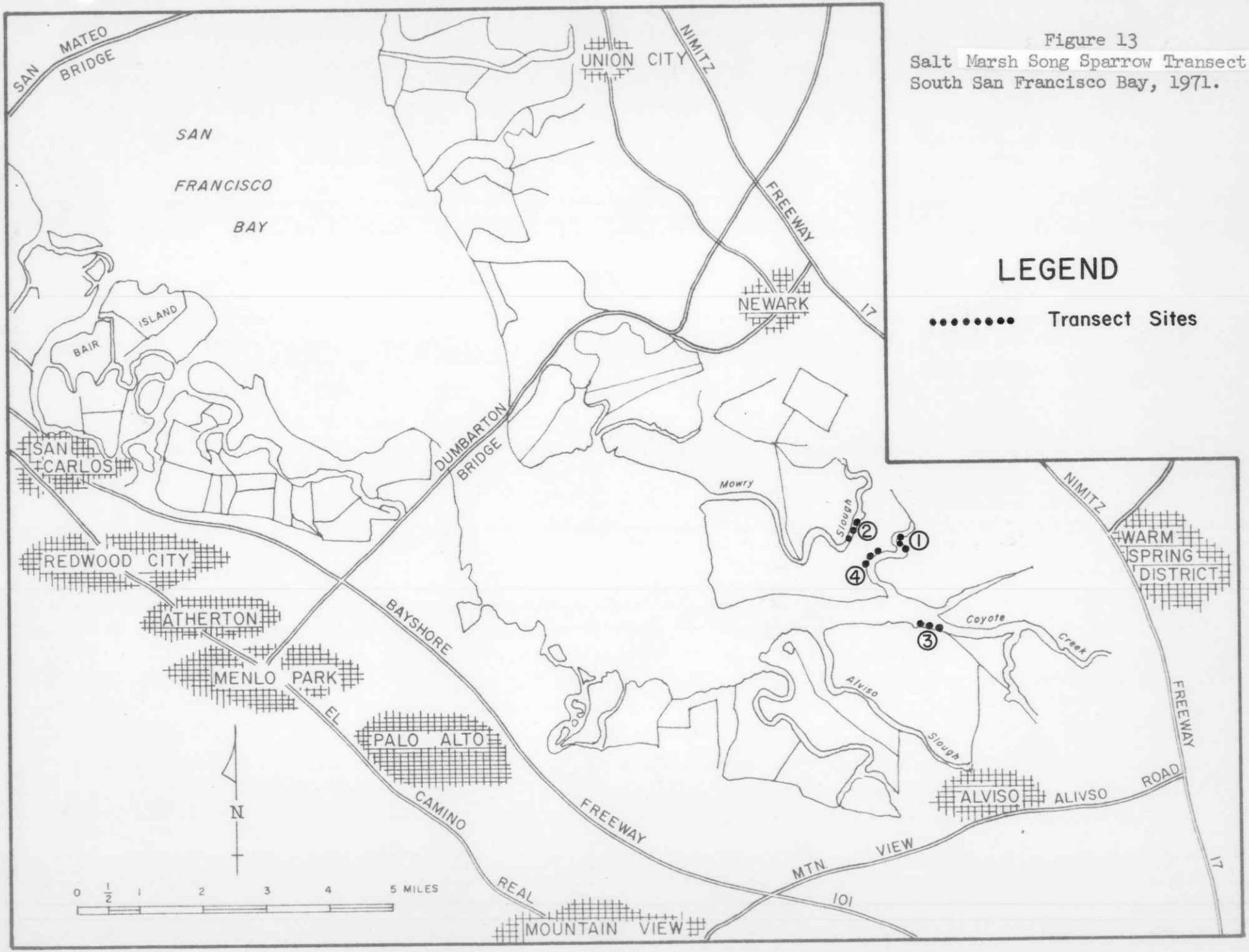


Figure 13
Salt Marsh Song Sparrow Transect
South San Francisco Bay, 1971.

Johnston has projected overall densities in Salicornia at 105 pairs per 100 acres. This figure is inclusive of all marsh area, i.e., that area outside the 30 foot wide section along the sloughs. Over a six year period (1950-55) Johnston reports a range of 87-124 pairs per 100 acres of Salicornia during the nesting season. Marshall (1948) reports song sparrow pairs in Salicornia portions of the marsh are spaced 30-100 yards apart. Assuming the same 30 foot width used by Johnston, Marshall found densities ranging from 5-16 pairs per acre. Marshall also reports on densities for cord grass marsh at being spaced 76-100 yards apart or 5-6 pairs per acre.

Densities for the study area as figured from the three transects run in April average 8.9 breeding pairs per acre for Salicornia marsh actually utilized, or approximately 96 pairs per 100 acres of marsh. Densities for cord grass marsh were not figured during 1971 and are computed from those reported by Marshall (5-6 pairs per acre utilized or 60 pairs per 100 acres of cord grass marsh). Total Salicornia marsh suitable for nesting was figured at 1,000 acres for the study area while total cord grass marsh was figured at 1,400 acres. Population projection for the study area during 1971 is 1,800 pairs. This includes 960 pairs in Salicornia marsh and 840 pairs in cord grass marsh.

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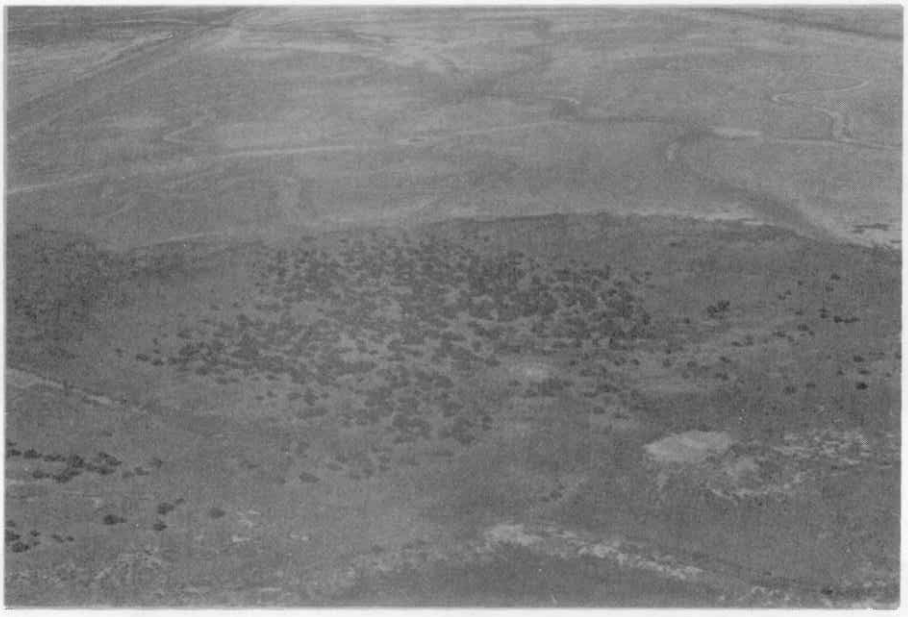
APPENDIX 1

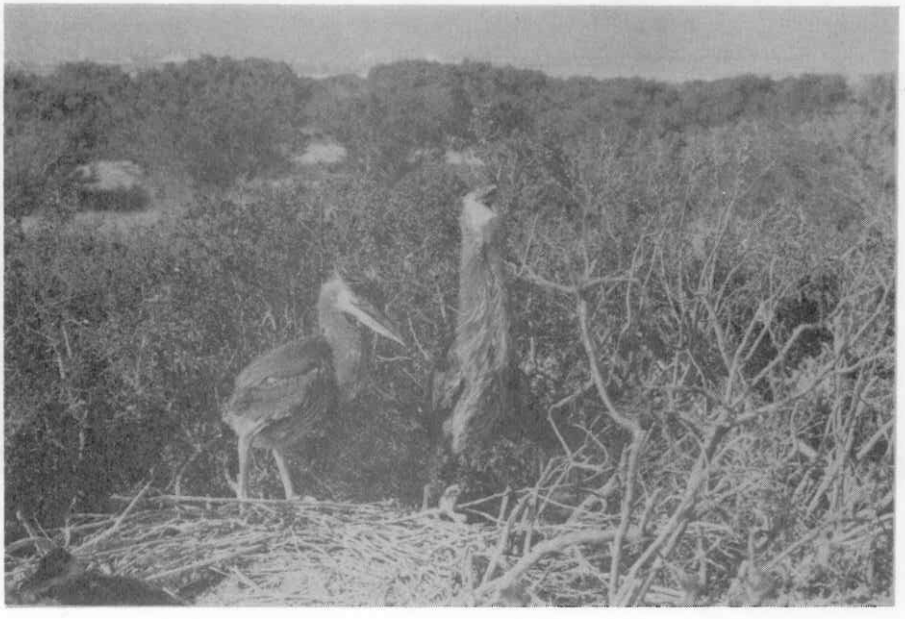
Flora of South San Francisco Bay Study Area

Scarlet pimpernel (Anagallis arvensis)
Dog-fennel (Anthemis cotula)
Garden orache (Atriplex hortensis)
Fat-hen (Atriplex hastata)
Redscale (Atriplex rosea)
Australian saltbush (Atriplex semibaccata)
Coyote bush (Baccharis pilularis)
Goldfields (Baeria chrysostoma)
Hitlerweed (Bassia hyssopifolia)
Garden beet (Beta vulgaris)
Field mustard (Brassica campestris)
Shepherd's purse (Capsella bursa-pastoris)
Italian thistle (Carduus pycnocephalus)
Star thistle (Centaurea solstitialis)
Pigweed, lamb's quarters (Chenepodium album)
Bull thistle (Cirsium vulgare)
Bindweed (Convolvolus arvensis)
Brass buttons (Cotula coronopifolia)
Dodder (Cuscuta salina)
Salt grass (Distichlis spicata)
California poppy (Eschsholtzia californica)
Sweet fennel (Foeniculum vulgare)
Alkali heath (Frankenia grandiflora)
Gum plant (Grindelia humilis)
Jaumea (Jaumea carnosa)
Lasthenia (Lasthenia glabrata)
Sea lavender (Limonium californicum)
Cheeseweed (Malva parviflora)
Pineapple weed (Matricaria matricarioides)
Ice plant (Mesembryanthemum nodiflorum)
Bermuda-buttercup (Oxalis pes-capra)
Bristly ox-tongue (Picris echioides)
Smartweed or Knotweed (Polygonum coccineum)
Wild radish (Raphanus sativus)
Curly dock (Rumex crispus)
Fiddle dock (Rumex pulcher)
Common pickleweed (Salicornia pacifica)
Annual pickleweed (Salicornia ambigua)
No common name (Salsola soda)
Sow-thistle (Sonchus oleraceus)
Alkali bulrush (Scirpus robustus)
Groundsel (Senecio sylvaticus)
Hedge mustard (Sisymbrium officinale)
Perennial sandspurry (Spurgularia macroteca)
Sandspurry (Spurgularia marina)
Sea blite (Suaeda californica)
New Zealand spinach (Tetragonia expansa)
Cattail (Typha latifolia)
Sea lettuce (Ulva sp.)

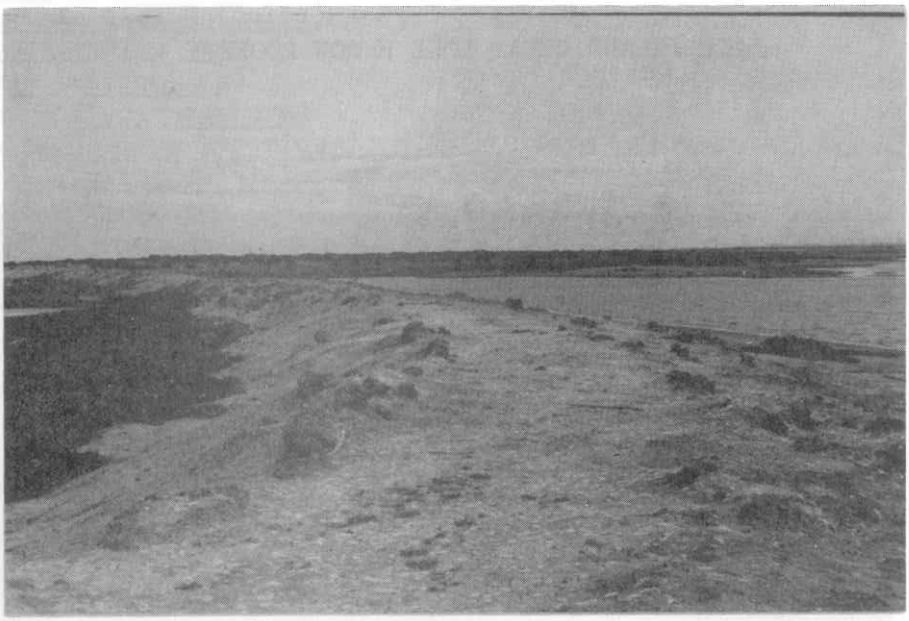
Wild oat (Avena fatua)
Soft chess (Bromus mollis)
Ripgut grass (Bromus rigidus)
Foxtail grass (Bromus rubens)
Cheat grass (Bromus tectorum)
Sedge (Carex sp.)
Bermuda grass (Cyordon dactylon)
Nutgrass (Cyperus sp.)
Crab grass (Digitaria sanguinalis)
Cord grass (Spartina foliosa)
Wild rye (Elymus triticoides)
Foxtail fescue (Festuca megalura)
Farmer's foxtail (Hordeum leporinum)
Italian ryegrass (Lolium multiflorum)
Monerma (Monerma cylindrica)
Sickle grass (Parapholis incurva)
Canary grass (Phalaris minor)
Annual bluegrass (Poa annua)
Kentucky bluegrass (Poa pratensis)
Rabbitsfoot grass (Polypogon monspeliensis)
Marsh grass (Puccinellia maritima)

BAIR ISLAND GREAT BLUE HERON ROOKERY - 1971





BAIR ISLAND CASPIAN TERN COLONY - 1971



MOWRY SLOUGH, CALIFORNIA CLAPPER RAIL HABITAT - 1971