SUMMARY OF SENSITIVE PLANT AND WILDLIFE RESOURCES IN SUISUN MARSH DURING WATER YEARS 1984 - 1994

ENVIRONMENTAL SERVICES OFFICE
DEPARTMENT OF WATER RESOURCES
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Summary of Sensitive Plant and Wildlife Resources in Suisun Marsh

At the November 1, 1994 meeting, Board staff requested a summary of biological data and information regarding sensitive terrestrial species which are known to the Suisun Marsh vicinity. The summary was to include all available information on sensitive biological resources in Suisun Marsh since the 1984 Plan of Protection. This information is to be used in support of the 1994 Draft Water Quality Control Plan. Please find attached a report entitled "Summary of Sensitive Plant and Wildlife Resources in Suisun Marsh during Water Years 1984 - 1994".

An advance copy of the summary report was hand-carried to you on the morning of December 14, 1994. The summary report contains data and information compiled to assist the State Water Resources Control Board in their preparation of a biological assessment for consultation with the Department of Fish and Game and the U.S. Fish and Wildlife Service on the potential impacts of salinity standards proposed for Suisun Marsh.

Please do not hesitate to call me at (916) 227-7520 if you have any questions about the report.

Original Signed By

Brenda J. Grewell
Environmental Specialist
Environmental Services Office

Attachment

cc: (See attached list.)

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SUMMARY OF SENSITIVE PLANT AND WILDLIFE RESOURCES IN SUISUN MARSH DURING WATER YEARS 1984 - 1994

INTRODUCTION

This report includes data and information compiled to assist the State Water Resources Control Board (SWRCB) in their preparation of a biological assessment for consultation with the Department of Fish and Game (DFG) and the U. S. Fish and Wildlife Service (USFWS) on the potential impacts of salinity standards proposed for Suisun Marsh. At the request of SWRCB staff, the scope of this report is limited to sensitive wetland plant and wildlife species of Suisun Marsh. SWRCB staff are relying on other sources of information for their assessment of impacts to Suisun Marsh fishery resources.

These data are preliminary results of a Suisun Marsh Biological Assessment requested by the SWRCB in 1991. The results of this study were due in a report to the SWRCB by April 1996. The immediate need for these data to support the SWRCB's preparation of the 1994 Draft Water Quality Control Plan for Salinity in the Bay-Delta limited the breadth and depth of information presented in this document. These results should be considered preliminary. An in-depth evaluation of species distributions and associations along salinity gradients has not been completed. The request for these data 17 months before the projected end of the study precluded the presentation and evaluation of all habitat and water quality data measured in support of the Biological Assessment.

This report includes brief descriptions of the pertinent sensitive species' status and habitat requirements. The report also includes information on the distribution of sensitive plant and wildlife species in Suisun Marsh and throughout the San Francisco Bay - Delta Estuary. These data were generated through intensive field surveys conducted by Department of Water Resources and Department of Fish and Game biologists in response to SWRCB's request for a biological assessment. Supplemental survey information conducted since the 1984 Plan of Protection for the Suisun Marsh was also compiled from the literature and included in this report.

SWRCB staff requested that the potential impacts of proposed salinity standards be evaluated with regard to their potential impacts on sensitive species. These preliminary evaluations are based on current sensitive species' distributions and observed channel water salinity conditions. Two salinity standard scenarios were considered. The first scenario assumes D-1485 standards will remain in place for the eastern Marsh channel salinity monitoring stations including Sacramento River at Collinsville (C-2), Montezuma Slough at National Steel (S-64), and

Montezuma Slough at Beldon's Landing (S-49) (Figure 1). The second scenario is that the Suisun Marsh Preservation Agreement and standards proposed by DWR, DFG, SRCD, and USBR be implemented. Concurrent modeling studies are being conducted to determine the affect of draft CUWA/AG proposed Bay salinity standards on interior Marsh channel water salinity. An evaluation of potential impacts of the CUWA/AG standards on sensitive species within Suisun Marsh is not included in this report.

Observed salinity conditions in Suisun Marsh are discussed relative to distributions of individual species which may be influenced by channel water salinity. It should be noted that salinity is only one of many complex environmental variables which influence the distribution of biological resources.

SUMMARY OF SALINITY CONDITIONS IN SUISUN MARSH

A summary of 1984 - 1992 salinity conditions in Suisun Marsh was prepared by the Department of Water Resources at the request of State Water Resources Control Board staff in support of the 1994 Draft Water Quality Control Program for the San Francisco Bay - Delta (DWR 1994). This report describes factors affecting salinity trends in Suisun Marsh with emphasis on a comparison of conditions in the eastern and western Marsh, specifically with respect to Decision 1485 standards and Suisun Marsh Preservation Agreement standards. A comparison of these salinity standards is presented in Table 1. This water quality summary should be referred to for details of salinity conditions observed since the Suisun Marsh Plan of Protection.

TABLE 1

SWRCB D-1485 and Suisun Marsh Preservation Agreement Salinity Standards

	MEAN MONTHLY HIGH TIDE ELECTRICAL CONDUCTIVITY (in mmhos/cm)		
Month	D1485 Standards	SMPA Normal	SMPA Deficiency
October	19.0	19.0	19.0
November	15.5	16.5	16.5
December	15.5	15.5	15.6
January	12.5	12.5	15.6
February	8.0	8.0	15.6
March	8.0	8.0	15.6
April	11.0	11.0	14.0
May	11.0	11.0	12.5

SMPA - Suisun Marsh Preservation Agreement

Water year classifications for water years 1984 through 1994 as defined in Footnote 2 of Table II of SWRCB Decision 1485 and the SMPA are shown below.

Water Year	Runoff (1000's AF)	D-1485	SMPA
1984	22,351	WET	NORMAL
1985	11,041	DRY	NORMAL
1986	25,716	WET	NORMAL
1987	9,202	CRITICAL	NORMAL
1988	9,190	CRITICAL	DEFICIENCY
1989	14,792	DRY	DEFICIENCY
1990	9,232	CRITICAL	DEFICIENCY
1991	8,436	CRITICAL	DEFICIENCY
1992	8,890	CRITICAL	DEFICIENCY
1993	22,397	ABOVE NORMAL	NORMAL
1994	7,800	CRITICAL	NORMAL

The locations of channel water salinity compliance monitoring stations, and other salinity recording stations are shown on Figure 1. A summary of salinity ranges observed at key eastern, western, and bayshore monitoring stations is presented in Table 2.

TABLE 2

Range of Mean Daily Salinity (SC, in uS/cm)
Recorded at Selected Suisun Bay and Marsh Stations During Water Years 1991- 1993

Station No.	Location	WY 91 Min./Max.	WY 92 Min./Max.	WY 93 Min./Max.
ANT	Antioch	387/7271	407/8162	131/8097
MTZ	Martinez	3642/30758	3791/31690	275/32327
MAL	Mallard	960/15904	322/16334	114/16966
C-2	Collinsville	218/11699	196/12311	96/12157
S04	Hill Slough	2348/14558	1844/16349	698/16012
S21	Sunrise Club @ Chadbourne Slough	961/18733	2604/17544	630/18730
S33	Cordelia Slough @ Cygnus	3095/20883	3840/19624	1113/20851
S35	Goodyear Slough @ Morrow Island	3784/20765	3674/20738	1228/21152
S42	Suisun Slough @ Volanti	2867/17726	2814/18975	1385/18669
S49	Montezuma Slough @ Beldons	864/18235	1484/19807	616/19689
S54	Montezuma Slough @ Hunter Cut	1476/19411	1951/20263	733/19506
S64	Montezuma Slough @ National Steel	400/14195	306/17723	212/17842
S71	Montezuma Slough @ Roaring River	142/12750	226/13806	115/12894
S72	Roaring River @ Montezuma Slough	446/13187	393/13624	190/12848
S90	Roaring River @ Sprig	567/12982	790/13842	402/13258
S97	Ibis	1980/19227	2959/19657	737/21738

COMPLIANCE / MONITORING SITES 25 HOUR MIN. AND MAX. MEAN DAILY SALINITY

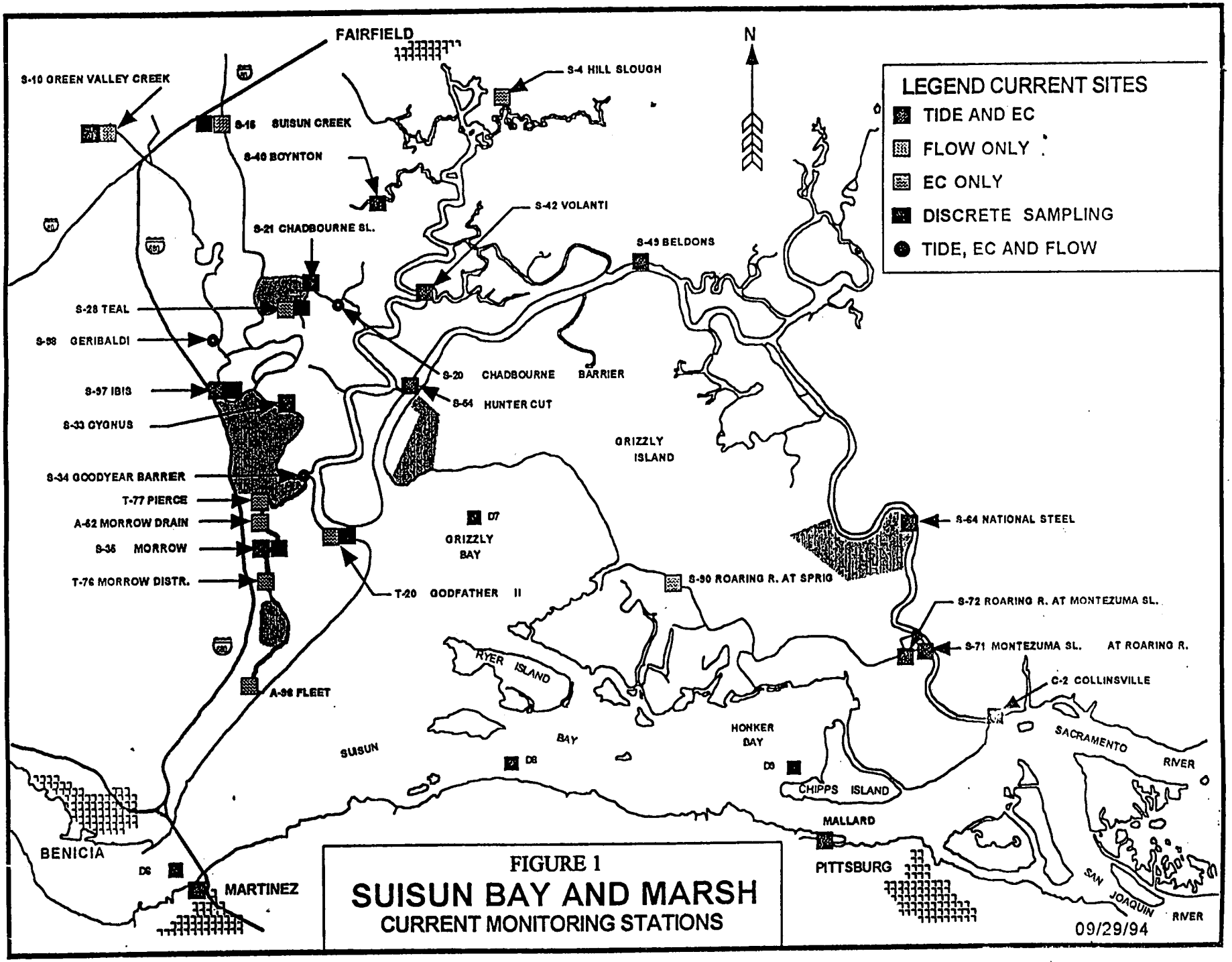


FIGURE 1

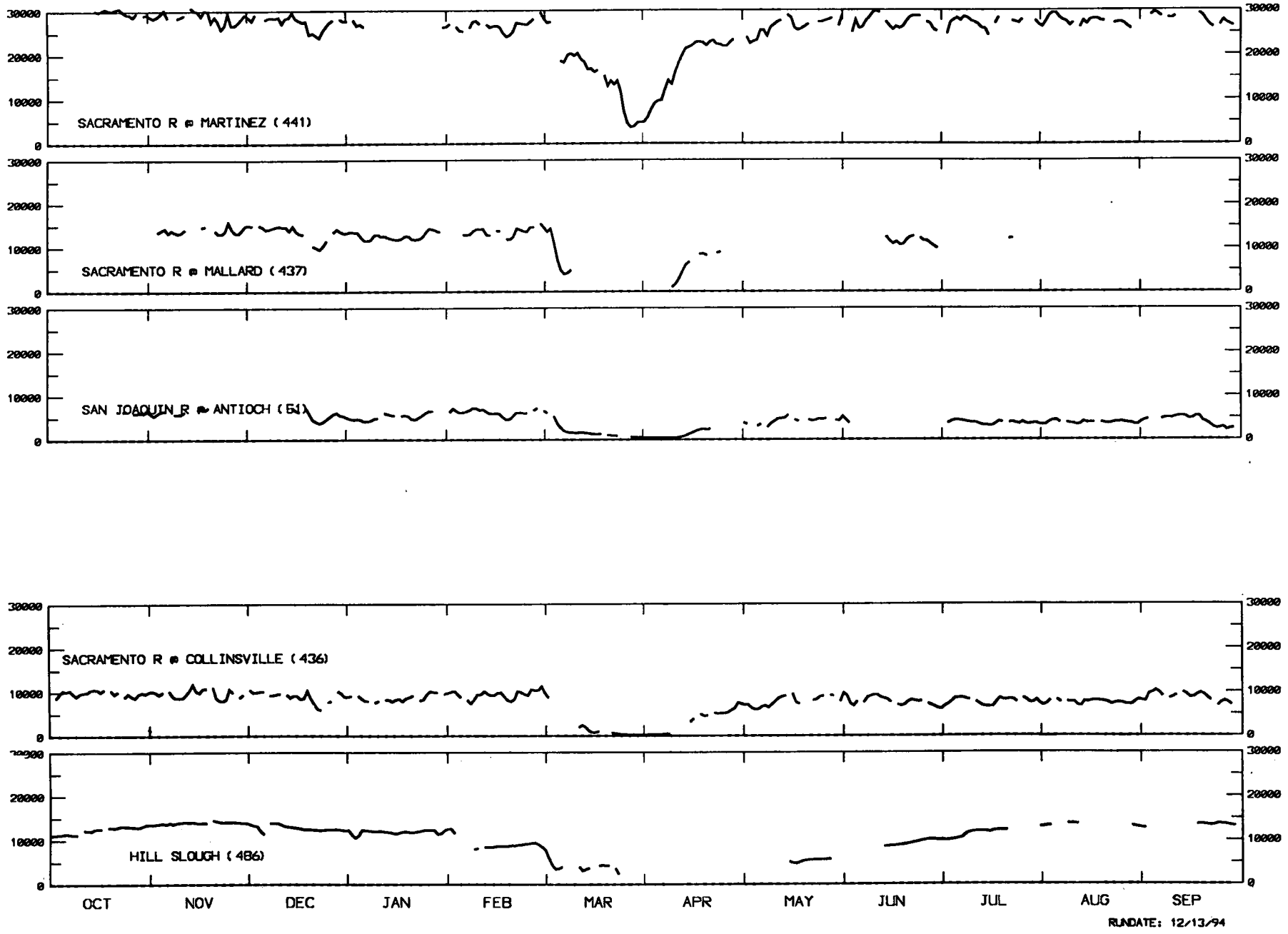
SUISUN BAY AND MARSH

CURRENT MONITORING STATIONS

FIGURE 2

1991 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE .SC IN uS/cm



RUNDATE: 12/13/94

WY-91.HST

FIGURE 2

1991 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

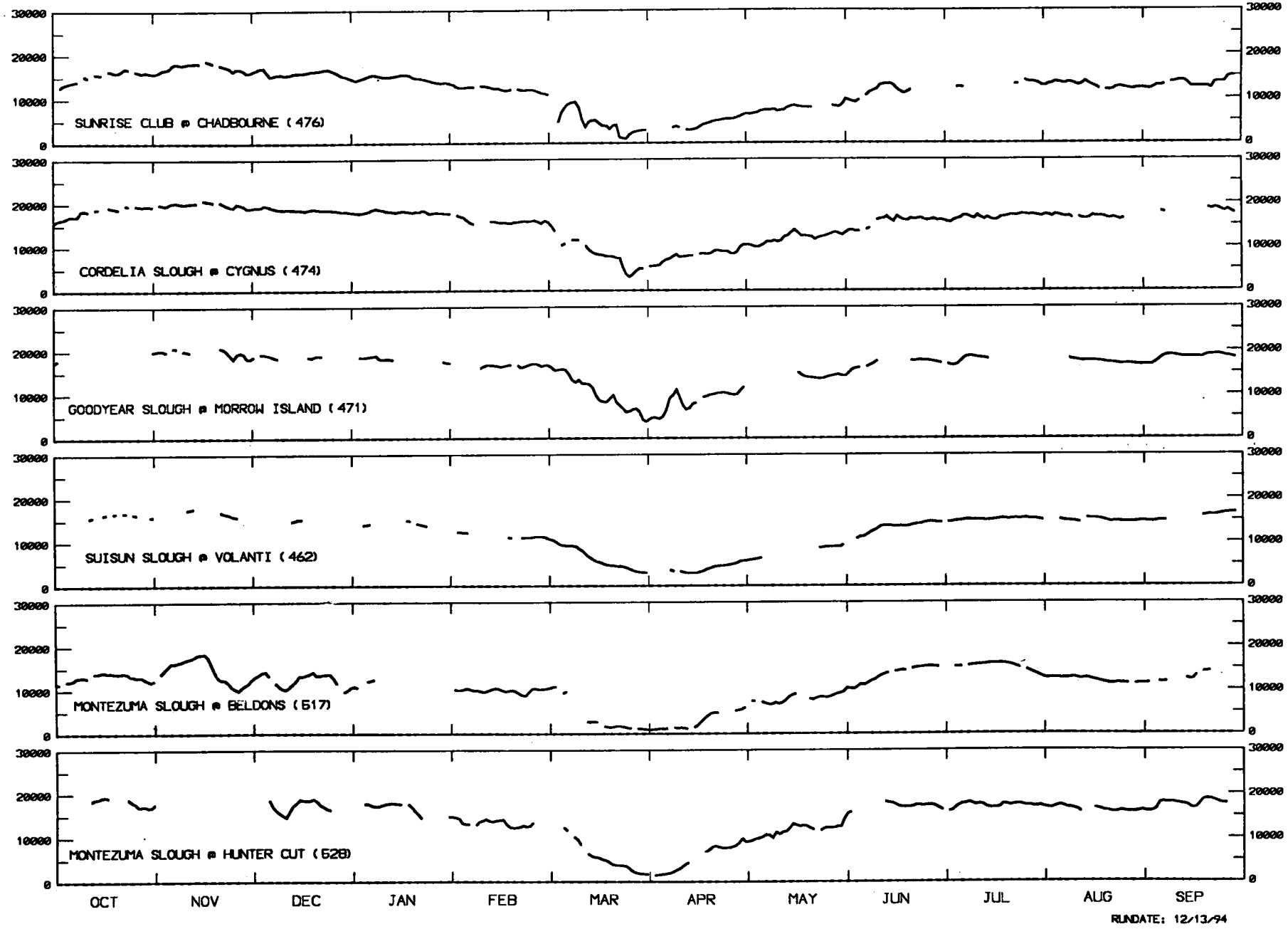


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FIGURE 2

1991 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

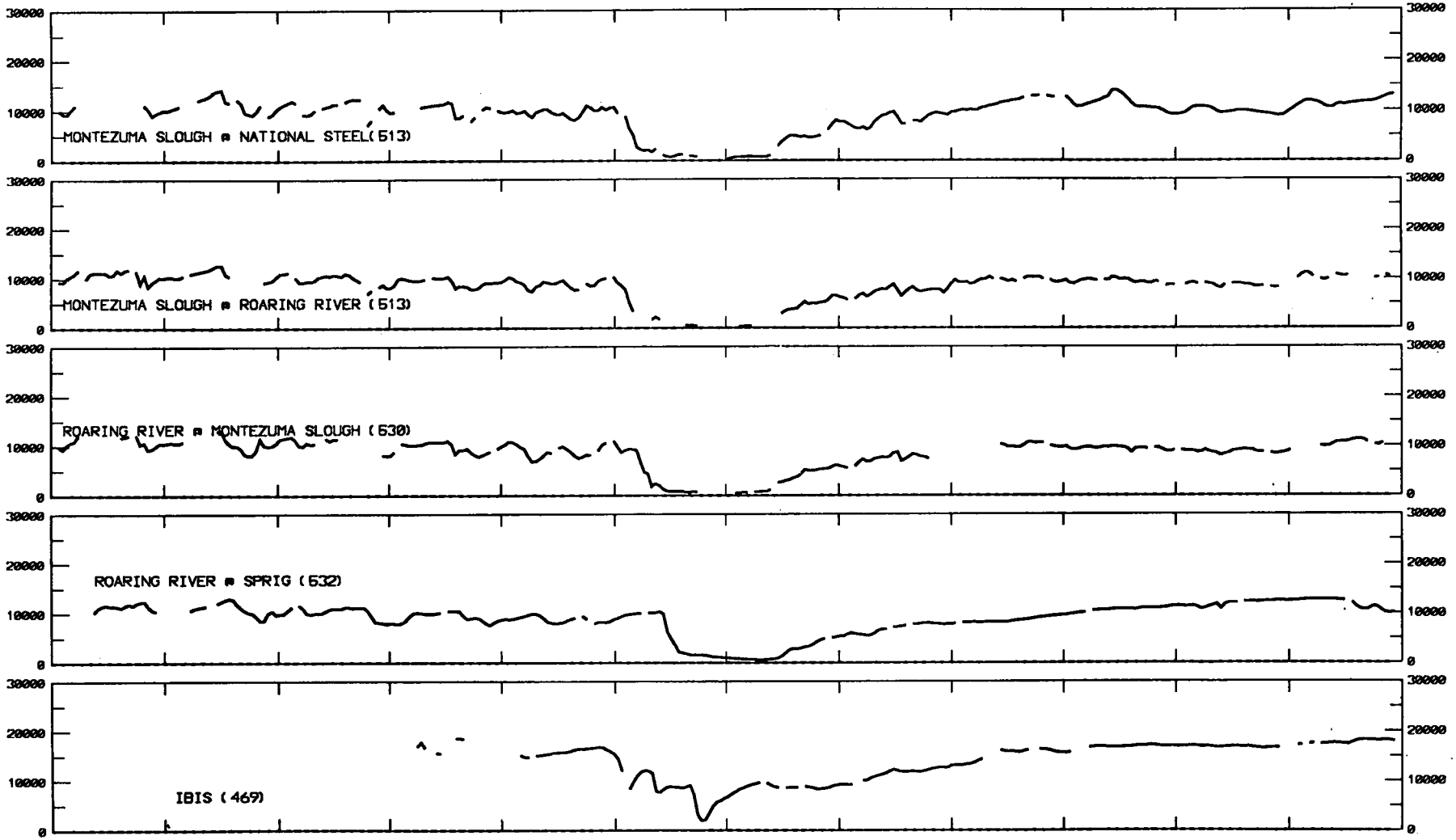

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FIGURE 3

1992 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

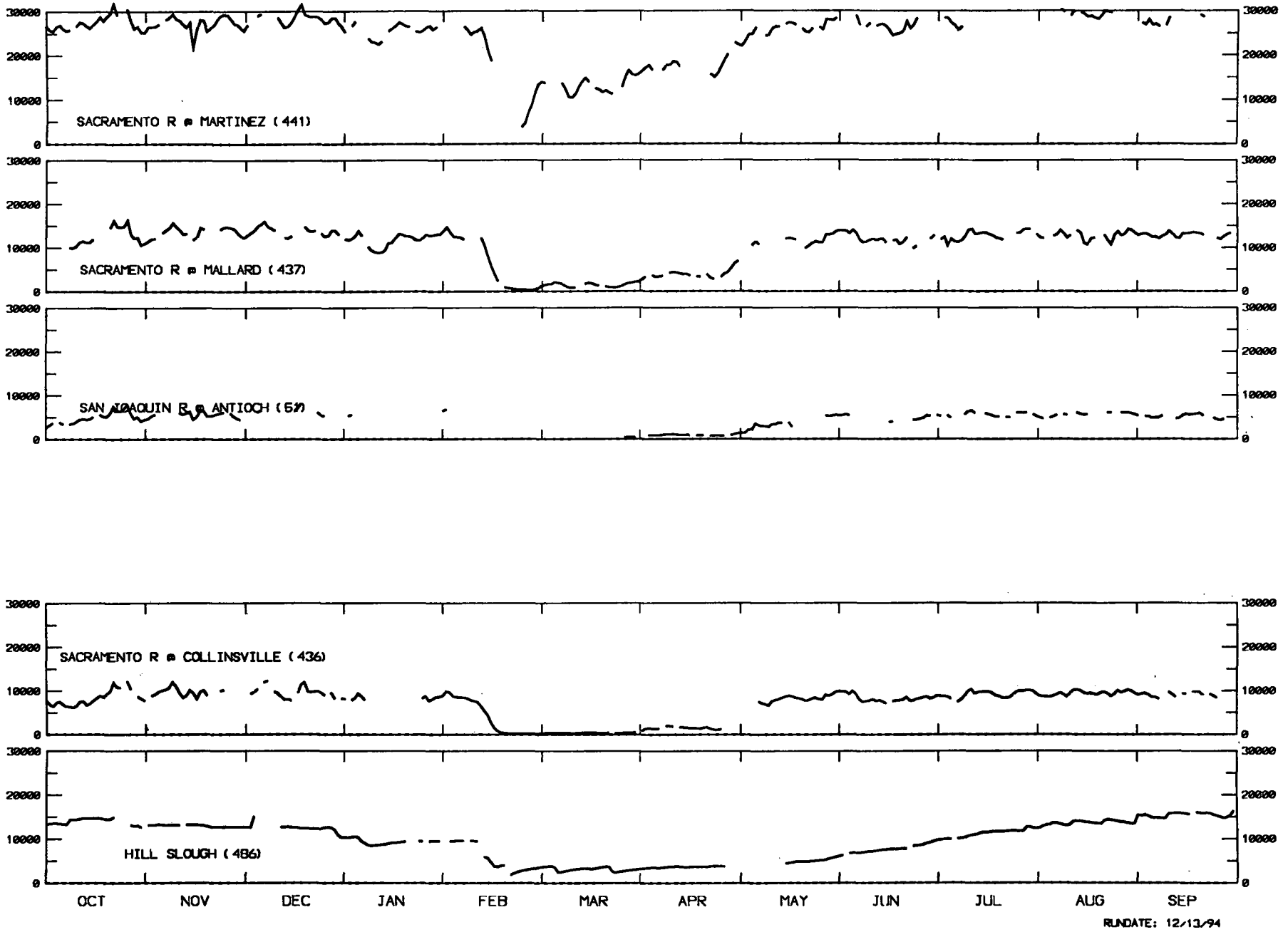

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FIGURE 3

1992 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

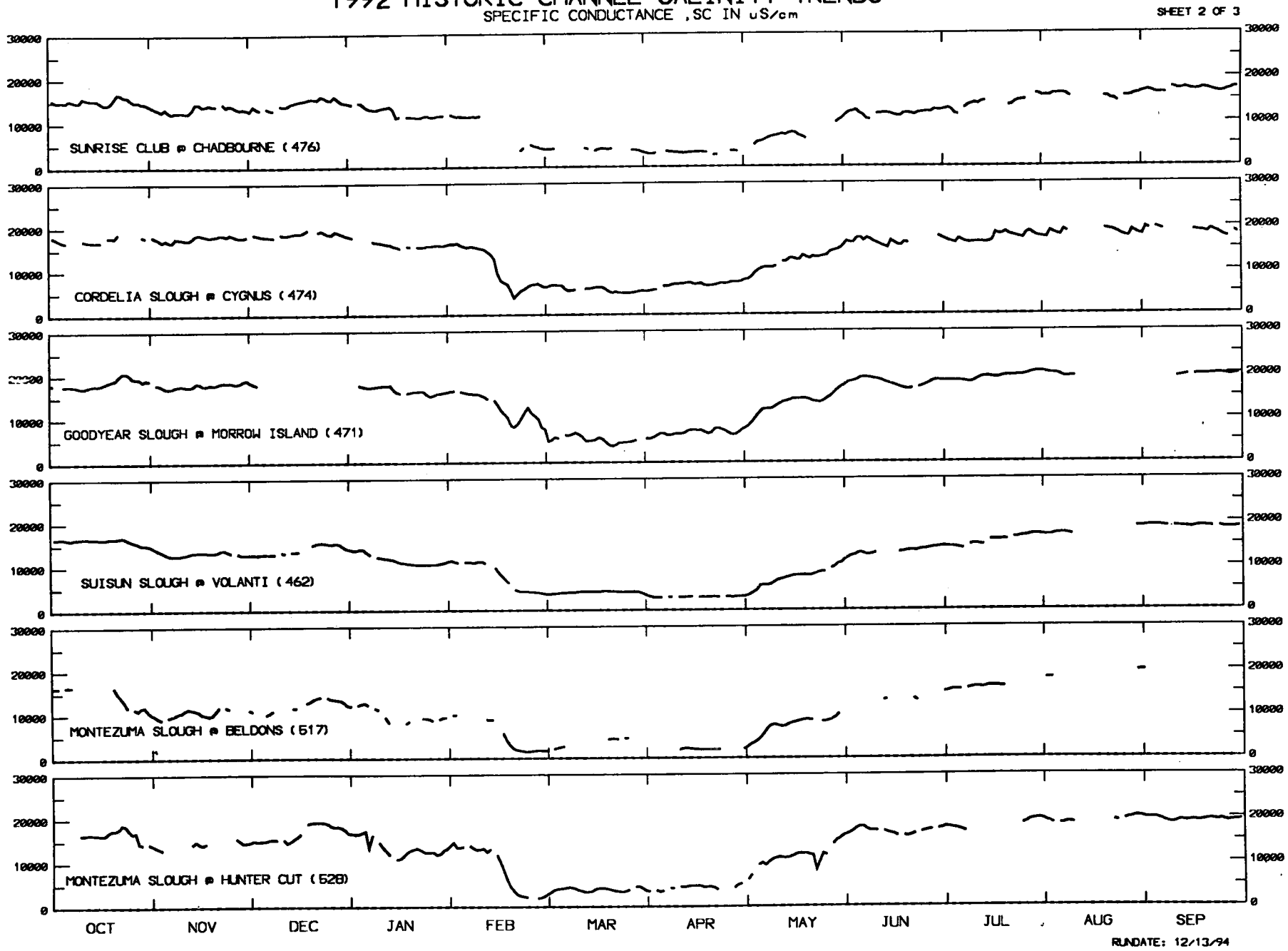

FIGURE 3

1992 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

SHEET 3 OF 3

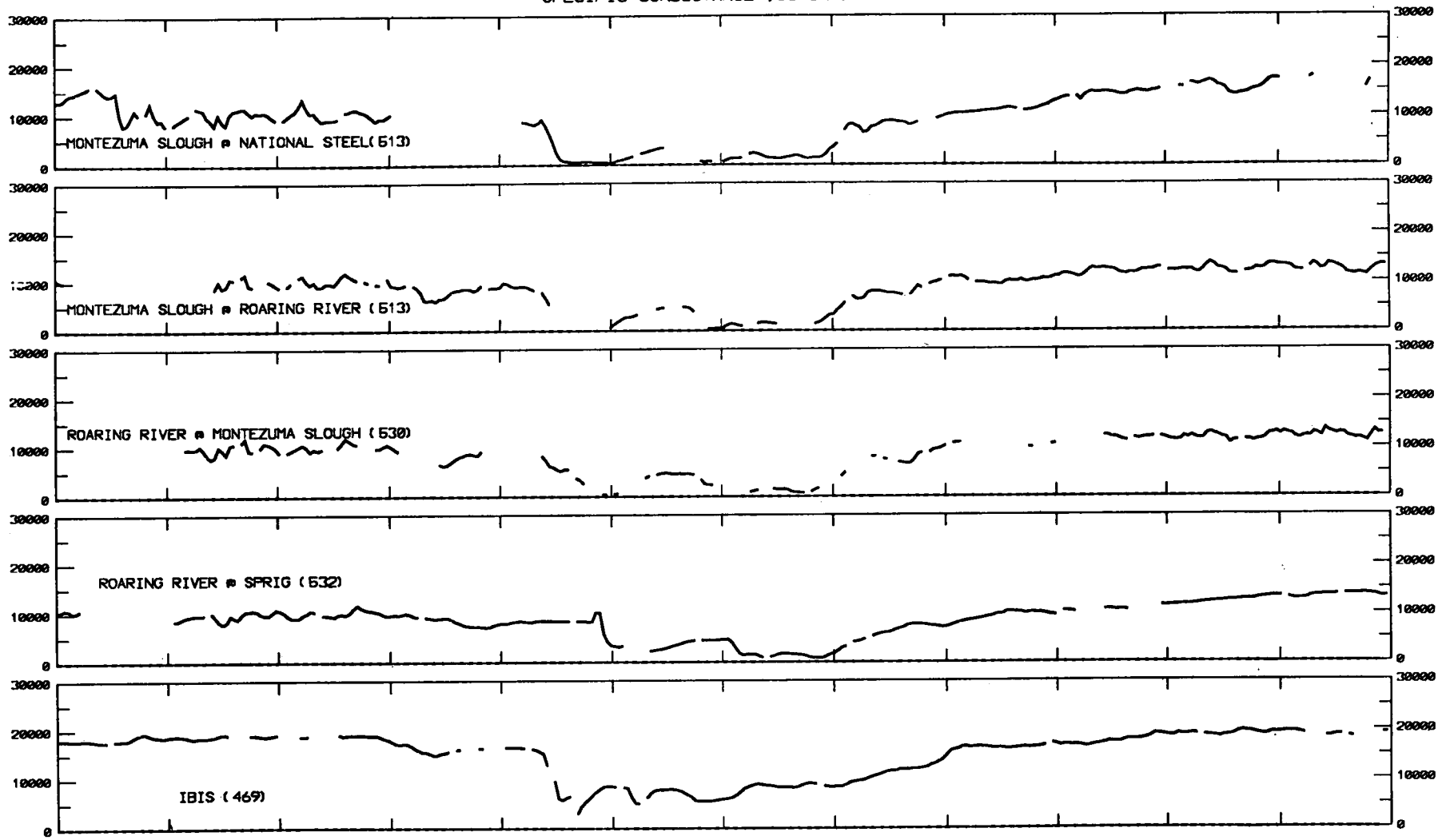

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FIGURE 4

1993 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

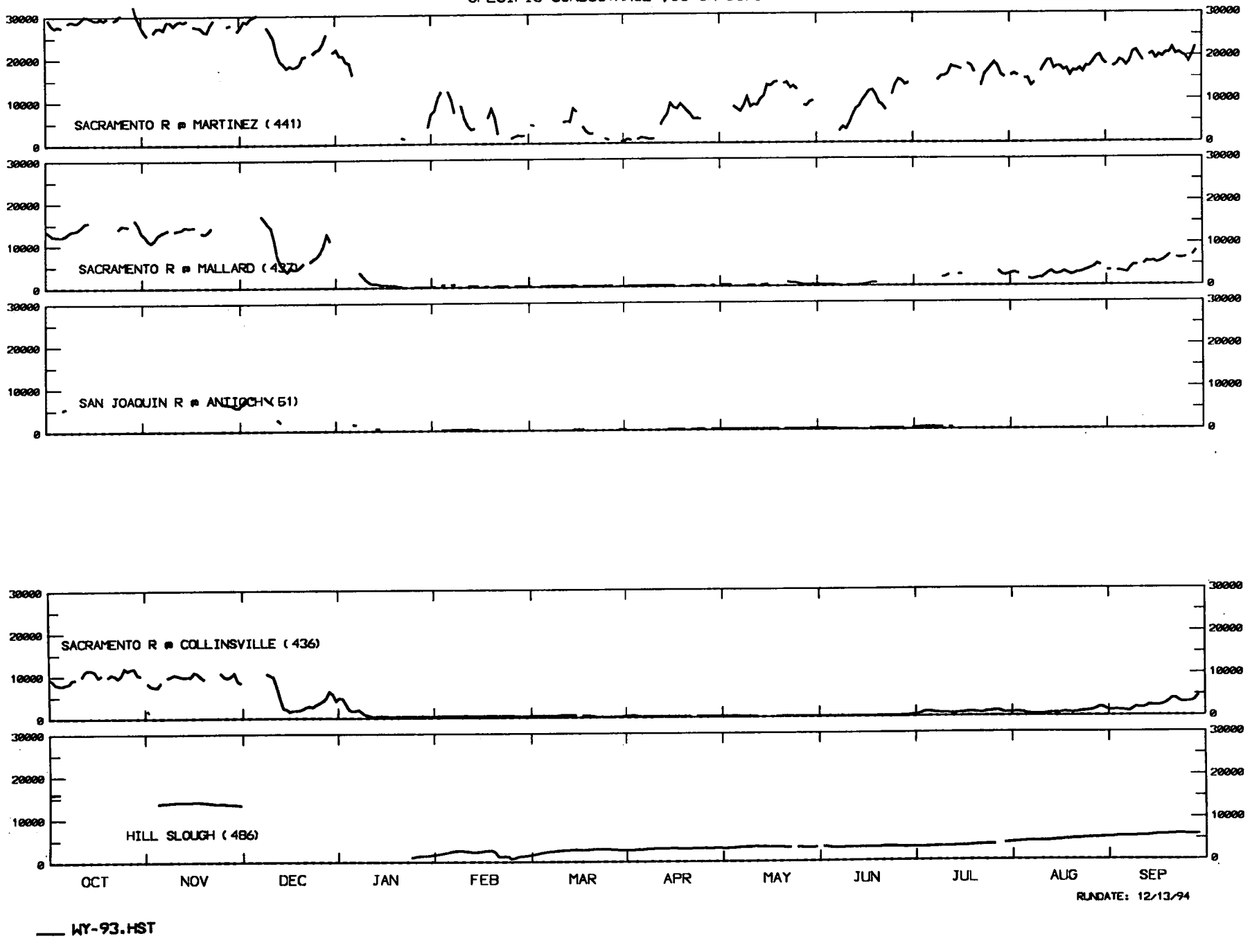

FIGURE 4

1993 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm

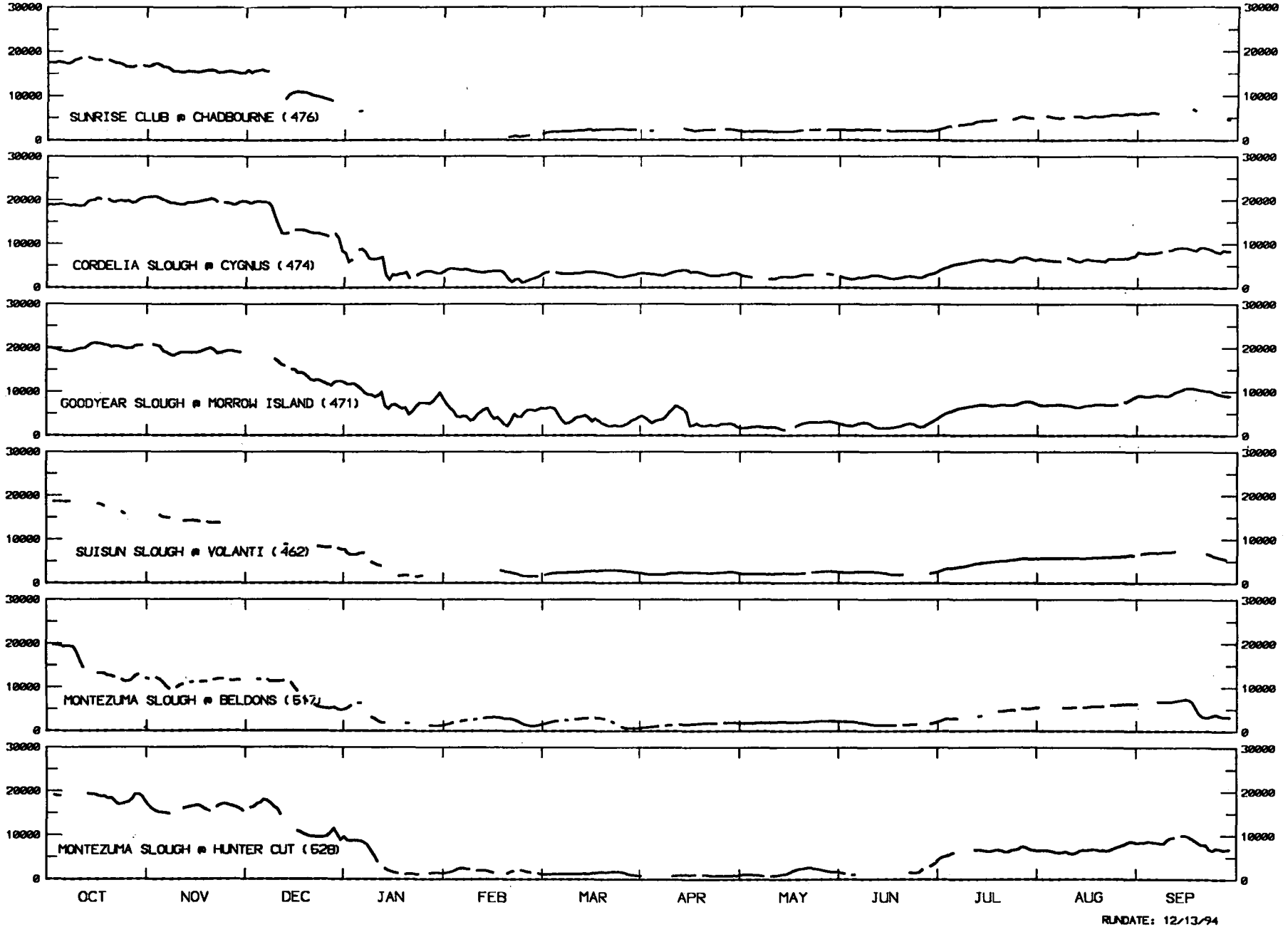

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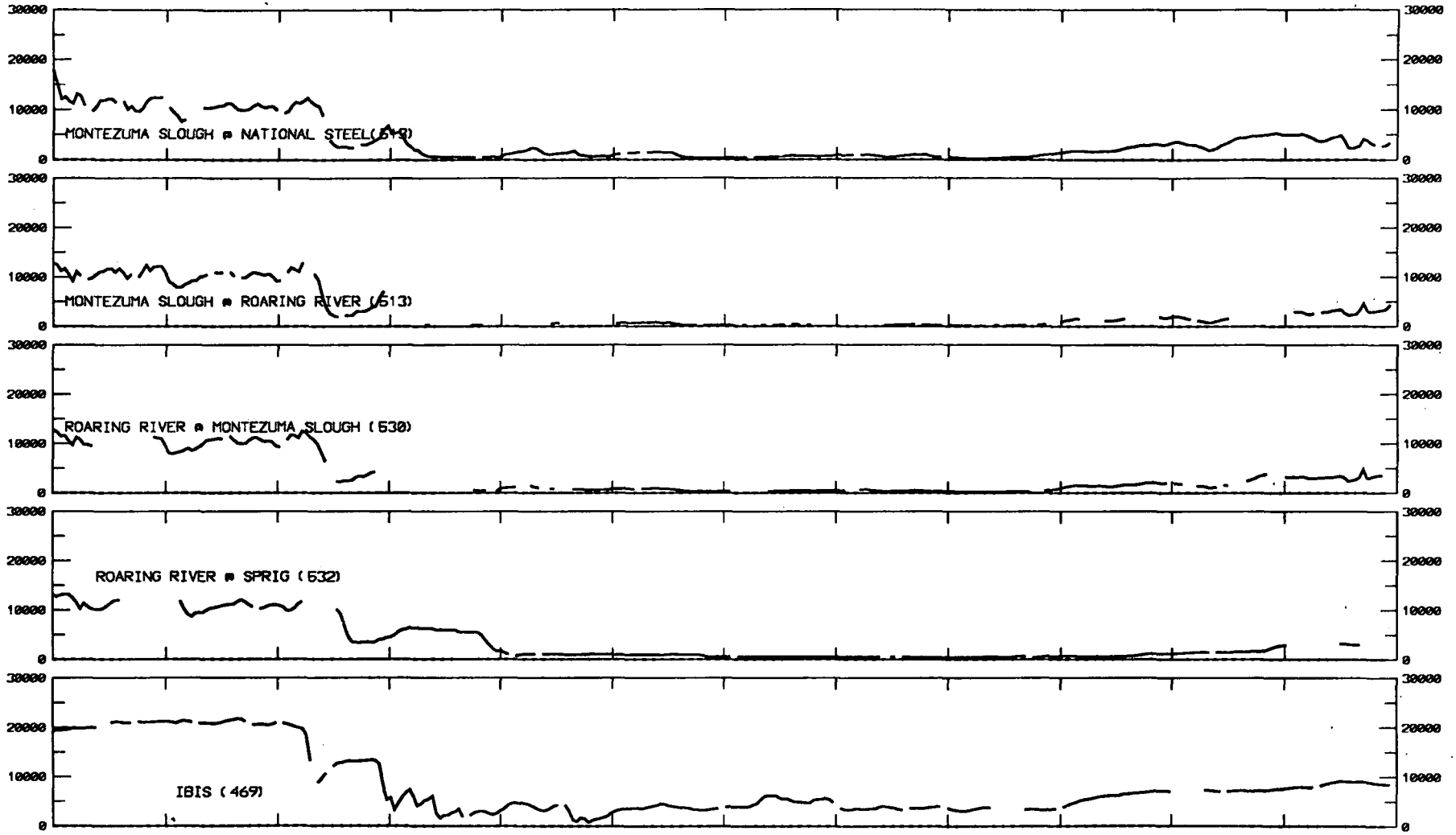
FIGURE 4

1993 HISTORIC CHANNEL SALINITY TRENDS

SPECIFIC CONDUCTANCE ,SC IN uS/cm



OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP

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The majority of the intensive field surveys for sensitive species which followed the 1991 data request from SWRCB took place during water years 1991 - 1993. Channel salinity trends observed at Suisun Marsh monitoring stations during the 1991 through 1993 water years are included for comparison with the observations of sensitive species which were recorded during this time period (Figures 2 - 4).

SUISUN MARSH WETLAND HABITAT

The Suisun Marsh includes the brackish estuarine wetlands of Solano County, California located between the freshwater wetlands of the Sacramento - San Joaquin Delta and the salt marshes of San Francisco Bay. Today it contains approximately 12 percent of the remaining wetlands of California. There are about 7,160 hectares (17,691 acres) of publically owned wetland habitat in the Suisun Marsh, including 5,950 hectares (14,700 acres) managed by DFG through the Grizzly Island complex, 308 hectares (761 acres) at Point Edith Marsh managed by the DFG Region 3 office in Yountville, 457 hectares (1130 acres) managed by Solano County Farmlands and Open Space Foundation, and 445 hectares (1100 acres) administered by the U.S. Navy's Concord Naval Weapons Station. Private waterfowl hunting clubs maintain an additional 17,406 hectares (43,010 acres) of managed wetland habitat. The bays and tidal sloughs include 10,927 hectares (27,000 acres) of open water habitat.

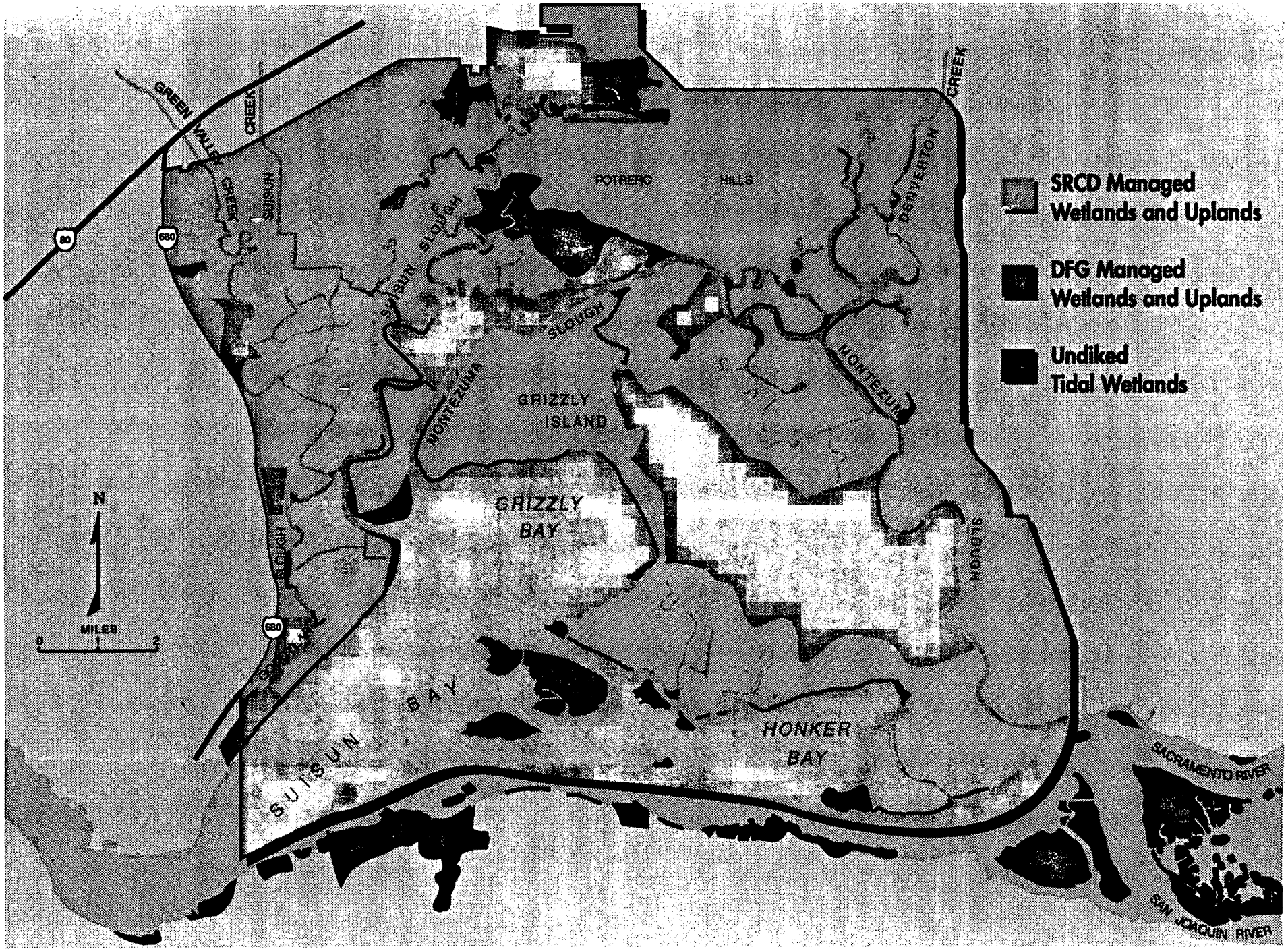
The Central Valley of California, including Suisun Marsh, is the most important wintering area for waterfowl of the Pacific Flyway, supporting 60 percent of the total population (Central Valley Habitat Joint Venture, 1990). Suisun Marsh is one of nine drainage basins important to wintering waterfowl in the Central Valley. Five percent of the Pacific Flyway winter population in the Central Valley may be found in Suisun Marsh (CVHJV, 1990).

Suisun Marsh wetlands also support resident populations of rare, threatened, or endangered avian, mammal, and plant species including California clapper rail, California black rail, American peregrine falcon, salt marsh harvest mouse, Mason's lilaeopsis, and soft bird's beak.

WETLAND HABITAT INFLUENCED BY CHANNEL WATER SALINITY

A variety of wetland habitat types may be found in Suisun Marsh (Figure 5). Hydrology is the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes (Mitsch and Gosselink, 1993). Hydrologic conditions affect many abiotic factors, including but not limited to channel water salinity. These factors, in turn, determine the flora and fauna that develop in wetlands. The three Suisun Marsh wetland types which are influenced by channel water salinity include historic undiked tidal wetlands, diked seasonal wetlands, and diked permanent wetlands.

Suisun Marsh Wetlands



Undiked Tidal Wetlands

The Suisun Marsh of the early Nineteenth century was a brackish tidal basin encompassing more than 30,000 hectares (74,000 acres) of natural tidal wetlands. Over the decades, reclamation for urban, agricultural, industrial. and managed waterfowl habitat development has reduced this historic wetland type to approximately 2,630 hectares (6,500 acres). These tidal marshes are subject to tidal cycle inundation regimes resulting in irregular exposure from the ebb and flood tides. The brackish tidal marshes are dominated by dense stands of native, intertidal, emergent vegetation. Plant heights vary from prostrate to nearly three meters, creating a complex structural mosaic of wildlife habitat. The character of this habitat varies with elevation and distance from the channel water source.

About 92 percent of the Estuary's tidal marshes have been filled or converted to other wetland types (Harvey et al. 1992). Many wildlife species that depend on this habitat type are endangered or are candidates for endangered species status. Sensitive species present in the Suisun Marsh tidal marshes include California clapper rail, California black rail, salt marsh harvest mouse, Suisun ornate shrew, Mason's lilaeopsis, soft bird's beak, and the extremely rare Suisun thistle. American bittern, black-crowned night heron, marsh wren, common yellowthroat, mallard, cinnamon teal, Canada goose, white-tailed kite, northern harrier, short-eared owl, Virginia rail, sora, red-winged blackbird, tricolored blackbird, and ring-necked pheasant are other avian species observed nesting in the tidal brackish wetlands of Suisun Marsh (Granholm 1987; Grewell 1993). River otters, beaver, muskrats, mink, raccoons, California vole, house mice, western harvest mice, and coyotes are mammals frequently observed in Suisun Marsh tidal marshes (Grewell 1993).

The few remaining tidal marshes in Suisun Marsh include the portion of Hill Slough Wildlife Area east of McCoy Creek, Peytonia Slough Ecological Reserve, Solano County Farmlands and Open Space Foundation's Rush Ranch north of Cutoff Slough, a small portion of DFG's Joice Island unit north and east of Cutoff Slough, the south end of lower Joice Island, Roe Island, portions of Ryer Island, and fragmented small wetland areas along the Contra Costa shoreline (Figure 5).

The two primary types of tidal wetlands in Suisun Marsh are relict tidal marshes, and fringe tidal wetlands. Relict tidal marshes are characterized by a fully developed natural marsh hydrology, with small first order channels in the high marsh grading into large tidal sloughs at the low marsh zone. Atwater and Hedel (1976) identified three vegetation zones in brackish marshes of the northern Estuary: low marsh (Mean low tide (MTL) or lower), middle marsh (MTL to mean higher high water (MHHW)), and high marsh (at or above MHHW). The low marsh is dominated by tall tules such as hardstem bulrush and California bulrush; middle marsh is characterized by a mixture of cattails and bulrushes; and the high marsh supports a variety of halophytes including salt grass, alkali heath, baltic rush, and pickleweed. Historic high marsh habitat provides an important ecological transition to adjacent uplands. The relict natural tidal marshes in the Suisun exhibit this zonation of vegetation. They are characterized by a high diversity of plant and wildlife

species.

A second type of tidal marsh present in Suisun Marsh are fringe tidal wetlands. These wetlands are found on the outboard sides of levees of diked wetlands. They front the tidal sloughs and bayshores of Suisun Marsh, Grizzly Bay, Honker Bay, and Suisun Bay. The fringe or "strip" marshes are typically less than 100 meters wide. These narrow tidal wetlands do not exhibit the complex zonation of habitat types that are found in the relict undiked tidal marshes. The upper elevations of many of the levees are dominated by introduced exotic vegetation species. Fringe marshes are occupied by sensitive species including California clapper rail, Suisun song sparrow, Mason's lilaeopsis, Delta tule pea, and Suisun Marsh aster.

Vegetation was characterized in undiked tidal marshes throughout Suisun Marsh in 1992. Species composition and cover were evaluated, along with measurements of vegetation stature. These habitat variables were measured to characterize the vegetation of areas occupied by sensitive species. These data are available for future analyses, and may serve as a reference framework for future tidal marsh biological monitoring.

Diked Seasonal Wetlands

Suisun Marsh comprises the largest diked seasonal wetland complex in the Estuary (Harvey et al., 1992). The primary wetland type in Suisun Marsh are diked, seasonal wetlands which are managed for wintering waterfowl habitat. The character of wetland habitat in these managed marshes is reflective of water management and waterfowl habitat objectives. The single most important factor influencing plant composition and cover in these wetlands is the length of soil submergence provided through water management (Mall, 1969). Other abiotic factors such as channel water salinity, soil salinity, and soil characteristics also influence these plant communities. Of these factors, soil salinity may be managed with implementation of leach cycles (Rollins, 1973). Active water management of muted tidal flow through water control structures can result in moist soil management regimes which are critical to the production of waterfowl food plants. The water management plans for these wetlands specify flooding for hunting season and for soil salinity control after the hunting season. The primary water management schemes in Suisun Marsh are late drawdown and early drawdown schedules with leach cycles required to manage the soil salt balance (Rollins 1981). Late drawdown water management favors vegetation which requires a lengthy period of submergence. This management promotes a wide variety of key waterfowl food plants including alkali bulrush, fat hen, and brass buttons. Early drawdown water management favors fathen stands, which requires a short period of flooding. This management regime suppresses obligate wetland species such as cattails and tules. The short flooding period also provides growth conditions for pickleweed which harbors important aquatic invertebrate waterfowl food sources (Batzer, et al. 1993). Seasonal wetlands of this character also support the endangered salt marsh harvest mouse, and many other plant and wildlife species.

DFG cultivates barley in Suisun Marsh to attract waterfowl and reduce crop depredation in the

Central Valley. Barley is somewhat tolerant of saline soils, but it will not grow under flooded conditions. Therefore, diked marshes are flooded only for the waterfowl hunting season. Barley is planted after the ponds are drained. Pacific flyway ducks begin to arrive in Suisun Marsh in August. Ducks feed on the grain during September and early October before the seasonal marshes are flooded. Geese feed on the grain and the new young plants throughout the winter.

A small number of Suisun Marsh managers attempt to grow watergrass (wild millet) or Japanese (black) millet. These annual grasses (also known as "barnyard grass") grow in moist soils. The plants produce large quantities of seeds which are relished by ducks, songbirds, and rodents. Intensive water management, agricultural cultivation, and summer irrigation cycles are required for the successful production of this seed crop.

Seasonal Waterfowl Habitat Maintenance and Channel Salinity Standards

Mall (1969) examined gizzard contents of Suisun Marsh ducks, and concluded that alkali bulrush (*Scirpus robustus*) seeds were the most important waterfowl food item. The salinity standards set forth in D-1485 for Suisun Marsh tidal channels were promulgated to provide the key growth requirements for this single waterfowl food plant. Other studies have demonstrated that analyses of gizzard contents inflates the importance of seeds in the diet of ducks, and esophageal content analysis is a more accurate reflection of waterfowl diet (for example: Swanson and Bartonek 1970). Waterfowl have different nutritional energetic requirements throughout the year. Individual waterfowl species also have different food, habitat, and social preferences and requirements (CVHJV, 1990).

Knowledge of waterfowl habitat management has continued to evolve since the original development of the Suisun Marsh standards. Research conducted since the 1984 Plan of Protection for the Suisun Marsh suggests a movement away from this single waterfowl food species management approach. A recent study by the University of California, Berkeley and DFG has documented the importance of invertebrates in pickleweed habitat as a food source for Suisun Marsh mallards (Batzer,et al. 1993). Other studies have documented the importance of an invertebrate animal matter diet to winter (November to February) northern pintails in the northern San Joaquin Valley, whereas vegetative food items were selected in the fall (Connelly and Chesemore, 1980). Miller (1987) and Euliss and Harris (1987) found comparable results in their studies of waterfowl food habits in the Sacramento and San Joaquin Valleys.

Movement of waterfowl out of Suisun Marsh may be related to hunting pressure, food resources, poor habitat quality in Suisun Marsh, and the availability of newly flooded sanctuary habitat in the Delta (Miller et al. 1993 and CVHJV 1990). A recent study in Suisun Marsh has indicated northern pintail preference for habitats supported by Suisun peaty muck soil type (Miller et al. 1993). Radio marked northern pintails did not remain within Suisun Marsh all winter. They started moving to the Delta in September, and had moved out of the Marsh to primarily the Sacramento Valley by December (Miller et al. 1993). Preliminary habitat use information also shows that during 1991 and 1992, northern pintail location in Suisun Marsh was limited to a small

geographic area in the northcentral marsh. Northern pintail showed a habitat preference for brass buttons while in Suisun Marsh, and appeared to avoid areas dominated by alkali bulrush (Casazza, Personal Communication, 1994).

Effective wetland management for waterfowl species in Suisun Marsh depends on a knowledge of habitats used, duration of use, and location. This information is being developed for northern pintail ducks and mallards in Suisun Marsh (Miller et al. 1993; McLandress, Personal communication 1994). It is important to consider the specific needs of other waterfowl and wildlife species for integrated ecosystem management in the Suisun Marsh. The refinement of habitat use information should be a focus of efforts to modernize future water management plans, and maximize salinity control in Suisun Marsh.

It is essential for marsh landowners to actively manage their wetlands, otherwise habitat quality will continue to decline. It is not possible to maintain high quality brackish wetland habitat on diked lands if the lands are only flooded during the brief waterfowl hunting season. The Department of Fish and Game recognizes the lack of active management by many landowners, and has endorsed the concept of a water master to provide more consistent and efficient water management practices critical for the long term maintenance of seasonally flooded wetlands (Herrgesell 1994). Data also show that a minority of private landowners actually implement their water management plans for soil salinity control. The majority of the landowners continue to flood only for hunting season. A key challenge which will provide the bridge between channel salinity conditions and quality habitat is to implement active water management on these diked seasonal wetlands.

The Department of Fish and Game, Suisun Resource Conservation District, Department of Water Resources, and Bureau of Reclamation have requested implementation of the Suisun Marsh Preservation Agreement. The water quality standards within this Agreement differ from D-1485 in that they allow for deficiency standards during prolonged dry periods. Implementation of SMPA standards in the western marsh would maintain of the natural salinity gradient which has been discussed in draft narrative standards proposed by EPA and SWRCB. Data generated from eight years of monitoring in the seasonal wetlands of Suisun Marsh indicate that current waterfowl habitat management objectives can be achieved with the implementation of the SMPA standards.

Diked Permanent Wetlands

A small percentage of diked waterfowl habitat is dedicated to permanent flooding. This habitat type is limited because of mosquito abatement regulations. The most critical ecological factor limiting the variety of plants in permanent ponds is the continuous state of inundation. Suisun Marsh is primarily a wintering area for waterfowl of the Pacific Flyway. Moist soil management in seasonal wetlands is preferable for providing food resources for wintering waterfowl. Shallow permanent ponds support local breeding mallards, and a variety of other wildlife species.

California Waterfowl Association and DFG initiated a Duck Stamp Project in 1985 to evaluate duck production, management, and the breeding biology of resident Suisun Marsh ducks. Radio telemetry studies were initiated in 1987 to monitor wetland use and survival of marked mallard hens and broods. Harvest of mallards on Grizzly Island has been directly correlated with local production (McLandress, Personal communication, 1994).

Diked permanent wetlands may be managed for waterfowl brood production. The significance of Suisun Marsh as a historic breeding area for waterfowl is unknown. The frequent lack of spring precipitation limits the stature of upland grasses necessary for nesting waterfowl cover. Brackish channel water salinity can also limit brood production. Studies from important waterfowl breeding areas in the Canadian provinces and northern prairies of the United States indicate that 50% of one to three day old ducklings die at water salinity of 17 mS, and others exhibited stunted growth at salinity ranges of 10 - 17 mS (McLandress, Personal communication 1994). D-1485 and SMPA normal year mean monthly high tide salinity standards during spring waterfowl breeding season range from 8 - 11 mS. This range approaches the impact level for breeding waterfowl. SMPA deficiency standards for the February - May season range from 12.5 - 15.6 mS. Channel water salinity standards developed for D-1485 and the SMPA were recommended by DFG to preserve quality wintering habitat for waterfowl. The development of these standards did not encompass the needs of brood production.

WETLAND HABITAT NOT INFLUENCED BY CHANNEL WATER SALINITY

Vernal Pools

Vernal pools are another type of natural, undiked seasonal wetlands present in the upland edges surrounding Suisun Marsh. Numerous plant and wildlife species have been observed in vernal pool complexes. Vernal pools are shallow, intermittently flooded wet meadows. They are generally dry most of the summer and fall. The water source for these ephemeral wetlands is precipitation. Vernal pools in the Suisun Marsh area are independent of tidal marsh channels and are not influenced by salinity standards.

SENSITIVE PLANT AND WILDLIFE RESOURCES OF SUISUN MARSH

Reference to protective status levels under the federal Endangered Species Act are defined as follows:

> Endangered Species: Any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of the Act would present an overwhelming and overriding risk to man.

Threatened Species: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The State of California has similar definitions for endangered and threatened species under the California Endangered Species Act of 1970. California law also designates a "rare" status for plants which is defined as follows:

Rare Species: A plant species which is "in such small numbers throughout its range that it may become endangered if its present environment worsens".

Where these terms are used, the state and/or federal status designations are cited.

This status report presents data regarding the distribution of seven avian, two mammal, two amphibian, one reptile, and thirteen plant species which were known or were suspected of potentially occurring in the Suisun Marsh area. These species and their protective status are detailed in Table 3. Of these 25 species, the salt marsh harvest mouse, California clapper rail, bald eagle, American peregrine falcon, Antioch dunes evening primrose, and Contra Costa wallflower are currently listed as endangered and are afforded federal and state protection under the Endangered Species Acts. Colusa grass is listed as endangered under the California Endangered Species Act, and is proposed for endangered listing by USFWS. Of the remaining federal candidate species, the California Black Rail and Tiburon paintbrush are listed as threatened by the California Department of Fish and Game. Mason's lilaeopsis and soft-haired bird's beak are state -listed rare plants.

There are 14 candidate species listed in Table 1 which do not hold legal protective status. However, candidate taxa are frequently evaluated in biological assessments because of their uncertain or potentially changeable status. Should any of these species become listed or be officially proposed for listing during the salinity standards' evaluation, they would also be subject to full biological assessment and the possible need for formal consultation.

A summary of sensitive plant and wildlife species known to Suisun Marsh (Table 3) which may be influenced by changes in estuarine salinity gradients resulting from proposed channel water salinity standards are shown in Table 4. Sensitive plant and wildlife species known to the Suisun Marsh or Solano County which are not likely to be affected by changes in estuarine salinity gradients resulting from proposed salinity standards are shown in Table 5.

TABLE 3. Special status and sensitive plant and wildlife species that may occur in the Suisun Marsh Area (USFWS, April 1994).

BIRDS

Common Name	Scientific Name	Federal Status	State Status
California clapper rail	*Rallus longirostrus obsoletus*	FE	CE
American peregrine falcon	*Falco peregrinus anatum*	FE	CE
Bald eagle	*Haliaeetus leucocephalus*	FE	CE
California black rail	*Laterallus jamaicensis coturniculus*	FC-2	CT
Ferruginous hawk	*Buteo regalis*	FC-2	CSC
Saltmarsh common yellowthroat	*Geothylpis trichos sinuosa*	FC-2	CSC
Suisun song sparrow	*Melospiza melodia maxillaris*	FC-2	CSC

MAMMALS

Common Name	Scientific Name	Federal Status	State Status
Salt marsh harvest mouse	*Reithrodontomys raviventris*	FE	CE
Suisun ornate shrew	*Sorex ornatus sinuosus*	FC-1	CSC

REPTILES AND AMPHIBIANS

Common Name	Scientific Name	Federal Status	State Status
Northwestern pond turtle	*Clemmys marmorata marmorata*	FC-2	CSC
California tiger salamander	*Ambystoma californiense*	FC-2 *	CSC
Western spadefoot toad	*Scaphiopus hammondi hammondi*	FC-2R	CSC

PLANTS

Common Name	Scientific Name	Federal Status	State Status
Mason's lilaeopsis	*Lilaeopsis masonii*	FC-2	CR
Soft-haired bird's beak	*Cordylanthus mollis ssp. mollis*	FC-1	CR
Antioch dunes evening primrose	*Oenothera deltoides ssp. howellii*	FE	CE
Contra Costa wallflower	*Erysimum capitatu ssp. angustatum*	FE	CE
Tiburon paintbrush	*Castilleja neglecta*	FPE	CT
Colusa grass	*Neostapfia colusana*	FPT	CE
Suisun Slough thistle	*Cirsium hydrophilum var. hydrophilum*	FC-1	CSC
Contra Costa goldfields	*Lasthenia conjugens*	FC-1	CSC
Hispid bird's beak	*Cordylanthus mollis ssp. hispidis*	FC-2	CSC
Delta tule pea	*Lathyrus jepsonii jepsonii*	FC -2	CSC
Suisun aster	*Aster chilensis var. lentus*	FC-2	CSC
Heartscale	*Atriplex Cordulata*	FC-2	
Legenere	*Legenere limosa*	FC-2	

FEDERAL STATUS

FE = Federal endangered
FT = Federal threatened
FPT = Federal proposed threatened
FPE = Federal proposed endangered
FC-1 = Federal Category 1 Candidate
FC-2 Federal Category 2 Candidate,

STATE STATUS

CE = California endangered
CT = Cailfornia threatened
CR = California rare
CSC = DFG Species of Special Concern (DFG, 1992)

TABLE 4. Sensitive plant and wildlife species known to Suisun Marsh which may be influenced by changes in estuarine salinity gradients resulting from proposed channel water salinity standards.

BIRDS Common Name	Occur in Freshwater Marshes	Occur in Brackish Marshes	Occur in Salt Marshes
California clapper rail		X	X
Suisun song sparrow		X	
MAMMALS Common Name			
Salt marsh harvest mouse		X	X
Suisun ornate shrew		X	X
PLANTS Common Name			
Mason's lilaeopsis	X	X	
Soft-haired bird's beak		X	X
Suisun Slough thistle		X	
Delta tule pea	X	X	
Suisun aster	X	X	

TABLE 5. Sensitive plant and wildlife species known to Suisun Marsh which are not likely to be influenced by changes in estuarine salinity gradients resulting from proposed channel water salinity standards.

BIRDS Common Name	Occur in Freshwater Marshes	Occur in Brackish Marshes	Occur in Salt Marshes	Not Present in Affected Habitats
American peregrine falcon	X	X	X	
Bald eagle				X *
California black rail	X	X	X	
Ferruginous hawk				X
Saltmarsh common yellowthroat	X	X	X	
REPTILES AND AMPHIBIANS Common Name				
Northwestern pond turtle	X	X	X	
California tiger salamander				X
Western spadefoot toad				X
PLANTS Common Name				
Antioch dunes evening primrose				X
Contra Costa wallflower				X
Tiburon paintbrush				X
Colusa grass				X
Contra Costa goldfields				X
Hispid bird's beak				X
Heartscale				X
Legenere				X

* Bald Eagles are very occasional, transient winter visitors to the Estuary (Harvey et al. 1992)

THREATENED OR ENDANGERED AVIAN SPECIES

Special status species distributions were assessed using several methods. Specialized intensive surveys of suitable habitat were conducted for the California clapper rail and California black rail. Methodologies for field surveys were developed in consultation with DFG, USFWS, and other species experts. Field data generated by Department of Fish and Game and Department of Water Resources were supplemented with information from local Audubon Society bird counts and the literature.

American Peregrine Falcon,
Falco peregrinus anatum

Status

The American peregrine falcon is listed as endangered by both the USFWS and CDFG (USFWS 1984; CDFG 1982).

Habitat Requirements

Typical peregrine falcon nesting habitat is a cliff face. However, peregrines have been known to occasionally nest on slopes, river cutbanks, sand dunes, hollows of large trees, and tall man-made structures.

The primary requirement for wintering habitat appears to be the availability of an adequate food supply. These falcons prey on passerine birds, waterfowl, and shorebirds. Winter foraging habitat for the species is present along tidal sloughs and in the seasonal wetlands of the Suisun Marsh area, where waterfowl are present in high densities during the October through May salinity control season.

Distribution

The American peregrine falcon (*Falco peregrinus anatum*) is one of three subspecies of peregrine falcon found in North America. Peale's peregrine is found along the coastline of British Columbia and Alaska and in the Aleutian Islands and Queen Charlotte Islands. The Arctic peregrine is found in northern Alaska and across the Canadian tundra. The American peregrine is distributed throughout the rest of North America (Snow, 1972).

Observations of peregrine falcons can be expected throughout California, but the Sacramento - San Joaquin Delta and Suisun Marsh are used only irregularly by small numbers of these sensitive raptors. While breeding birds are typically residents, other birds from more northerly breeding populations either pass through the estuary during migrations, or may reside here only in winter.

In 1946, approximately 100 breeding pairs of peregrine falcons were resident to California (Snow 1972). A decline in nesting success attributed to the effects of organochlorine pesticides such as DDT reduced California nesting pairs to less than 10 by 1969. Currently, there are estimated to be about 50 breeding pairs in California.

The San Francisco Bay - Delta estuary harbors an estimated 10 to 20 wintering American peregrine falcons. There are four nesting pairs known to central San Francisco, San Pablo, and Suisun Bays; however, as of January 1992 none of these pairs were successfully reproducing (Harvey, T.E. et al 1992). The project area includes winter forage habitat for peregrine falcons. The Benicia count circle of the Napa - Solano Audubon Society's annual Christmas bird count includes the project area of impact, and peregrine falcons have been observed in December of 1986, 1989, 1991, 1992, and 1993 (Leong 1994).

Habitat Salinity Conditions

The proposed salinity standards are not expected to result in a loss of habitat for the peregrine falcon. No nesting areas would be affected, and no winter foraging habitat would be lost or altered. One intended purpose of the maintenance of salinity standards is to provide water of adequate quality to maintain seasonal wetland habitat to maintain the total number and density of available avian prey species in the marsh. This could be viewed as a benefit to peregrine falcons.

Bald Eagle
Haliaeetus leucocephalus

Status

The bald eagle is listed as endangered by both the USFWS and DFG. Removal of this species from the federal endangered list is under consideration by USFWS.

Habitat Requirements

Bald eagles are opportunistic foragers which prey on fish, waterfowl, small mammals, and invertebrates. They also scavenge on carrion. The species nests at inland sites in northern California in tall, live trees near shorelines of lakes and reservoirs. The species is a rare, localized winter resident near the northern and eastern periphery of the Estuary (Harvey, et al. 1992). The USFWS recovery plan for the bald eagle stresses the importance of preserving wetlands that produce fish and waterfowl for eagles to feed upon, and of protecting individual trees that eagles use for nesting and roosting. Large, open trees for perch sites and night roosts are important habitat elements for this bird.

Distribution

Bald eagles have not been seen by Department of Water Resources survey teams in Suisun Marsh. There are two records of bald eagles on Benicia Christmas bird counts. These birds were observed in 1989 and 1990 (Leong, Personal Communication, 1994). The are no documented records of wintering bald eagles on the flooded Sacramento - San Joaquin Delta islands. The rare occurrence of wintering bald eagles in the Suisun Marsh and Delta areas may be related to the lack of perch trees.

Habitat Salinity Conditions

There is no regular use of the Suisun Marsh or Delta regions of the Estuary by bald eagles. Therefore, proposed changes to estuarine salinity standards are not expected to impact the species.

California Clapper Rail,
Rallus longirostris obsoletus

Status

The California clapper rail (*Rallus longirostris obsoletus*) is listed as an endangered species under both the state and federal endangered species acts. California clapper rails were historically abundant in tidal marshes of the Estuary (Grinnell 1915). Between 1850 and 1913, sport and market hunting depleted California clapper rail populations. Populations showed some recovery after hunting this species was prohibited in 1913 (USFWS 1984). DeGroot (1927) reported that clapper rail numbers were fairly common in the northern half of the Bay region, but declined around the turn of the century when tidal marsh was drained for agricultural and industrial development. The recent precipitous decline of the population is due to loss and degradation of tidal marsh habitat.

The total California clapper rail population in the 1970's was estimated at 4,200 to 6,000 individuals (Gill, 1979). More resent surveys conducted in the 1980's suggest a decline to about 1,500 individuals (Harvey, 1988). Recent studies estimate the total San Francisco Bay population to be 700 individuals, with 200 - 300 rails in the north Bay and Suisun Marsh (Foerster 1989). The Estuary rail population was estimated at an all time low of about 500 birds in 1991 (USFWS memo to USBR, 1994). The dramatic population increase of introduced red foxes in the Estuary is directly related to the current decline of rail populations (Foerster, et al. 1990). The north Bay and Suisun Marsh population was recently estimated at 195 - 422 pairs (Evens and Collins, 1992). A very rough estimate of the Suisun Marsh population, based on pairs detected by DWR/DFG in the 1993 breeding season was 50 individuals. This subspecies is believed to be on the verge of extinction (Harvey et al. 1992).

Habitat Requirements

California clapper rails are secretive, nonmigratory residents of undiked tidal salt and brackish marshes which are patterned with tidal creeks and sloughs. Foraging habitat of California clapper rails around the Estuary includes low tide exposed mudflats and sloping banks of tidal creeks, sloughs, or shorelines. They also forage in adjacent salt marsh vegetation including pickleweed, cordgrass, and bulrush; or brackish emergent marsh vegetation including bulrushes, sedges, baltic rush, and gumplant. Clapper rails also forage in high marsh zones dominated by halophytic vegetation such as pickleweed, fleshy jaumea, salt grass, and alkali heath. This high marsh community also provides cover and refuge during winter flood tides (USFWS 1984).
The diet of clapper rails includes invertebrates and mollusks including worms, snails, crabs, mussels, clams, insects, and spiders; and occasional plant material (Willliams, 1929; Moffitt 1941). They have also been known to take small mammals such as salt marsh harvest mice (Josselyn

1983).

Breeding habitat for California clapper rails is concentrated along tidal creeks. Nesting areas show a long history of repeated use. Preferred nest sites are in dense cover near water, and built well above the high tide mark. Flotation nests attached to cordgrass move up and down with the tidal flux. Many nests are built with a concealment canopy of vegetation, and ramps of vegetation leading up to the nest are sometimes present. Clapper rails also nest in pickleweed and at the base of gumplant (DeGroot 1927; Wilbur and Tomlinson, 1976; Gill 1979). Nest sites in North Bay marshes are primarily constructed from alkali bulrush (Collins and Evens 1994).

Historic Distribution

The California clapper rail subspecies was historically known to tidal marshes of the California coast from Humboldt Bay to Morro Bay, and to estuarine marshes of San Francisco Bay and San Pablo Bay to the Carquinez Strait. Since historical times, the highest population densities and optimal habitat have been in South San Francisco Bay. Resident California clapper rail populations are now limited to San Francisco Bay, San Pablo Bay, and Suisun Bay and tidal marshes associated with estuarine sloughs draining into these bays. Clapper rails are occasional visitors to Elkhorn Slough at Moss Landing, Tomales Bay marshes, and Bolinas Lagoon.

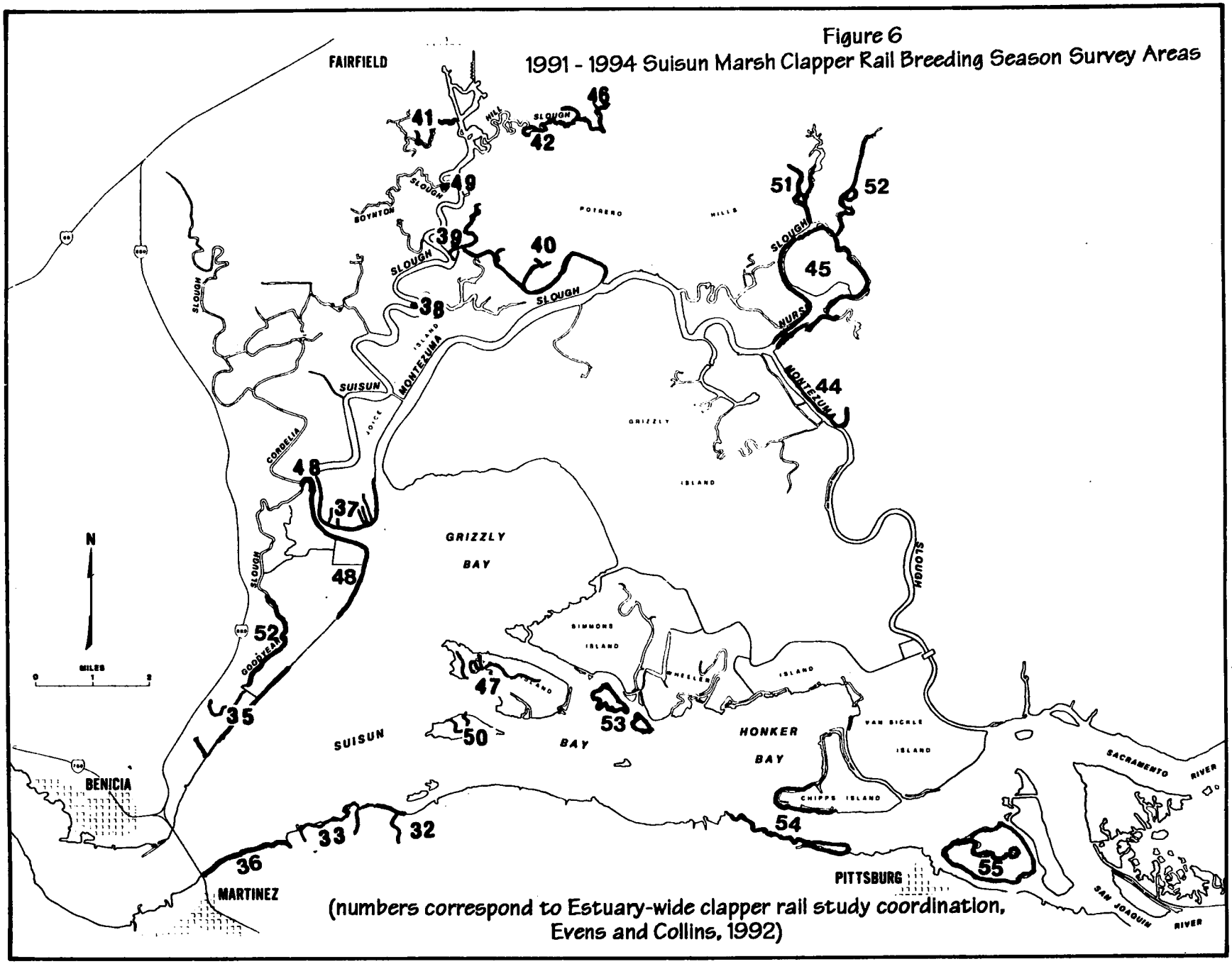
Suisun Marsh Clapper Rail Surveys

Adequate census for presence of this secretive species presents a challenge to the most experienced field ornithologist. Species accounts in the literature show a disjunct distribution that fluctuates widely from year to year. Annual clapper rail surveys are necessary to track the status and distribution of the species.

Breeding season censuses of California clapper rails were conducted throughout the undiked tidal marshes of Suisun Marsh in 1991, 1992, 1993, and 1994. The primary objective was to survey all areas of potential habitat for the presence of this elusive, rare bird; rather than to obtain accurate population size estimates. Survey season varied yearly between the months of February through May, depending on breeding season conditions. Censuses were conducted on low to medium tides ($\leq$3.0' above MLLW) because clapper rails call with greater frequency under these conditions (Zembal and Massey, 1987). Most surveys were conducted from shallow draft boats which provided access to the larger contiguous tidal marshes, and fringing marshes which are bordered by inaccessible private levee roads. Fixed listening stations within publically owned marshes were also established.

Study areas were selected based on the presence of undiked tidal marsh habitat (Figure 6). Nineteen study areas were censused in 1991; 1992 breeding season census was extended to 25 study areas; 1993 surveys covered 15 study areas; and the 1994 breeding season survey included 16 study areas. Study area numbers used in this report were selected in coordination with other

Figure 6
1991 - 1994 Suisun Marsh Clapper Rail Breeding Season Survey Areas



(numbers correspond to Estuary-wide clapper rail study coordination, Evens and Collins, 1992)

research efforts on this species in the North Bay region (Evens and Collins, 1992). Each study area encompassed a series of listening stations. Census stations were spaced approximately 200 meters apart. Each census station covered a circular area with a census radius of 100 m, thus covering an area of 3.4 hectares. The number of census stations per study area ranged from 2 to 33 depending on study area size and channel morphology.

Boat surveys were all conducted from two hours before sunrise until two hours after sunrise. A limited number of fixed listening stations accessed by land were censused one hour before sunrise until one hour after sunrise; and one hour before sunset until well after dark. Electric trawling motors were used to move quietly between census stations. Census protocol was to first listen quietly for spontaneous calls. If calls were not heard within 5 minutes, an audio tape recording of clapper rail calls (clapper, kek, and ked-burr) was played for one minute at 50 to 60 decibels to elicit a response. Tape player output was calibrated with a hand held sound level meter. Taped calls were not used when terrestrial or avian rail predators were observed at listening stations. Predators observed included northern harriers, barn owls, short-eared owls, raccoons, and feral cats. Coyotes were also observed in the high marsh zones. Clapper rails were identified by 7 different vocalizations. The functional significance of each call type was assumed to be the same as that of the light-footed clapper rail (Massey and Zembel; Zembel and Massey 1987).
The location, type, and time of every vocalization or direct observation of a rail were recorded. Detections of rail pairs were plotted on aerial photographs in the field. Other species of birds present, and associated vegetation were also recorded. All observed tracks were measured and recorded. At the end of each census, the minimum and maximum number of rails detected in the study area were estimated based on the distribution of plotted calls. Repeat surveys were conducted through the breeding season. A coefficient of variation was estimated for study sites where the same listening stations were covered at least twice and where at least one rail was detected on each visit. The average of these coefficients compared with other survey evaluations in the northern reaches of the Estuary (Collins, et al. 1994). Two or more censuses conducted during the same breeding season can differ by about 25%. The estimate of precision is based on a very small sample size. However, these data reinforce the importance of repeat coverage of survey areas to determine presence of the species.

Presence of Clapper Rails in Suisun Marsh

The historical distribution of California clapper rail was restricted to tidal marshes downstream of Suisun Marsh. Grinnell and Miller (1944) reported a recolonization of former clapper rail habitat in tidal marshes of Marin, Sonoma, Napa, Contra Costa, and extreme western Solano counties. Grinnell and Miller felt the upstream limit of the Clapper rail's range was the Carquinez Strait (1944). The first record of the extension of this range into Suisun Marsh was recorded at Cutoff Slough in December 1978 (Harvey 1980). Harvey (1980) estimated a population of 25 individuals in the tidal marshes associated with Cutoff Slough. Nine clapper rails were heard December 22, 1987, in these Cutoff Slough marshes (NDDB).

All confirmed locations of clapper rails within Suisun Marsh and Suisun Bay tidal marshes since the 1984 Plan of Protection are shown in Figure 7. The San Francisco Bay Bird Observatory (SFBBO) conducted a clapper rail study throughout the Estuary in 1983 - 1986 (SFBBO 1987). Areas surveyed by SFBBO included the tidal marsh at the lower end of Joice Island, Cutoff Slough, First Mallard Branch, Second Mallard Branch, Hill Slough from Suisun Slough to McCoy Creek, Peytonia Slough, and Sheldrake Slough. Two clapper rails were detected at the upper end of First Mallard Branch, and clapper rails were not detected in the other survey areas (SFBBO, 1987). The presence of clapper rails at the Concord Naval Weapons Station was confirmed in 1986 (O'Neil 1988).

Clapper rail surveys conducted by the DWR/DFG teams have determined the presence of rails in tidal marshes associated with Hill Slough; Cutoff Slough or Rush Ranch; fringe tidal marshes fronting Suisun Slough from Goodyear Slough to Suisun Bay; fringe tidal marshes along the Suisun Bay shoreline at the Suisun Marsh Reserve Fleet; Ryer Island; and Point Edith Marsh on the Contra Costa shoreline.

Breeding season surveys conducted by Grewell (DWR) and Briden (DFG) in 1991 detected clapper rails at the mouth of Boynton Slough, Cutoff Slough, First Mallard Branch. Clapper rails were also detected along Cutoff Slough and at the Suisun Marsh Reserve Fleet during the December Christmas bird count (Leong, 1993).

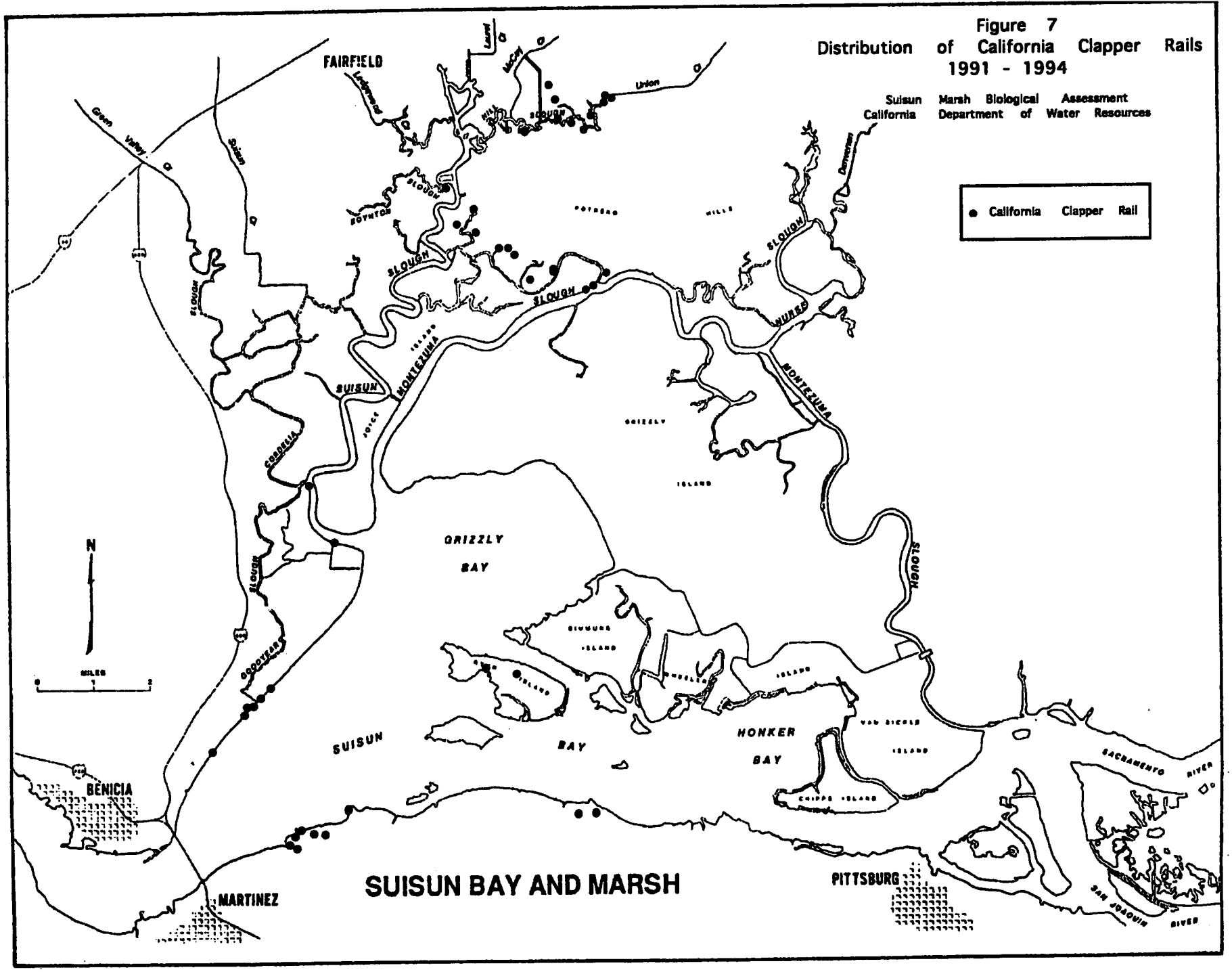
On February 27, 1992, Grewell (DWR) and Briden (DFG) detected clapper rails for the first time on a canoe survey of the Hill SLough tidal marsh near Union Creek. Clapper rails were also recorded in this area on April 2 and May 5, 1992 by Grewell (DWR) and Hagen (DFG). Clapper rails were observed at the Reserve Fleet marsh at Bahia on March 27 and 31, 1992. A single clapper rail was heard during a summer vegetation survey on Ryer Island. No clapper rails were detected in the Cutoff Slough tidal marshes during the 1992 breeding season. Other areas surveyed with no detections included Peytonia SLough, Luco Slough, Nurse Slough, Denverton Slough, Browns Island, Chipps Island, Mallard Island, Freeman Island, Snag Island, Roe Island, Lingos Landing/Kirby Hill SLough, and Hastings SLough.

Evens and Collins (1992) detected clapper rails in the Bahia area of Suisun Marsh shoreline at the Suisun Marsh Reserve Fleet ("mothball fleet"), and at Pt. Edith Marsh on the Contra Costa shoreline. These records were independent of, but in agreement with DWR/DFG survey results. Evens and Collins also experienced no detections at Luco Slough, Nurse SLough, Lingos Landing, and the mouth of Montezuma Slough. It is assumed that channel water salnity in these areas is too fresh for clapper rails.

During the 1993 breeding season, Grewell (DWR) and Hagen (DFG) detected clapper rails at Point Edith Marsh, Reserve Fleet marsh at Bahia, Cutoff Slough/First Mallard Branch, Cutoff Slough/Second Mallard Branch, Hill Slough/McCoy Creek, and Hill Slough/Union Creek. Clapper rail was also heard at Ryer Island, Point Edith Marsh, Reserve Fleet at Bahia, and Hill

Figure 7
Distribution of California Clapper Rails
1991 - 1994

Suisun Marsh Biological Assessment
California Department of Water Resources



Slough/Union Creek during December 1993 surveys.

Surveys in 1994 by Grewell (DWR) and Hagen (DFG) detected clapper rails at Point Edith Marsh, Reserve Fleet Marsh at Bahia, Cutoff Slough/Second Mallard Branch, Hill Slough/McCoy Creek, and in a fringe marsh along Suisun Slough at Morrow Island.

Sporadic breeding season occurrences suggest that post-breeding seasonal dispersal of clapper rails has been sufficient to establish pioneering pairs upstream from population centers in the more saline reaches of the Estuary (Collins, et al. 1994). Incidental sightings of clapper rails in late summer along Suisun Slough fringe marshes are likely juvenile birds dispersing from breeding territories.

Estuary-Wide Distribution of Clapper Rails

Figure 8 illustrates all known locations of California clapper rails in the Estuary (NDDB 1994; Collins, et al. 1994; Evens and Collins, 1993; Foerster et al. 1990; WESCO 1989; O'Neil, 1988; SFBBO 1987). Clapper rails are known to South San Francisco Bay, Richardson Bay, Corte Madera Ecological Preserve, Muzzi Marsh, San Clemente Creek, tidal marshes associated with the Petaluma and Napa Rivers, Sonoma Creek, Gallinas and Novato Creek, San Pablo Bay shoreline fringe marshes, Southhampton Marsh in the Carquinez Strait, and the described locations in Suisun Marsh.

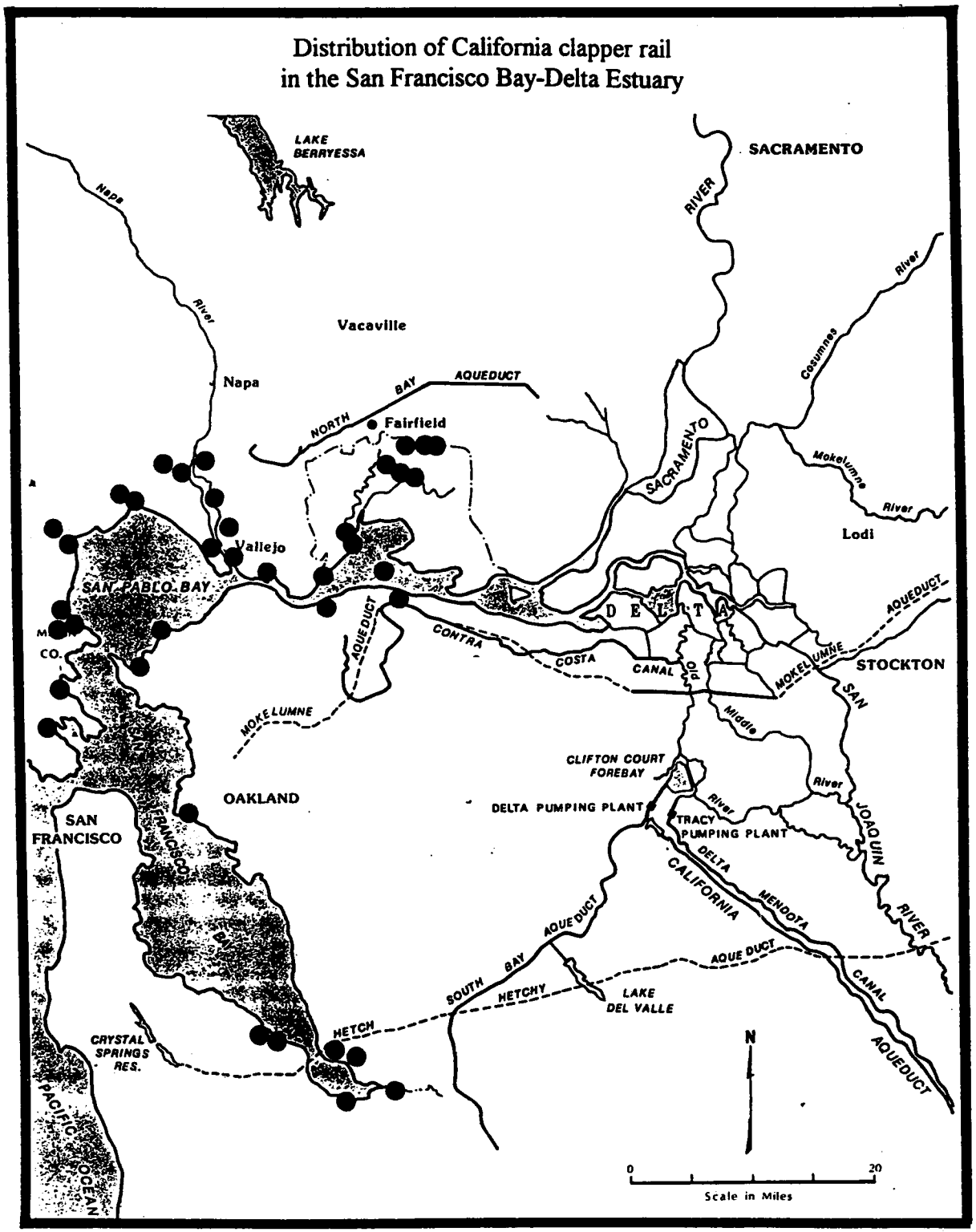
Habitat Salinity Conditions

Gill (1979) predicted that an extension of the clapper rail's range into Suisun Marsh might result from the continuing diversion of freshwater otflow and the concurrent increase in the salinity of Suisun Bay and its marshlands. Clapper rails are associated with tall emergent monocot vegetation throughout the Estuary. Cordgrass (*Spartina foliosa*) is present in the more saline marshes associated with the species. The upstream progression of cordgrass in the Estuary has been reported by Josselyn (1992) and Collins and Foin (1993). The species is associated with alkali bulrush (*Scirpus robustus*) in the more brackish wetlands associated with the Napa River and the Suisun Bay shorelines at Point Edith and at the Suisun Marsh Reserve Fleet. Napa Marsh nests were constructed of alkali bulrush (Evens and Collins 1992). Nest searches were not conducted in the DWR/DFG surveys, but clapper rail detections were associated with a range of brackish marsh vegetation including alkali bulrush, gumplant, pickleweed, hardstem bulrush, California bulrush, and (*Carex lyngbyei).*

The presence and density of clapper rails in the Estuary is highly variable from year to year at many study sites. The data suggest that a density of birds decreases with distance upstream from the Golden Gate (Evens and Collins 1992).

The presence of clapper rails in Suisun Marsh; and in brackish reaches of Alviso Creek and the

Figure 8


Distribution of California clapper rail
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
SACRAMENTO
RIVER
Napa
River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
Cosumnes River
SACRAMENTO
Mokelumne River
Lodi
Vallejo
SAN PABLO BAY
AQUEDUCT
CONTRA COSTA CANAL
D E L T A
AQUEDUCT
STOCKTON
MOKELUMNE
SAN
Middle
MOKELUMNE
CLIFTON COURT FOREBAY
River
OAKLAND
DELTA PUMPING PLANT
TRACY PUMPING PLANT
JOAQUIN
SAN FRANCISCO
DELTA
CALIFORNIA
MENDOTA
RIVER
AQUE DUCT
SOUTH BAY
AQUE DUCT
HETCHY
LAKE DEL VALLE
CANAL
HETCH
CRYSTAL SPRINGS RES.
AQUEDUCT
PACIFIC OCEAN
N
0
20
Scale in Miles

Napa River indicate a tolerance for brackish salinity regimes, although population densities are not high in these habitats. The movement of clapper rails into brackish reaches of Suisun Marsh may reflect extreme predation pressures and loss of habitat downstream in more saline reaches of the Estuary. The maintenance of these small populations which have adapted to brackish marsh conditions may be important to the long term survival and genetic variability of the species.

Alkali bulrush stands in undiked brackish tidal marshes have provided nesting material and cover for clapper rail. Suisun Marsh channel water salinity standards were developed from the growth requirements of alkali bulrush in diked seasonal marshes, where it is believed to be an important waterfowl food. Alkali bulrush also occurs naturally within undiked tidal marshes of the western Suisun Marsh and the Napa Marshes.

Collins and Foin (1993) mapped the distribution of cordgrass and alkali bulrush From San Pablo Bay through western Suisun Marsh. Alkali bulrush is an important component of the breeding habitat of clapper rails in brackish marshes of the Estuary. Alkali bulrush replaces cordgrass along the fringing marsh at the Carquinez Strait (Collins and Foin, 1993). The distribution of alkali bulrush along undiked tidal marshes associated with Suisun Bay and Suisun Marsh has also been recorded in vegetation surveys conducted as part of the Assessment for the SWRCB. Alkali bulrush in these tidal marshes is directly influenced by the channel water salinity experienced through normal tidal cycles throughout the year. It is not subject to the water management constraints imposed by a seasonal wetland management plan. The observed distribution of alkali bulrush along the bayshores and tidal sloughs indicates the salinity tolerance of the species may be greater than earlier studies suggest. The plant has been mapped around the western end of Roe Island. Alkali bulrush extends along the Contra Costa shoreline to the Concord Naval Weapons Station. It is dominant in the Point Edith Marsh. Alkali bulrush is also very prevalent along the Suisun Bay shoreline at the Suisun Marsh Reserve Fleet near Bahia.

Channel water salinity in these regions is recorded at the Suisun Bay at Martinez (MTZ) and Goodyear Slough at Morrow Island (S-35) recording stations. Salinity at these stations brackets the salinity range recorded in the areas obsrved with extensive alkali bulrush stands in the tidal marshes. Salinity trends recorded as specific conductance at these stations were from 3,642 - 30, 758 mS in water year 1991; 3,674 - 31,690 mS in water year 1992; and 275 - 32,327 mS in 1993(Table 2). D-1485 and SMPA deficiency standards are not proposed for the Martinez station. An evaluation of progressive mean monthly high tide salinity at the Goodyear Slough at Morrow Island station has been evaluated for the 1984 - 1992 water years at the request of SWRCB (DWR 1994). Compliance standards were not in place at this southwestern marsh station during this time period. Salinity recorded at the station was within future D-1485 target objectives for the site in wet water years, and years following above normal precipitation. During prolonged dry periods and critical water years, salinity often exceeded future target D-1485 and SMPA Deficiency standards (DWR 1994). It is important to note that alkali bulrush was very prevalent in the southwestern Marsh tidal marshes during this time period, and the plants produced seed.

A marshwide aerial survey is conducted in Suisun Marsh every three years. Vegetation distribution was determined by DFG from the 1991 aerial photographs and supplemental ground-truthing surveys. National Biological Survey and California Waterfowl Association biologists entered these data into a GIS system for comparison with northern pintail habitat use in Suisun Marsh. Figure 9 shows the distribution of alkali bulrush recorded in this 1991 survey (Cassazza, 1994). Alkali bulrush was more prevalent in managed marshes of the western Suisun Marsh than in the eastern Marsh. This distribution in the seasonal wetlands has much to do with implementation of water management regimes. The seasonal marshes with the highest occurrence of alkali bulrush were flooded from channels with the highest salinity recorded in Suisun Marsh. This applied water quality often exceeded future D-1485 and SMPA deficiency standards.

These data suggest that SMPA deficiency standards or their exceedance are not likely to limit the distribtution of California clapper rails. These data also suggest that implementation of SMPA deficiency standards in the southwestern marsh should not be limiting to waterfowl food production, if alkali bulrush production continues to be a management goal. The channel water which is diverted onto these seasonal wetlands is the the same channel water which provides natural tidal flow to the undiked fringing marshes in the western Marsh.

Alkali bulrush is displaced by California bulrush (Scirpus californicus) and hardstem bulrush (Scirpus acutus) upstream along Suisun Bay, and in the interior sloughs of eastern and central Suisun Marsh. Alkali bulrush is present, but not prolithic in the Cutoff Slough and Hill Slough tidal marshes. Clapper rails in Cutoff Slough (Rush Ranch) are found in California bulrush and hardstem bulrush vegetation which grades to gumplant, pickleweed, and saltgrass in the high marsh zones. Clapper rails in the Hill Slough marshes are utilizing areas with hardstem bulrush, gumplant, baltic rush, and sedge which also grade to pickleweed and saltgrass in the high marsh zones.

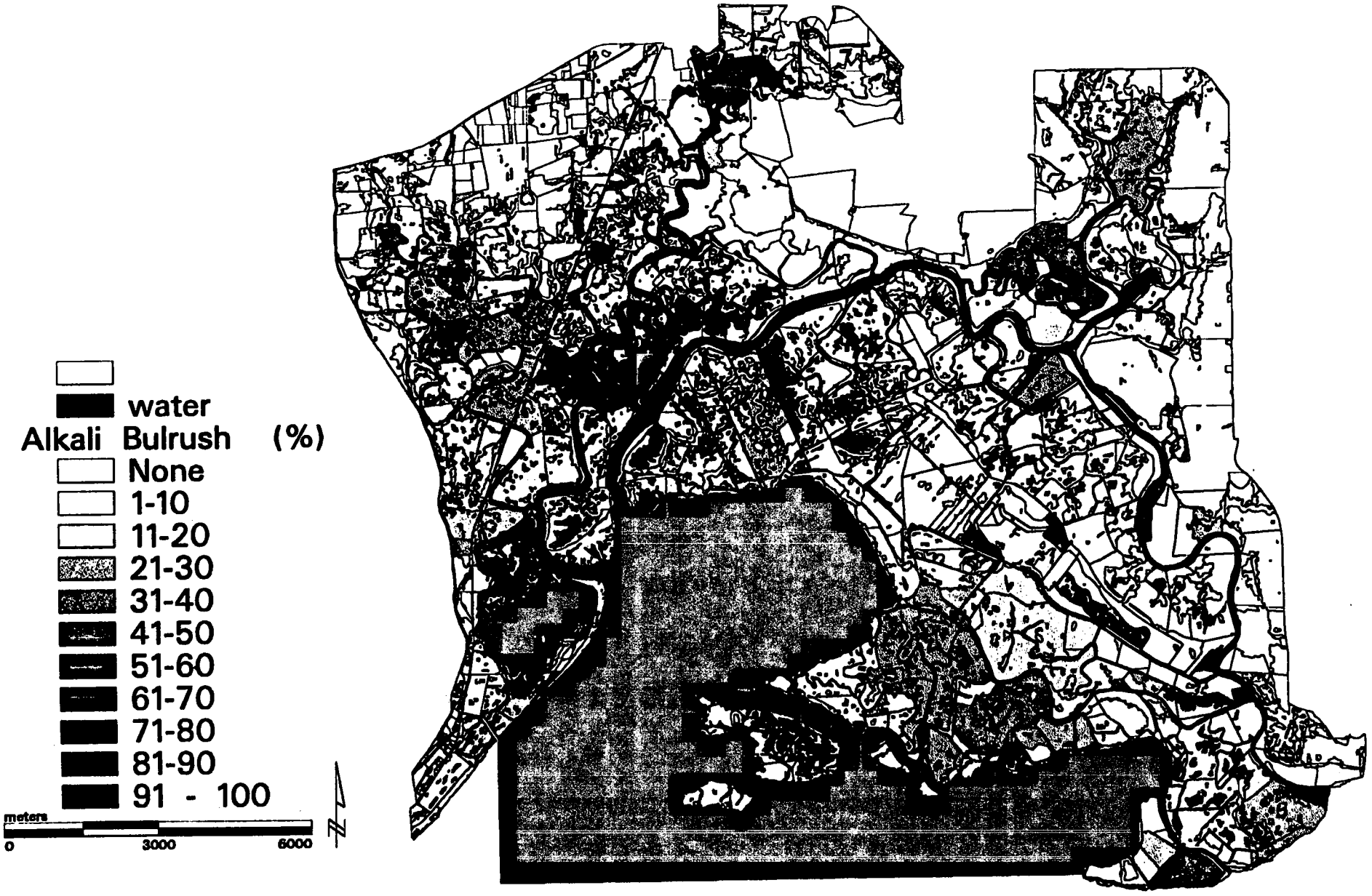
Channel water salinity in the northcentral and northeastern Suisun Marsh is influenced by operation of the Suisun Marsh Salinity Control Gates. Clapper rail populations in these marshes have experienced brackish salinity regimes which approach and slightly exceed D-1485 target objectives (DWR 1994). These marshes also receive seasonal freshwater inflows from McCoy Creek and Union Creek. Clapper rail presence in these areas suggest that the species may be somewhat tolerant of brackish salinity regimes. Population densities at this extreme upstream edge of the species range may fluctuate widely depending on yearly salinity ranges and the related available food resources.

The Department of Water Resources and Bureau of Reclamation are evaluating flow augmentation as a salinity control method in the western Marsh to comply with SWRCB mandated salinity standards. These flow augmentations are a component of the Western Salinity Control Test (DWR and USBR, 1993). The response to a request of U.S. Fish and Wildlife Service for informal consultation and approval of the 1994 Western Suisun Marsh Salinity Control Test included a discussion of the relevance and impacts of D-1485 salinity standards for maintaining appropriate fish and wildlife habitat in the western Suisun Marsh (USFWS 1994).

Figure 9

Distribution of Alkali Bulrush in the Suisun Marsh, 1991

(Casazza, 1994)



Original submittal to SWRCB: Color Graphic. Some detail may be lost in black and white reproduction.

The consultation concluded that the D-1485 salinity standards for the western marsh were designed to guarantee freshwater flows that would reduce salinity and enhance the physical environment for waterfowl food plants. The Service further stated that the salinity standards did not enhance the physical environment for salt tolerant species used by the federally listed salt marsh harvest mouse. Furthermore, the Service stated that long term maintenance of the D-1485 salinity standards may decrease or eliminate suitable tidal marsh habitat for federally-listed species, such as California clapper rails, thus perpetuating their decline (USFWS 1994).

California Black Rail,
Laterallus jamaicensis coturniculus

Status

The California black rail (*Laterallus jamaicensis coturniculus*) was listed as threatened by the California Department of Fish and Game in 1985, and is a category 1 candidate species under review for listing by the U.S. Fish and Wildlife Service (USFWS 1989).

Habitat Requirements

The California black rail is a slate-colored, sparrow-sized rail with white specks on its back a chestnut-colored nape. It is the most elusive North American rail, spending most of its life in rodent tunnels under dense marsh vegetation. Black rails utilize undiked tidal marshes which include a high marsh elevational zone. They are critically dependent on the narrow upper peripheral halophyte zone above the area of extreme and frequent tidal action where insect abundances are greatest (Evens et al. 1992).

Black rail habitat data collected in eight tidal marsh systems in the San Francisco Bay - Delta Estuary identified four variables that correspond with California black rail presence or absence 75 percent of the time: vegetation height, presence of *Frankenia salina* (alkali heath), presence of insects, and absence of amphipods (Evens et al. 1986). These variables suggest that marsh elevation, freshwater inflow, and tidal regime may be variables that control the occurrence of black rails in wetlands. Escape cover is critical to black rails. The presence of vegetation at the high marsh - upland ecotone provides additional cover during extreme high tides. Occurrence of black rails in Suisun Marsh is highly correlated with the presence of a pickleweed - alkali heath - American bulrush plant association in the high marsh zone (Grewell, 1992).

Distribution

The California black rail is believed to have occurred historically from Tomales Bay in Marin County, south along the coast into northern Baja California, and in the inland marshes of San Francisco Bay, the Sacramento-San Joaquin Delta, the San Bernadino-Riverside area, and along the lower Colorado River and the Salton Sea (Steinhart 1990). Throughout its range the species is known to inhabit tidal salt, brackish, and freshwater marshes. Loss, conversion, and fragmentation of natural tidal marshes has reduced the historic habitat of California black rails (Evens, et al 1989).

Highest densities of breeding black rails occur in the larger undiked tidal marshes associated with the Petaluma and Napa Rivers, and in some bayshore marshes of San Pablo Bay. Elsewhere in

San Pablo Bay, Suisun Bay, Suisun Marsh, and the Delta the distribution of the species in patchy due to habitat loss and fragmentation (Evens, et al 1989).

In breeding season, the secretive rail is almost never seen. Vocalizations are recorded to confirm presence of the species. The fact that no vocalizations are heard does not mean that no birds are presence. The birds are most vocal at night, dawn, and dusk; but some spontaneous vocalizations have also been heard in mid-day.

Black rail distribution throughout the San Francisco Bay estuary upstream to the Delta has been reported from 1986 - 1988 breeding season surveys by the Point Reyes Bird Observatory (Evens et al 1989). Breeding season surveys for California black rails within Suisun Marsh conducted by Department of Water Resources and Department of Fish and Game biologists in the 1991, 1992, 1993, and 1994 breeding seasons closely match the distribution observed in the historic surveys.

Breeding populations of California black rails are present in the Suisun Marsh (Figure 10). California black rails have also been detected during winter census, indicating year round presence in the marsh. Black rail presence has been confirmed by call in the Lower Joice Island tidal marsh, and a small tidal marsh adjacent to the downstream end of Goodyear Slough (Figure 10). Suitable habitat for this species is extremely limited and fragmented in the western Suisun Marsh. The majority of the remaining tidal marsh habitat in the study area is restricted to fringe marsh on the outboard side of levees. There are larger populations of breeding black rails in the more extensive tidal marshes associated with Cutoff Slough, Peytonia Slough, and Hill Slough in northeastern Suisun Marsh; and on Ryer Island, Roe Island, and the Suisun bayshore marshes of Contra Costa County.

California black rails are also present in freshwater marshes of the Sacramento - San Joaquin Delta (Figure 11). There is a scattered distribution of the species on mid-river bench islands (elongated, planar, high marshlands) throughout the Delta. Given the scarcity of such habitat, the population is thought to be small. California black rails are known to tidal *Scirpus/Typha* wetlands at the White Slough Wildlife Area near the headwaters of White Slough (NDDB 1994). They are also specifically known to the bench islands at the Little Potato Slough/White Slough confluence (ECOS 1990b). Small populations of black rails are also known to the bench islands of Middle River (near Bacon, Woodward, and Mildred Islands) and to Old River east of Holland Tract and Palm Tract (NDDB 1994).

California black rails are known to the tidal marshes associated with the Napa River and San Pablo Bay (Figure 11). At least 80% of the remaining population of California black rails is confined to the northern reaches of the Estuary, especially the tidal marshlands associated with San Pablo Bay and associated rivers (Evens, et al. 1992). Black rails have been documented in the Corte Madera Marsh, Palo Alto Baylands, and at San Francisco Bay National Wildlife Refuge tidal marshes at the southern end of San Francisco Bay (NDDB 1994).

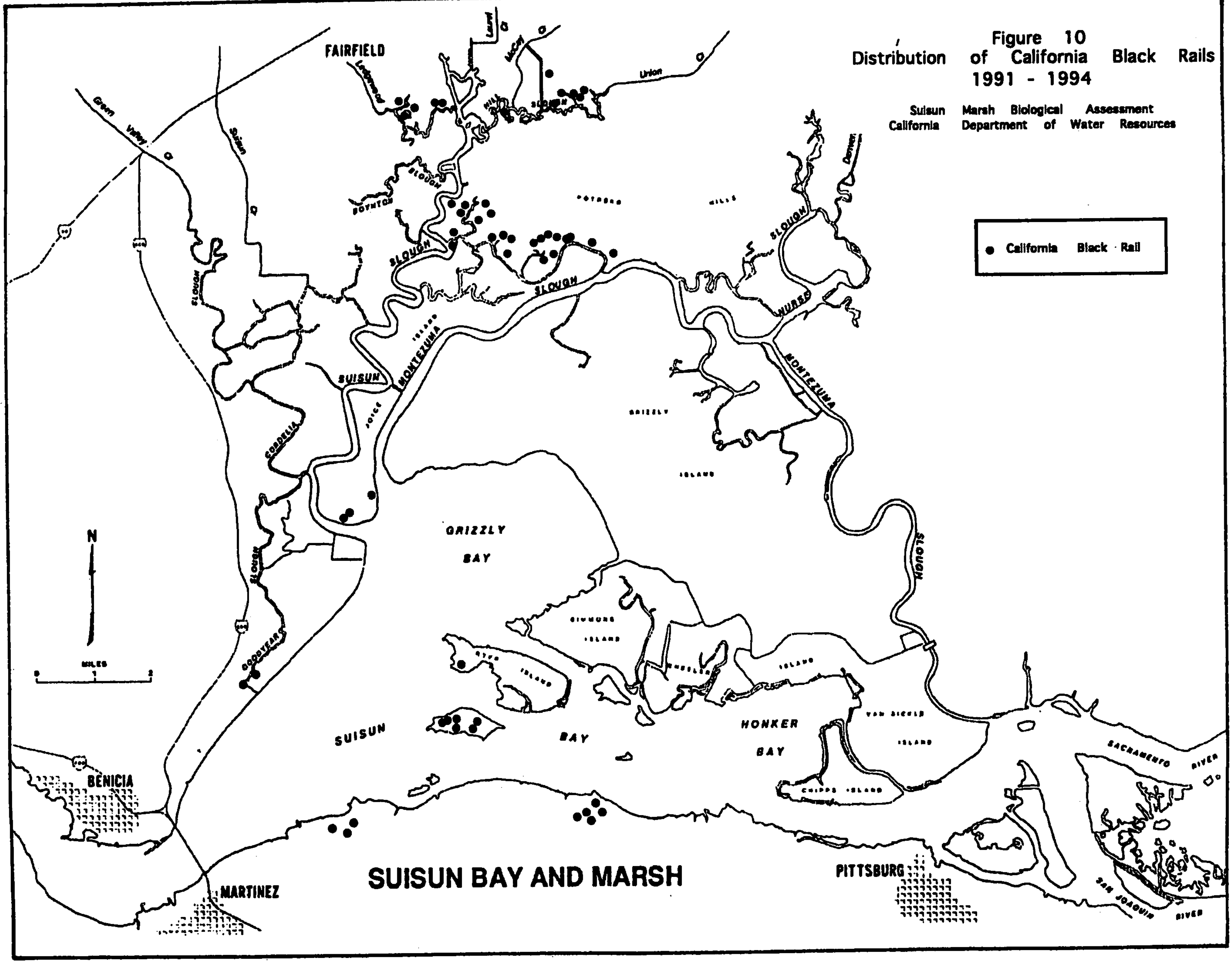
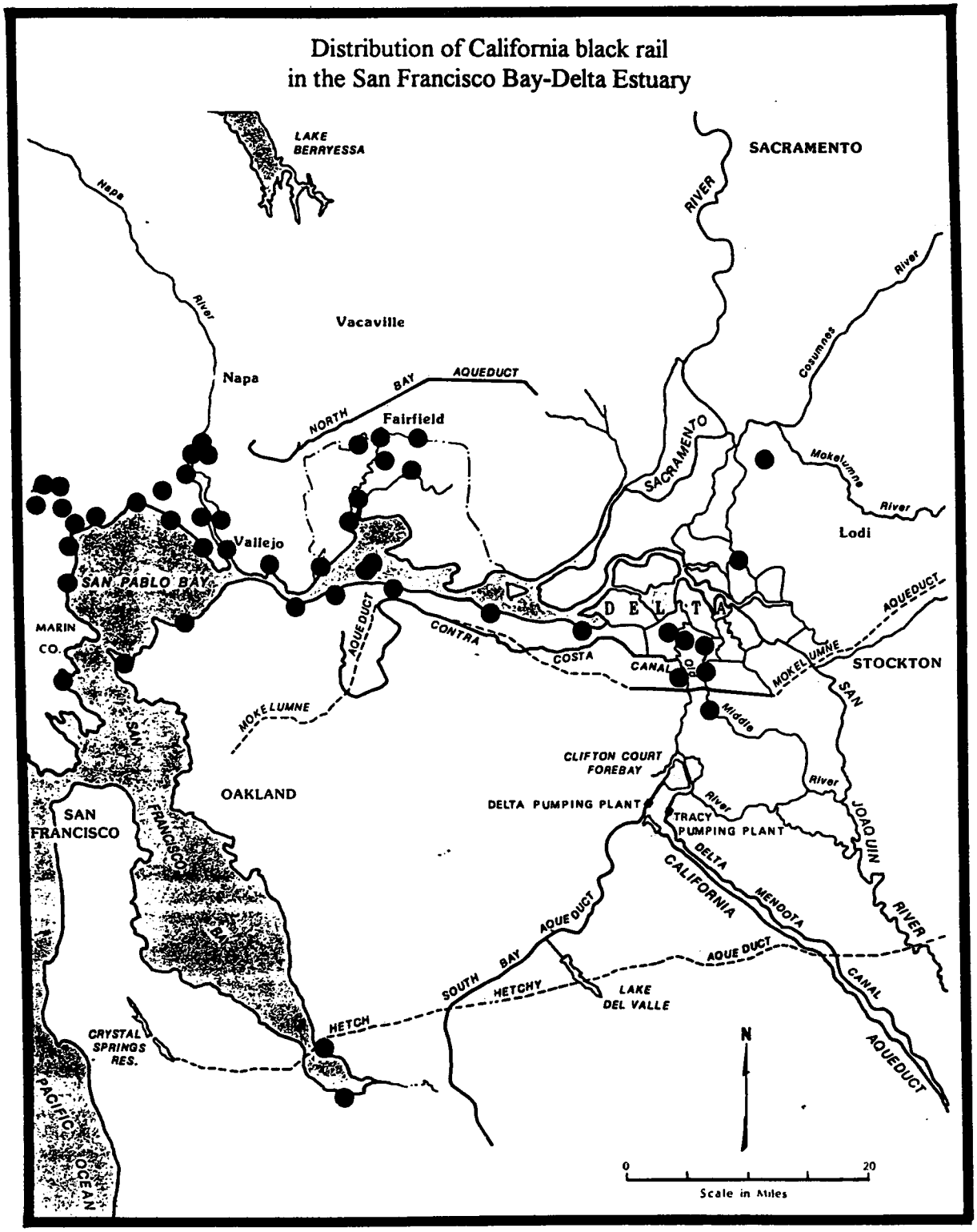


Figure 10
Distribution of California Black Rails
1991 - 1994

Suisun Marsh Biological Assessment
California Department of Water Resources

Figure 11


Distribution of California black rail
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
Vallejo
SAN PABLO BAY
MARIN CO.
SAN FRANCISCO BAY
OAKLAND
SAN FRANCISCO
PACIFIC OCEAN
CRYSTAL SPRINGS RES.
HETCH HETCHY AQUEDUCT
SOUTH BAY AQUEDUCT
LAKE DEL VALLE
MOKELUMNE AQUEDUCT
CONTRA COSTA CANAL
CLIFTON COURT FOREBAY
DELTA PUMPING PLANT
TRACY PUMPING PLANT
SACRAMENTO RIVER
SACRAMENTO
Cosumnes River
Mokelumne River
Lodi
STOCKTON
SAN JOAQUIN RIVER
Middle River
DELTA MENDOTA CANAL
CALIFORNIA AQUEDUCT
N
0
20
Scale in Miles

Habitat Salinity Conditions

The California black rail is a threatened species because of high tidal marsh habitat loss, fragmentation, and degradation. For this reason, the relict tidal marshes which grade to a natural upland habitat are significant to the survival of the species. A key factor in maintaining the character of these marshes is to sustain unimpaired tidal flow to maintain appropriate vegetation and food resources.

California black rail are known to Sacramento - San Joaquin Delta freshwater tidal marshes. The channel water salinity in these areas is considerably fresher than the standards proposed for the maintenance of brackish conditions in Suisun Marsh.

Black rails have been documented in the eastern and western Suisun Marsh. The salinity conditions present during the time of the 1991 - 1994 surveys indicate that California black rails inhabited areas influenced by channel salinity which were within D-1485 and SMPA salinity standards, and were present in areas where channel salinity exceeded future salinity compliance requirements (DWR 1994).
California black rails are also present downstream of the Suisun Marsh in salt marshes around San Pablo Bay and brackish marshes associated with the Napa River. These reaches of the Estuary experience salinity regimes which are much more saline than proposed salinity standards for Suisun Marsh.

Channel salinity ranges proposed in these standards do not appear to be a limiting factor to black rails. The limiting factor is the scarcity of undiked high marsh habitat.

ENDANGERED MAMMAL SPECIES

Special status mammal species distributions were assessed using several methods. Department of Fish and Game Bay-Delta Division biologists assumed responsibility for salt marsh harvest mouse trapping in support of the Biological Assessment requested by SWRCB. Planned surveys in marsh-wide undiked tidal marshes are not all complete to date. Methodologies for field surveys were developed in consultation with species experts. Methodology followed was intended to detect presence. Absence determination or species abundance data were not generated. Field data generated by Department of Fish and Game were supplemented with data from other trapping studies conducted in the Marsh since the 1984 Plan of Protection.

Salt Marsh Harvest Mouse,
Reithrodontomys raviventris

Status

The salt marsh harvest mouse was listed as endangered by USFWS in 1970. The State of California listed the mouse as endangered in 1971. A recovery plan for the species was prepared in 1984 (USFWS, 1984). This plan is currently under revision. Reasons for decline of the species are related to fragmentation of marshes remaining within its range, and loss of suitable habitat due to subsidence, changes in salinity, filling of high marsh, and resulting vegetation change (USFWS 1984).

Habitat Requirements

Salt marsh harvest mice are small cricetid rodents, weighing an average of 10 grams. The species is crepuscular and partially diurnal in its activity and generally has a very calm temperament. Shellhammer concluded that this behavior explained the habitat need for dense cover (Shellhammer 1977). Critical habitat factors include dense cover of marsh vegetation and presence of peripheral high marsh or upland cover to provide refugial habitat during high tides. Cover is also necessary for survival from predation by birds, reptiles, and other mammals. Salt marsh harvest mice differ from may other small rodents in that they do not burrow. Their nests are often a loose ball of dry grasses or sedge built on the surface of the ground.

Distribution

The salt marsh harvest mouse is endemic to San Francisco Bay, occurring in marshes bordering San Francisco, San Pablo, and Suisun Bays. There are two subspecies of salt marsh harvest mouse

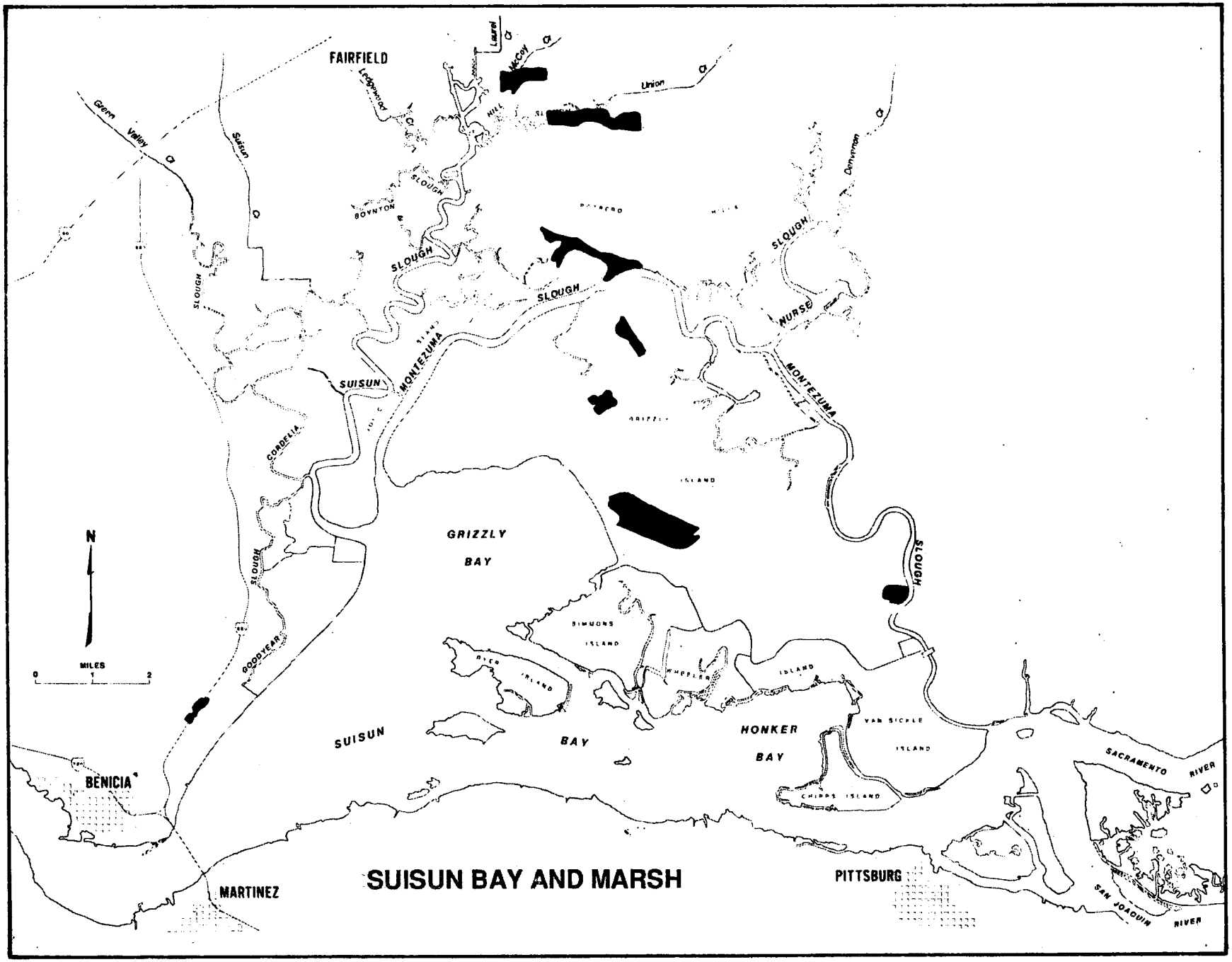
in the San Francisco Bay - Delta estuary. The northern subspecies (*Reithrodontomys raviventris haliocetes*) is found east from Gallinas Creek in Marin County through western San Pablo Bay and Suisun Bay to Collinsville where the freshwater influence becomes to great (USFWS 1984). The southern subspecies (*R. r. raviventris*) is primarily found in south San Francisco Bay. Overlap of the two subspecies occur near the Richmond landfill in Contra Costa County (Shellhammer, 1992; USFWS 1984).

Trapping surveys for salt marsh harvest mouse prior to 1984 were reported in the Plan of Protection for the Suisun Marsh (1984). These historic surveys recorded occurrences of the northern subspecies of salt marsh harvest mice in the Grizzly Island, Hill Slough, and Simmons Island. Salt marsh harvest mice were also trapped in the tidal marshes of Concord Naval Weapons Station on the Contra Costa shoreline in 1979, 1980, and 1982 (Harvey et al 1979,1980; Jones and Stokes, 1982).

There has not been a comprehensive survey of salt marsh harvest mice in Suisun Marsh since the early work for the Plan of Protection. The Department of Fish and Game set aside 1100 acres of habitat to be managed specifically for this endangered species to mitigate for the implementation of the Suisun Marsh management plans (Figure 12). To date, the population status of these species has not be evaluated on the mitigation lands. A compilation of all known trapping efforts for this species undertaken in Suisun Marsh since the 1984 Plan of Protection are presented in Figure 13. The limited surveys conducted indicate that salt marsh harvest mice are still present in Suisun Marsh (Briden, 1993; Cordes, 1994) Additional trapping was planned for a marsh-wide evaluation of the species before the projected end of this study in 1996.

Salt marsh harvest mice were found on Roe Island, Van Sickle Island, Morrow Island, Grizzly Island, Peytonia Slough Ecological Reserve, near the south end of Goodyear Slough, and south of Pierce Road near Goodyear Slough (Briden, 1993; Cordes, 1994). Salt marsh harvest mice were trapped by DFG Region 3 biologists in the Hill Slough area (Botti, 1988). Salt marsh harvest mice have also been reported in the proposed Montezuma Wetlands project area near Collinsville (Shellhammer, 1991). Endangered species surveys at Concord Naval Weapons station continue to document the presence of salt marsh harvest mice on the Contra Costa shoreline, and on Roe and Ryer Islands (Harvey et al, 1985; Kovach and Voigt, 1986).

Estuary wide distribution of the northern subspecies of salt marsh harvest mouse is shown in Figure 14. There are no records of salt marsh harvest mouse upstream of the Collinsville marsh site in Suisun Marsh reported by Shellhammer (1991). The Collinsville - Antioch area is thought to be the historic and current eastern limit of their distribution (USFWS 1981). Salt marsh harvest mice were trapped on Mare Island downstream of Suisun Marsh in 1985 (Kovach and Voight, 1986). Salt marsh harvest mouse trapping data generated for a thesis project on the species on Mare Island and in the San Pablo Bay and associated Petaluma and Napa River marshes are included in Figure 12 (Bias, Personal Communication, 1994). Salt marsh harvest mice have also been identified at Point San Pedro and Pinole Point (NDDB 1994).



SUISUN BAY AND MARSH

Figure 13
Observations of Salt Marsh Harvest Mouse
1985 - 1994

Suisun Marsh Biological Assessment
California Department of Water Resources

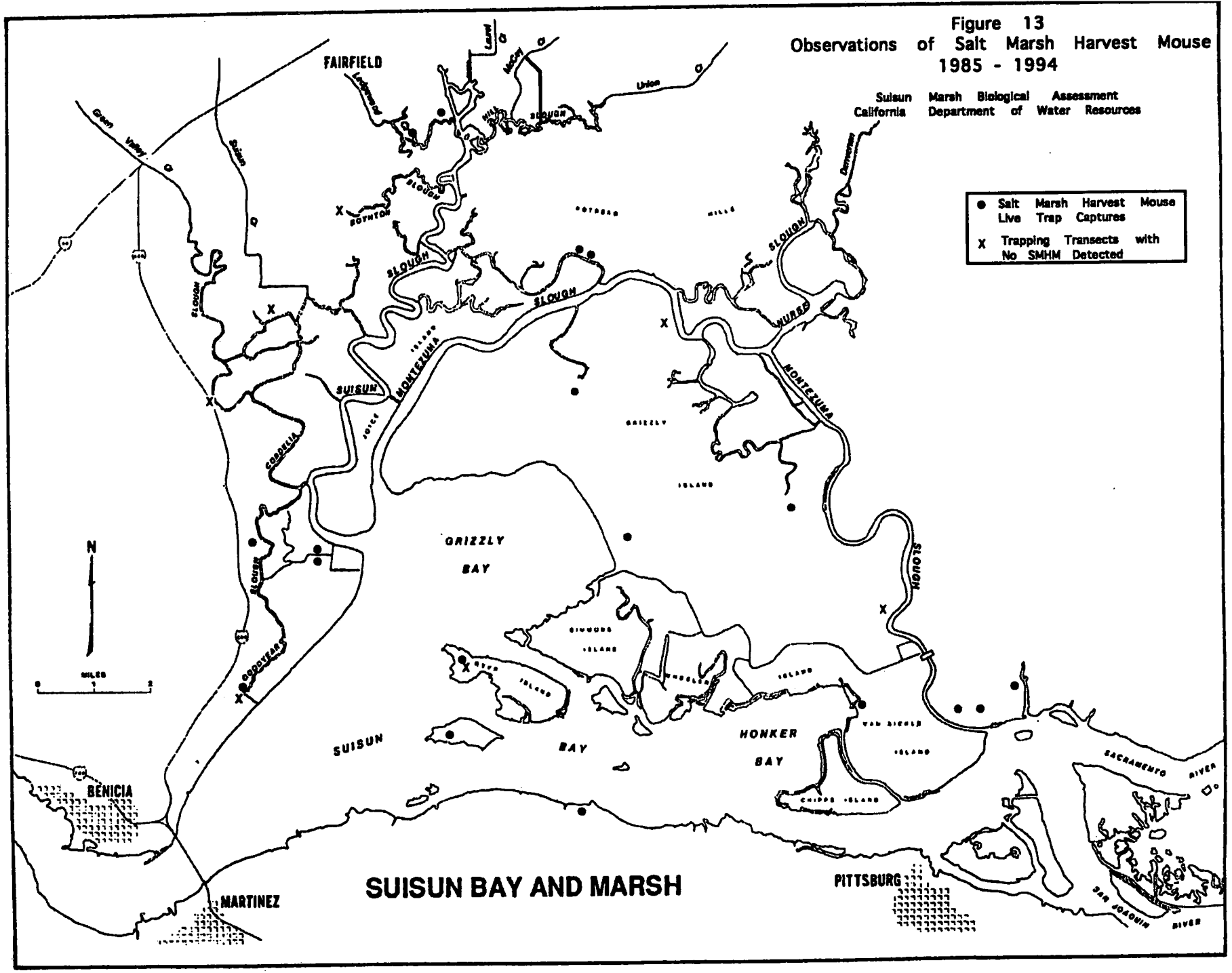
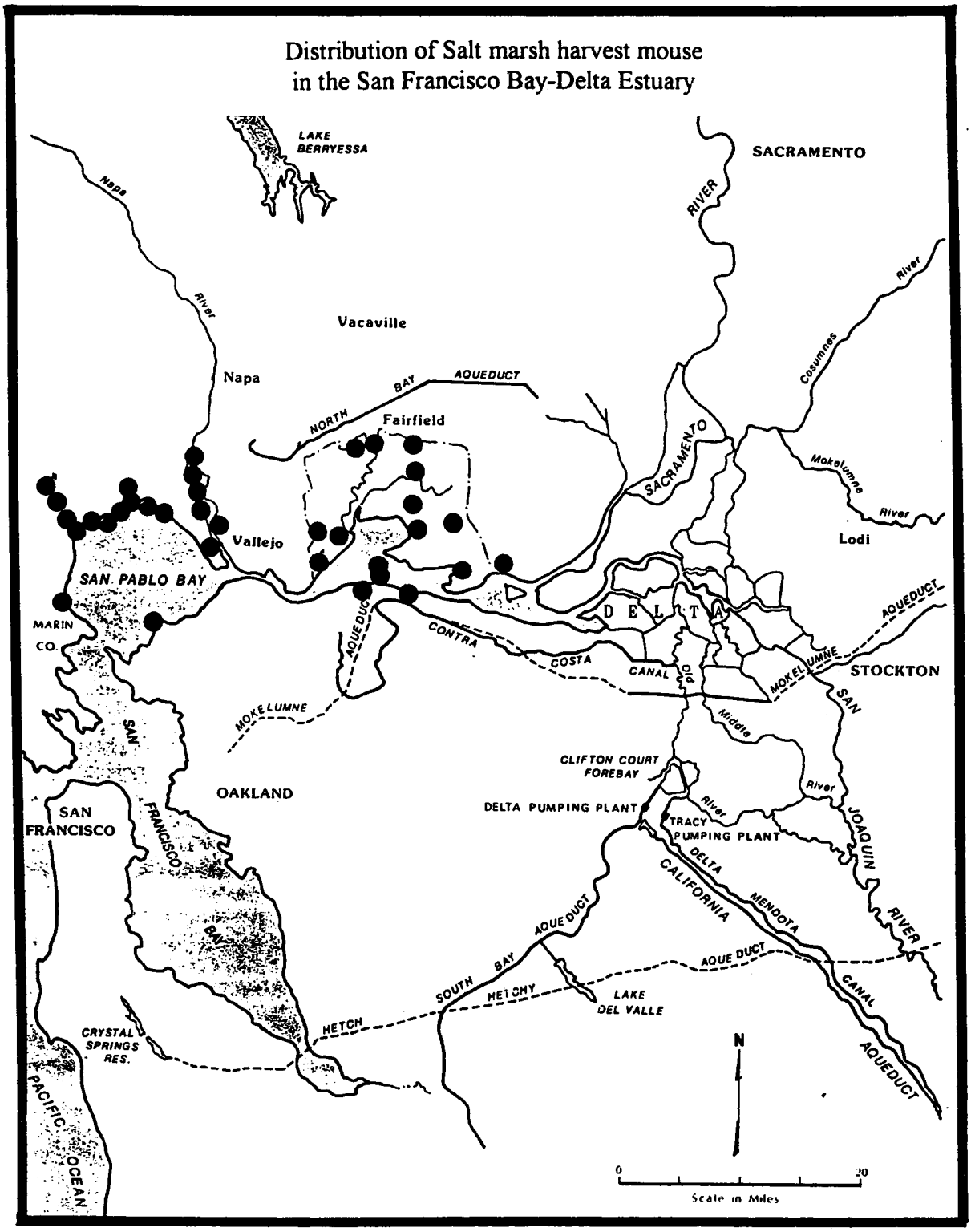


Figure 14


Distribution of Salt marsh harvest mouse
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa
River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
SACRAMENTO
RIVER
Cosumnes
River
Mokelumne
River
Lodi
SACRAMENTO
Vallejo
SAN PABLO BAY
MARIN CO.
D E L T A
AQUEDUCT
CONTRA COSTA CANAL
DIC
MOKELUMNE AQUEDUCT
STOCKTON
SAN
Middle
MOKELUMNE
CLIFTON COURT FOREBAY
River
OAKLAND
SAN FRANCISCO
DELTA PUMPING PLANT
TRACY PUMPING PLANT
JOAQUIN
DELTA CALIFORNIA MENDOTA CANAL
RIVER
AQUEDUCT
SOUTH BAY AQUEDUCT
HETCHY
LAKE DEL VALLE
HETCH
CRYSTAL SPRINGS RES.
PACIFIC OCEAN
N
0
20
Scale in Miles

Habitat Salinity Conditions

The salt marsh harvest mouse is found in the more saline areas of Suisun Marsh where pickleweed is common. DFG testified in the Bay Delta hearings that they do not expect these species to be adversely affected by an increase in channel water salinity in Suisun Marsh (SWRCB, 1991). Salt marsh harvest mice are known to occupy salt marshes of San Pablo Bay where water salinity is much higher than any proposed channel water salinity standards for Suisun Marsh.

The long term impacts of D-1485 standards or Suisun Marsh Preservation Agreement Standards on the species are unknown. There is evidence in the literature to suggest that adherence to these standards could result in a negative impact to salt marsh harvest mice. Resulting channel water salinity may be too fresh for the long term viability of habitat for this species.

Shellhammer conducted a study of the salt marsh harvest mouse in Suisun Marsh and concluded that if the water management plan proposed in the Plan of Protection for the Suisun Marsh were implemented, and if the salinity standards (D-1485) were met and maintained, the future of the salt marsh harvest mouse in Suisun Marsh would be "dubious" (Shellhammer, 1980). The Shellhammer study indicated that Suisun marsh habitat for salt marsh harvest mouse was poor in 1980. The study also concluded that if salinity objectives for alkali bulrush production were maintained, and marsh water management was effective,the resulting loss of pickleweed habitat would exclude the species from Suisun Marsh (Shellhammer, 1980).

The Department of Water Resources and Bureau of Reclamation are evaluating flow augmentation as a salinity control method in the western Marsh through the implementation of the Western Salinity Control Test (DWR and USBR, 1993). The response to a request of U.S. Fish and Wildlife Service for informal consultation and approval of the 1994 Western Suisun Marsh Salinity Control Test included a discussion of the relevance of the salinity standards for maintaining appropriate fish and wildlife habitat in the western Suisun Marsh (USFWS 1994). The consultation concluded that the D-1485 salinity standards for the western marsh were designed to guarantee freshwater flows that would reduce salinity and enhance the physical environment for waterfowl food plants. The Service further stated that the salinity standards did not enhance the physical environment for salt tolerant plant species used by the federally listed salt marsh harvest mouse. Furthermore, the Service stated that long term maintenance of the D-1485 salinity standards may decrease or eliminate suitable tidal marsh habitat for federally-listed terrestrial species, such as salt marsh harvest mice, thus perpetuating their decline (USFWS 1994).

RARE PLANT SPECIES

Special status plant species distributions were assessed using several methods. Specialized intensive floristic surveys of all suitable habitat were conducted for state-listed Mason's lilaeopsis and soft bird's beak. Methodologies for field surveys were developed in consultation with DFG, USFWS, and other species experts. Field data generated by Department of Water Resources and Department of Fish and Game teams were supplemented with information from the literature, and all other known surveys in the Estuary.

Soft Bird's-beak
Cordylanthus mollis Gray ssp. *mollis*

Status

Soft bird's beak (*Cordylanthus mollis* Gray ssp. *mollis*) is listed as a rare plant under the California Endangered Species Act. It is a Category 1 federal candidate species. A status evaluation for federal listing of this species is currently underway (White, 1993). CNPS includes this plant on List 1B: Plants rare, threatened, or endangered in California and elsewhere.

Habitat Requirements

Soft bird's beak is found in the upper peripheral halophyte zone of relict undiked tidal marshes. This annual species is most commonly associated with pickleweed (*Salicornia virginica*) and dodder (*Cuscuta salina*), and it often parasitizes the roots of pickleweed. A natural hydrologic connection to a tidal slough system is an important component of the habitat of this rare plant. Diked seasonal wetlands which are isolated from natural, year round tidal cycle hydrology do not appear to support this species.

Distribution

Soft bird's beak is a member of the figwort family (Scrophulariaceae). This species is endemic to the north bay marshes, and was originally described from material collected along the shores of Suisun Bay (Mason, 1972). There are six to ten extant populations of soft bird's beak known to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Rugyt, 1993). Suisun Marsh populations occur in the undiked tidal marshes associated with Cutoff Slough, First Mallard Branch, Second Mallard Branch, Hill Slough, McCoy Creek, and Luco Slough in Suisun Marsh. Contra Costa county occurrences include populations at Point Pinole, McAvoy Marsh, and on the Concord Naval Weapons Station property adjacent to Hastings Slough (Figure 15). Historic

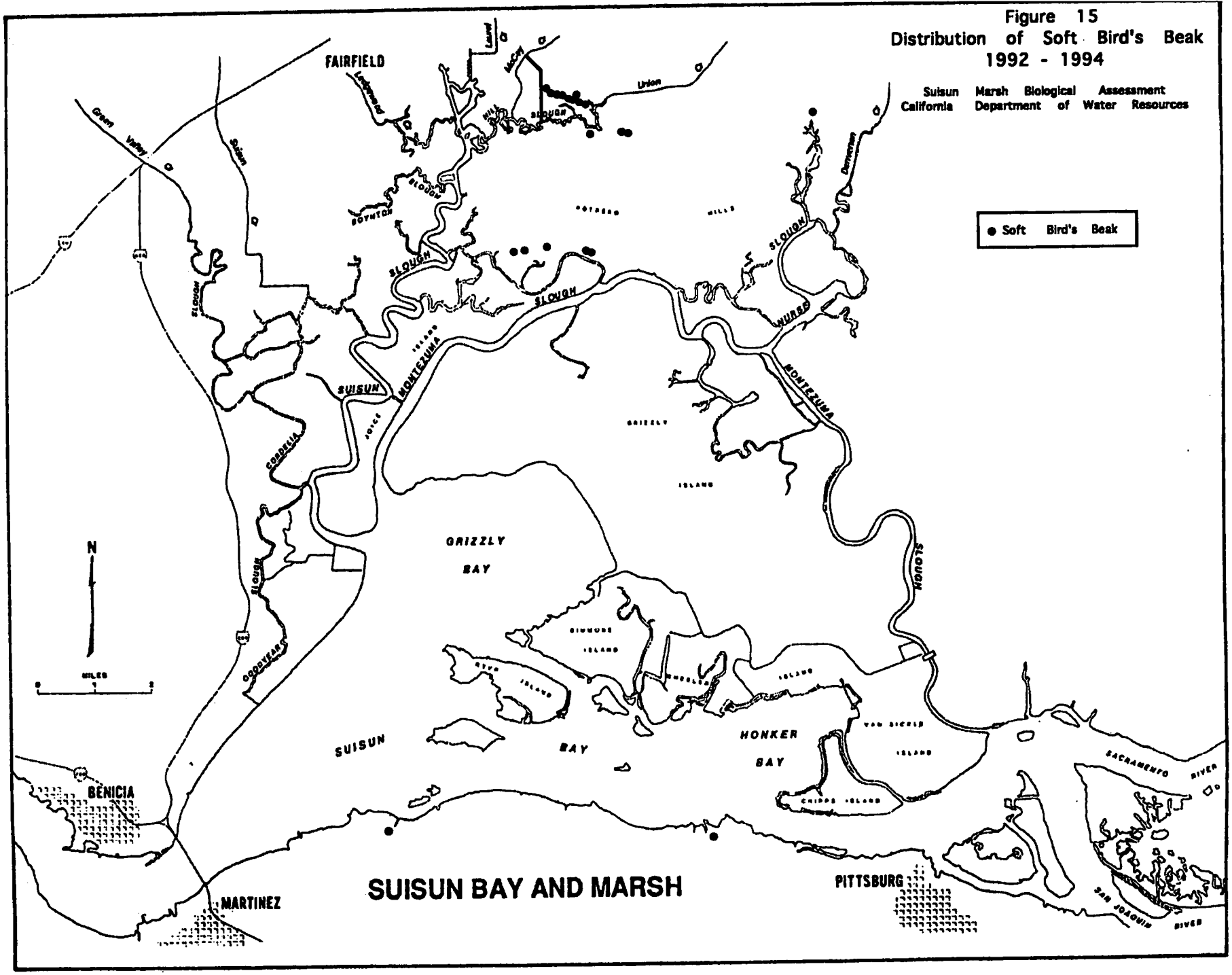


Figure 15
Distribution of Soft Bird's Beak
1992 - 1994
Suisun Marsh Biological Assessment
California Department of Water Resources
Soft Bird's Beak
FAIRFIELD
Green Valley
Suisun
Lagoon
Union
Denverton
SLOUGH
MONTEZUMA
SUISUN
CORDELIA
GOODYEAR
GRIZZLY BAY
SUISUN BAY
HONKER BAY
BENICIA
MARTINEZ
PITTSBURG
SACRAMENTO RIVER
SAN JOAQUIN RIVER
N
MILES
SUISUN BAY AND MARSH

Contra Costa populations at Mare Island and Martinez are thought to be extirpated. Soft-haired bird's beak is also present in the Fagan Slough Ecological Reserve east of the Napa River , and the Petaluma Marsh of Sonoma County (Figure 16). A historic population reported at the Cullinan Ranch marsh in Napa County was not found in 1993 surveys, and is thought to be extirpated (Ruygt, 1993). The Hill Slough population in Suisun Marsh and a population in the Concord Naval Weapons Station tidal marsh on the Contra Costa shoreline are the largest remaining populations of this very rare plant.

Department of Water Resources biologists conducted intensive floristic surveys of undiked tidal marshes throughout Suisun Marsh in 1992 and 1993. The DFG Joice Island Unit northeast of the Joice Island Bridge over Cutoff Slough, and the Rush Ranch property were also searched in 1991. Searches corresponded to the June through September bloom of this species. Suisun Marsh observations of soft bird's beak have been limited to the Hill Slough, Rush Ranch, and the undiked tidal marsh east of the Joice Island bridge. Soft-haired bird's beak has also been observed on Concord Naval Weapons Station property on the Contra Costa shoreline. Caltrans biologists located a small population of this sensitive plant near Highway 12 in the upper reaches of the Luco Slough tidal system (Alvarez, 1994).

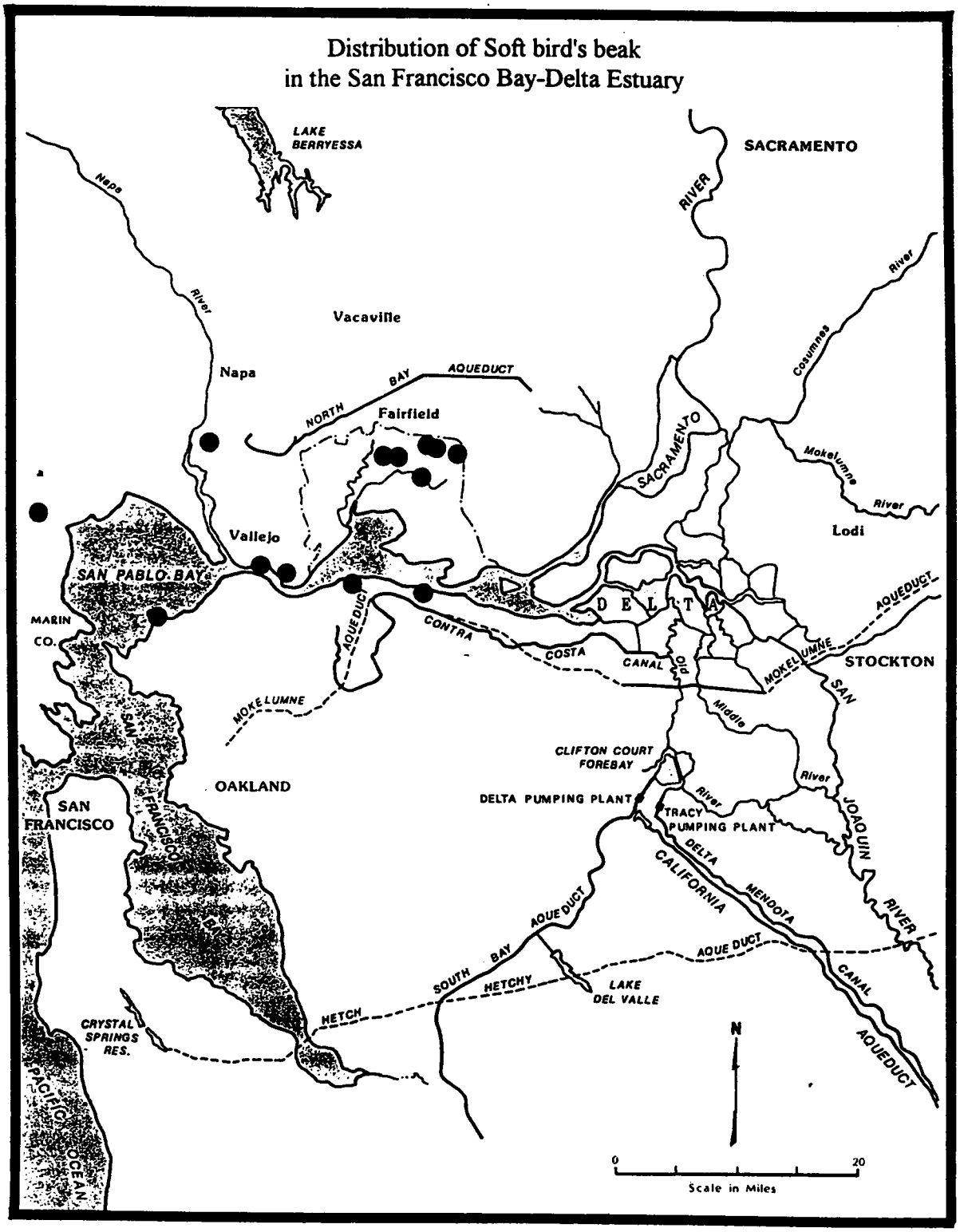
Surveys were also conducted in the narrow strip marshes associated with the outboard levees of Cordelia Slough, Ibis Cut, Frank Horan Slough, Chadbourne Slough, Wells Slough, Suisun Slough, and Goodyear Slough. Soft bird's beak was not observed in these narrow fringe marshes. We have also surveyed the 7 hectare tidal marsh at the south end of the DFG Cordelia Unit adjacent to Cordelia Slough, approximately 18 hectares of undiked tidal marsh associated with Goodyear Slough, the undiked tidal marsh at the south end of lower Joice Island, and portions of Ryer and Roe Islands. Soft bird's beak was not found at any of these locations.

Habitat Salinity Conditions

Soft bird's beak has been observed in tidal marshes influenced by channel salinity conditions in Hill Slough, Cutoff Slough, and Luco Slough. These three channels are all east of Suisun Slough in the northeastern region of Suisun Marsh. Channel water salinity in this region of the Marsh is influenced by operation of the Suisun Marsh Salinity Control Gates during the October through May salinity control season (DWR 1994). Channel salinity is monitored in Hill Slough at Grizzly Island Road, and in Montezuma Slough at Beldon's Landing. These monitoring stations are the closest recording stations to the soft bird's beak populations.

The rare plants were all in high marsh upper halophyte zones 140 to 370 meters above the large tidal sloughs. The specific population locations are in high marsh at the extreme high tidal overflow limit. Soil salinity in these areas is related to high tide flooding from tidal sloughs or bays, high evaporation rates, winter precipitation, and local freshwater discharges. The annual species germinates in early winter, as we have observed small seedlings as early as December. Most germination appears to occur in areas of bare soil. These areas are also most likely to have

Figure 16


Distribution of Soft bird's beak
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
SACRAMENTO RIVER
Cosumnes River
Mokelumne River
Lodi
SACRAMENTO
Vallejo
SAN PABLO BAY
MARIN CO.
AQUEDUCT
CONTRA COSTA CANAL
D E L T A
AQUEDUCT
MOKELUMNE
STOCKTON
SAN JOAQUIN
Middle
MOKELUMNE
CLIFTON COURT FOREBAY
OAKLAND
SAN FRANCISCO
SAN FRANCISCO BAY
DELTA PUMPING PLANT
TRACY PUMPING PLANT
River
JOAQUIN RIVER
DELTA CALIFORNIA MENDOTA CANAL
AQUE DUCT
SOUTH BAY AQUE DUCT
HETCHY
LAKE DEL VALLE
HETCH
CRYSTAL SPRINGS RES.
PACIFIC OCEAN
AQUEDUCT
N
0
20
Scale in Miles

the highest concentrations of soil salts. Other sensitive plant species in Suisun Marsh do not germinate until spring.

Channel salinity recorded in the large tidal sloughs is not likely to be the same as the salinity of water which has progressed up the smaller tidal creeks, inundated these plants, and influenced soil salinity. Channel water salinity ultimately influences the salt balance in these high marsh zones. The seasonal high evaporation rate in high marsh zones also contributes to a concentration of soil salts. However, channel water salinity relative to compliance standards can be used as an indication of what affect proposed salinity standards may have on these populations.

Channel water salinity measured as specific conductance monitored at Hill Slough (S-4; Figure 1) ranged from 1,844 - 16,349 mS in the 1992 water year, and 698 - 16,012 mS in the 1993 water year when populations of this annual species were observed in the Hill Slough tidal marsh (Table 2). Channel water salinity measured as specific conductance in Montezuma Slough at Beldon's Landing ranged from 1,484 - 19,807 mS during the 1993 water year, and 616 - 19,689 mS during 1993 when the Rush Ranch and Joice Island populations were observed (Table 2). The trends of channel water salinity through these water years are shown in Figures 3 and 4. D-1485 salinity standards were exceeded at the Beldon's Landing compliance station in 1992. D-1485 salinity standards calculated as mean month high tide electrical were achieved throughout the Marsh in 1993.

There are no local freshwater discharges influencing the populations observed on the Rush Ranch and DFG-Joice Island Units. The Hill Slough area receives some freshwater input from Fairfield storm drains to McCoy Creek. The Solano County Water Agency may also discharge fresh water from a Putah South Canal outfall to McCoy Creek. The eastern end of the Hill Slough system receives seasonal freshwater runoff from Union Creek. These discharges are upstream of the Hill Slough at Grizzly Island Road monitoring station, and may also indirectly influence soil salinity in the vicinity of the soft bird's beak population.

Soft bird's beak has also been observed in the high marsh zone along the Contra Costa shoreline. The Chipps Island (measured at Mallard Island) salinity monitoring station is the closest recording station to the population observed east of McAvoy Harbor (Figure 1). This population was only observed in 1993. Salinity recorded as specific conductance at this station ranged from 114 - 16,966 mS in the 1993 water year (Table 2; Figure 4).

Salinity standards proposed for the interior Marsh channels are not expected to be limiting to soft bird's beak. Soft bird's beak is not known to the western Suisun Marsh area where Suisun Marsh Preservation Agreement standards are proposed to be implemented. Most tidal marsh habitat with a high marsh zone has been eliminated by conversion to diked seasonal marsh in the western Marsh. Some of the historic high marsh zone is under the fill for Interstate Highway 680, and

industrial development. Soft bird's beak has been present in areas where D-1485 salinity standards have been achieved, and it has been observed in areas such as Pinole Point in San Pablo Bay where salinity exceeds numerical values proposed as SMPA deficiency standards.

Mason's Lilaeopsis
Lilaeopsis masonii Mathias and Constance

Status

Mason's lilaeopsis (*Lilaeopsis masonii* Mathias and Constance) is classified as a Category 2 candidate species, and is listed as rare under the California Endangered Species Act. CNPS includes this species on List 1B: Plants rare, threatened, or endangered in California or elsewhere.

Habitat Requirements

Mason's lilaeopsis is a member of the Umbelliferae (carrot family). It is a low-growing, glabrous herbaceous perennial which spreads laterally by rhizomatous growth. The plant appears grasslike from a distance, and often associated with a complex low turf community with three-ribbed arrowgrass (*Triglochin striata*), low club rush (*Scirpus cernuus*), and marsh pennywort (*Hydrocotyl verticillata*). Leaves are reduced to threadlike, linear, or reduced phyllodes that form dense tufts along horizontal rhizomes. Leaves bear transverse septa. Weak flowering branches are usually shorter than the leaves, and bear 3 to 8 small, white flowers in simple umbels. Flowering period for the species extends from April through October.

Mason's lilaeopsis habitat is restricted to the littoral zone of freshwater and brackish marshes. It is most common on actively eroding slough banks, wave cut beaches, or earthen levees with a clay substrate. However, it has also been observed on rotting wood (pilings or emergent snags), and in sand along the edges of waterways. Plants are inundated twice daily by high tides, and are exposed during low tides. The plants are photosynthetically active during daylight low tide exposures. Observations of population positions on exposed mud banks indicate a growth zone above the high and low tide equilibrium point (zero flood level).

The habitat of Mason's lilaeopsis is transient and varies as a function of bank stability and changing water salinity. Erosion of bank or wave-cut beach habitat result in substrate slump into the adjacent water body. The plant tolerates these disturbances by its ability to spread laterally by rhizotomatous growth (Golden and Fiedler 1991). Populations may be composed of clonal colonies as floating clonal tufts (ramets) of the species break away from the eroding channel, float with the tides, and colonize on other suitable bank habitat. Clonal tufts of Mason's lilaeopsis were seen floating in the Delta region, supporting the colonization theory (Golden and Fiedler 1991). Clonal tufts were also seen floating in Roos Cut and Suisun Slough during the 1992 surveys reported in this assessment.

Distribution

Mason's lilaeopsis is found in the intertidal zone of freshwater and brackish marshes of the Delta, Suisun Bay, Suisun Marsh, Carquinez Straits, and the Napa River. A herbarium voucher specimen was collected from Tomales Bay at Chicken Ranch Beach. This Tomales Bay population has not been found in recent years (Golden and Fiedler 1991).

Department of Water Resources and Department of Fish and Game survey teams conducted Mason's lilaeopsis surveys throughout Suisun Marsh from shallow draft boats at low tide. A pilot survey was conducted along Boynton Slough in 1990 to support the evaluation of the proposed Boynton-Cordelia Ditch. Both channel banks of western marsh channels including Cordelia Slough, Goodyear Slough, Ibis Cut, Frank Horan Slough, and Suisun Slough from Hunter Cut to Goodyear Slough were surveyed for this diminutive species in 1991, 1992, and 1993 in support of the Western Suisun Marsh Salinity Control Project. An intensive marsh-wide survey for the species was conducted in 1992 as part of the Suisun Marsh Biological Assessment.

The 1992 survey included the low tide exposed intertidal zone of all interior Suisun Marsh channels, and the bayshores of Suisun Bay, Grizzly Bay, Honker Bay, and Little Honker Bay. All navigable tidal reaches were surveyed, including: Suisun Slough, Peytonia Slough, Hill Slough, Boynton Slough, Sheldrake Slough, Cutoff Slough, First Mallard Branch, Second Mallard Branch, Wells Slough, Roos Cut, Hunter Cut, Goodyear Slough, Cordelia Slough, Ibis Cut, Frank Horan Slough, Chadbourne Slough, Montezuma Slough, Tree Slough, Cross Slough, Frost Slough, Hastings Slough, Nurse Slough, Luco Slough, Denverton Slough, Frost Slough, Kirby Hill Branch, Sacramento River confluence east to Collinsville, Spoonbill Creek, and Suisun Cutoff. The entire shoreline of Ryer Island, Roe Island, Seal Island, Freeman Island, Snag Island, Brown's Island, Chipps Island, and Chain Island were also surveyed.

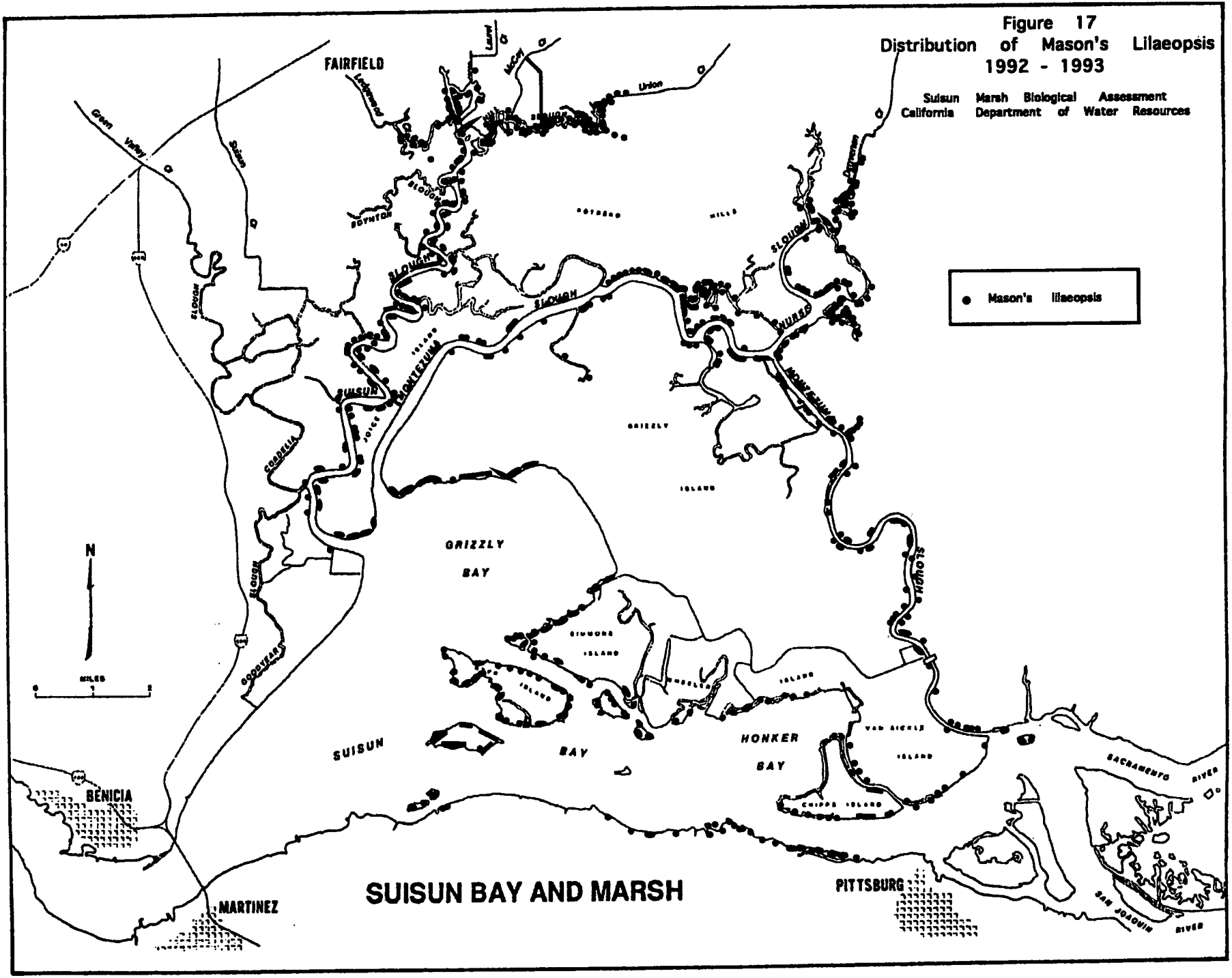
Mason's lilaeopsis is present in Suisun Marsh (Figure 17). Field surveys have located this species throughout most regions of the marsh. Population location, size, phenology, plant associates, bank condition, and substrate type were recorded at all field locations.

Eastern Suisun Marsh occurrences of Mason's lilaeopsis were recorded along Hill Slough, McCoy Creek, Montezuma Slough, Cutoff Slough, Hunter Cut, Tree Slough, Cross Slough, Nurse Slough, Frost Slough, Denverton Slough, Luco Slough, Little Honker Bay, Shilo Slough, and Kirby Hill Slough. Western Suisun Marsh occurrences of Mason's lilaeopsis were documented along Suisun Slough, Suisun Slough islands, Peytonia Slough, Boynton Slough, Sheldrake Slough, Roos Cut from Suisun Slough to fence blocking navigation, Chadbourne Slough, Frank Horan Slough, Ibis Cut, and Goodyear Slough.

Suisun Bay, Honker Bay, and Grizzly Bay populations were observed along Spoonbill Creek, Honker Bay shoreline between Spoonbill Creek and Suisun Cutoff, Freeman Island, Snag Island, Chipps Island, Brown's Island, Snag Island, Contra Costa shoreline between New York Slough and Mallard Island, Mallard Island, Contra Costa shoreline between Mallard Island and Stake

Figure 17
Distribution of Mason's Lilaeopsis
1992 - 1993

Suisun Marsh Biological Assessment
California Department of Water Resources



Point, Concord Naval Weapons Station shoreline, Point Edith, Simmons Island shoreline, Grizzly Bay shoreline from Montezuma Slough to Pelican Point, Anna Mesa Slough, Point Buckler Island, Suisun Cutoff, Ryer Island, Roe Island, and Seal Island.

The highest density of occurrences of this rare plant were observed along the reaches of Suisun Slough and Montezuma Slough where active slump blocks are eroding from the channel banks. The populations along Suisun Slough range in size from 0.6 to 1097 meters of horizontal coverage along the channel banks. The largest continuous population was observed along the west bank of Suisun Slough south of Sheldrake Slough. An exceptionally large and vigorous population was present along Nurse Slough. Extensive populations are also present around the west end of Ryer Island and other Suisun Bay islands.

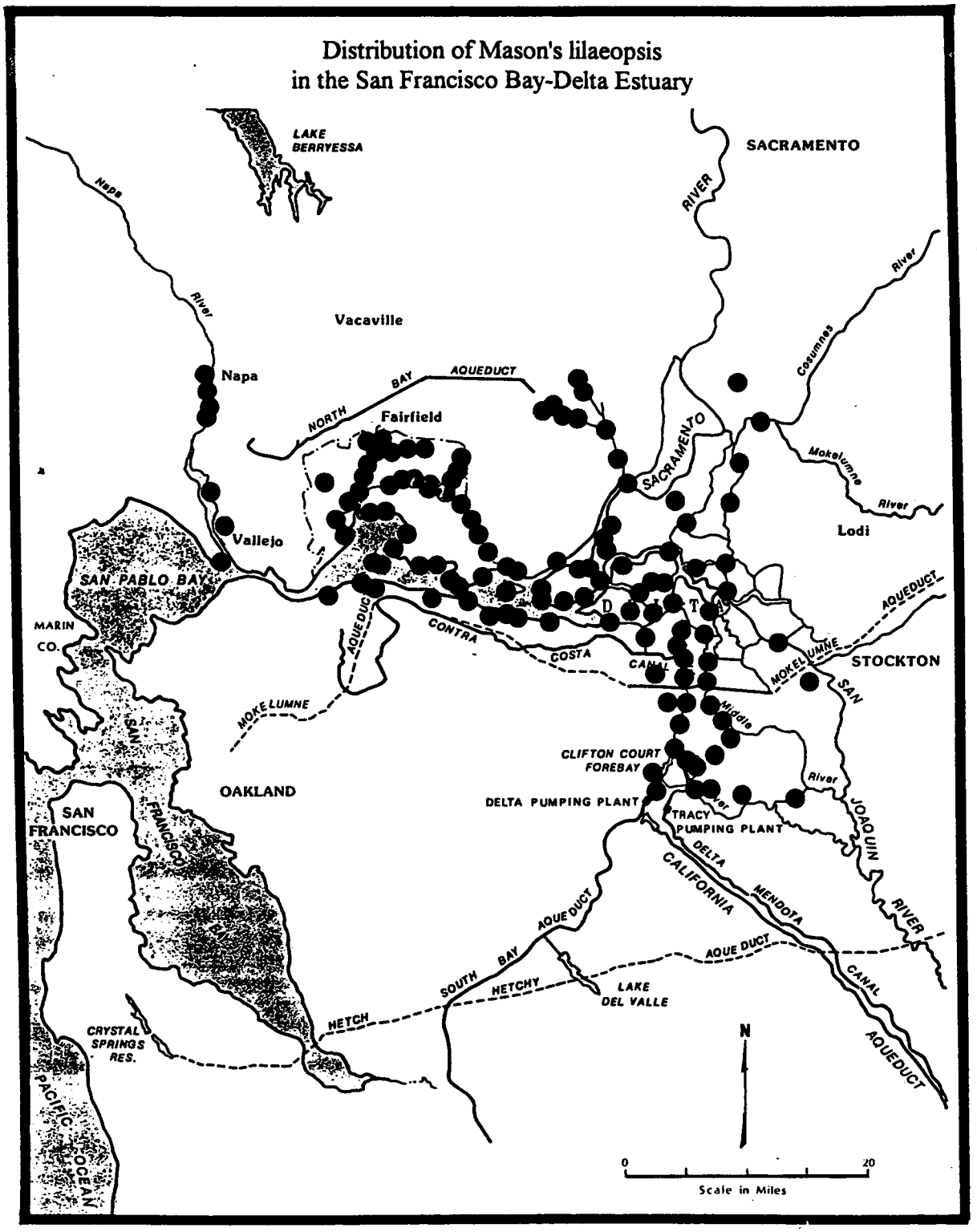
Western marsh surveys were repeated in 1993. Four new occurrences were recorded along Goodyear Slough near the confluence with Cordelia Slough. Mason's lilaeopsis was not present in this area in 1992.

Mason's lilaeopsis has not been observed along the entire length of Cordelia Slough. One small population of *Heliocharis acicularis* was observed on upper Cordelia Slough in 1992 and 1993. This intertidal zone species is sometimes associated with Mason's lilaeopsis is the freshwater marshes of the Delta. Other typical plant associates of this rare plant are also absent from Cordelia Slough channel banks. There is a freshwater to brackish salinity gradient from Green Valley Creek above Cordelia Road south to Cordelia Slough at the Suisun Slough confluence. Freshwater marsh species including common cattail, horsetail, water smartweed, and water cress, and tules are dominant at the Cordelia Road crossing of Cordelia Slough. The vegetation and salinity grades to brackish conditions south of this point, and narrow leaf cattail, common tule, California tule, and California wild rose are interspersed with introduced species such as Himalayan berry and common reed. There is an active, undisturbed tidal influence along the entire reach of the slough. There are only a few rip-rapped reaches of channel bank near the south end of the channel. This is the only tidal channel in Suisun Marsh without a single documented population of Mason's lilaeopsis. Populations of this sensitive plant are also in low abundance in other western Marsh channels. The reason for the absense of the species in this area seems to be independent of salinity. Reyes silty clay soil of a mineral character is more prevalent in the western Marsh than the high organic mucks found in the central, north, and eastern Marsh (Miller et al. 1975). This may be one possible explanation for the observed distribution of the species.

Department of Water Resources and DFG surveys for Mason's lilaeopsis in sequential years have indicated the distribution of this species to be highly dynamic (DWR 1993). Evaluation of long term impacts to the species will likely require repeat surveys over time to track the movement of Mason's lilaeopsis.

Species experts were contacted and the literature was searched to ascertain the Estuary wide distribution of this species (Figure 18). Department of Water Resources and Department of Fish

Figure 18


Distribution of Mason's lilaeopsis
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
SACRAMENTO
RIVER
Napa
River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
Cosumnes River
Mokelumne River
SACRAMENTO
Lodi
Vallejo
SAN PABLO BAY
MARIN CO.
AQUEDUCT
CONTRA COSTA CANAL
MOKELUMNE AQUEDUCT
STOCKTON
SAN JOAQUIN
MOKELUMNE AQUEDUCT
Middle River
CLIFTON COURT FOREBAY
OAKLAND
DELTA PUMPING PLANT
TRACY PUMPING PLANT
SAN FRANCISCO
SAN FRANCISCO BAY
DELTA CALIFORNIA MENDOTA CANAL
JOAQUIN RIVER
SOUTH BAY AQUEDUCT
AQUEDUCT
HETCHY HETCH
LAKE DEL VALLE
CRYSTAL SPRINGS RES.
PACIFIC OCEAN
N
0
20
Scale in Miles

and Game biologists surveyed the Napa River, Napa Slough, and Mud Slough for Mason's lilaeopsis in 1993. Data were also included from occurrences reported in NDDB (1994), Rugyt (1994), Fiedler and Zebell (1993), McCarten (1993), Golden and Fiedler (1991), ECOS, Inc. (1990a), ECOS, Inc. (1990b), Jones & Stokes (1990), and Ruyget (1987).

There is a relationship between channel water salinity and the distribution of Mason's lilaeopsis. Other environmental variables such as mean tidal equilibrium elevation, tidal range, soil type, and active bank erosion also influence the distribution. The most downstream population of the species has been observed at the south end of Mare Island in the Carquinez Straits. Vegetation communities in this area suggest a more brackish environment than is observed between the Edgerley Island and Vallejo where salt marsh species including cordgrass and alkali bulrush are dominant along the Napa River. Mason's lilaeopsis has been observed with this salt marsh vegetation. Mason's lilaeopsis is present along the brackish to freshwater reach of the Napa River at the city of Napa (Ruygt, 1987).

Mason's lilaeopsis is also widely distributed throughout the Sacramento - San Joaquin Delta (Figure 18). The species drops out in the northern Delta where tidal range is diminished. The occurrence of Mason's lilaeopsis appears to be most abundant in the northern, central, and eastern regions of Suisun Marsh and Suisun Bay.

Habitat Salinity Conditions

Potential threats to Mason's lilaeopsis populations include dredging close to shorelines, deposition of dredge spoils on levee banks of tidal sloughs, riprapping of outboard levees, oil spills, human recreational activities, and agricultural grazing on shorelines. Changes to the natural processes that sustain suitable habitat including changes to the tidal regime, water velocity, water salinity, and erosional processes are also impacting the species (Golden and Fiedler 1991).

Distribution, greenhouse growth and salinity tolerance studies, ecophysiology, and molecular genetics of Mason's lilaeopsis are being researched by Fiedler and Zebell (1993). Greenhouse experiments have demonstrated a significant morphological response of decreasing growth with increasing levels of applied water salinity (Fiedler and Zebell 1993). Results of these studies have also demonstrated a strong negative correlation between water salinity and seed germination success. Seeds of Mason's lilaeopsis germinated in salinities of up to 12 ppt. Fiedler and Zebell (1993) concluded that increased water salinity levels in the Sacramento - San Joaquin Delta could adversely affect growth and establishment of Mason's lilaeopsis.

Mason's lilaeopsis is not known to salt marshes of San Pablo Bay or San Francisco Bay. The downstream limit of the distribution appears to be Mare Island at the Carquinez Straits. Mason's lilaeopsis is known to areas of the eastern Suisun Marsh which have been under D-1485 compliance standards, and the direct influence of operation of the Suisun Marsh Salinity Control

Gates. Populations are extensive along Suisun Slough. The Suisun Slough at Volanti salinity monitoring station (S-42) is more representative of western Marsh salinity conditions than the eastern Marsh control stations (DWR 1994). Mason's lilaeopsis is also known to the Sacramento - San Joaquin Delta where fresh water marsh conditions predominant.

Mason's lilaeopsis occurrences are most abundant in Suisun Marsh and Suisun Bay when compared with distribution throughout the Estuary. Professional consensus among species experts is that this has more to do with available habitat than salinity gradient. The species is obviously tolerant of brackish conditions observed in Suisun Marsh. Greenhouse studies have shown that germination and growth improve with fresh water. However, much of the potential habitat in the freshwater tidal marshes of the Delta has been filled, rip-rapped, or otherwise disturbed.

If salinity is a controlling factor in the observed distribution of Mason's lilaeopsis, this distribution is not expected to change with the management for D-1485 water quality goals. Salinity conditions resulting from management for deficiency standards proposed in the SMPA are not expected to limit this species. Healthy, vigorous populations of Mason's lilaeopsis were observed along Suisun Slough during the critical 1992 water year. Salinity recorded during the October - May compliance season at the Suisun Slough at Volanti (S-42) station slightly exceeded future D-1485 standards, but were well below the SMPA standards (DWR 1994). An increase of channel water salinity above these management goals for the preservation of a brackish marsh could be detrimental to the species.

Antioch Dunes Evening Primrose
Oenothera deltoides Torr. & Frem. ssp. *howellii* Munz W. Klein

Status

The Antioch dunes evening primrose (*Oenothera deltoides* [Torr. & Frem.] ssp. *howellii* [Munz] W. Klein) is listed with endangered status in California and the United States.

Habitat Requirements

This perennial primrose is found on stabilized interior dunes. It is restricted to Delhi sand or Piper loamy sand soils. Loss of habitat is the Antioch area due to mining, agriculture, industrial development, and heavy recreation pressures has contributed to the decline of the species.

Distribution

Antioch dunes evening primrose is known from seven occurrences in the west Delta (CNPS 1994; NDDB 1994). Populations are present at Antioch Dunes National Wildlife Refuge and in the private Antioch dunes area along the San Joaquin River. There is one transplant population in the Delta on Brannon Island. There is also one transplant population at the very eastern boundary of Suisun Marsh on Brown's Island.

Habitat Salinity Conditions

The only known populations of this species are located within the Estuary. However, these plants are not found in wetlands influenced by the proposed salinity standards. Implementation of the salinity control plan should not affect this species.

Contra Costa Wallflower
Erysimum capitatu ssp. angustatum

Status

Contra Costa wallflower (*Erysimum capitatu* [Doug.] Greene ssp. *angustatum* [Greene] R. Price) is listed as endangered under both the federal and California endangered species acts.

Habitat Requirements

Contra Costa wallflower is found on the north and east facing sloped of stabilized riverine dunes. It occupies areas with sparse cover. Critical habitat for the species has been designated as the 60 acre area within the Antioch Dunes National Wildlife Refuge.

Distribution

This endangered plant is known from only two occurrences at the Antioch Dunes area near Antioch in Contra Costa County (CNPS, 1994; NDDB 1994).

Habitat Salinity Conditions

The only known populations of this species are located within the Estuary. However, these plants are not found in wetlands influenced by the proposed salinity standards. Implementation of the salinity control plan should not affect this species.

Colusa Grass
Neostapfia colusana

Status

Colusa grass (*Neostapfia colusana* [Davy] Davy) is listed as endangered in California. It is a Category 1 candidate species for federal listing under the Endangered Species Act. CNPS includes Colusa grass on list 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere.

Habitat Requirements

Colusa grass has narrow habitat requirements which restrict it to alkaline playa lakes or inundated vernal pools (Hickman, 1993; NDDB 1994). It is an annual grass which is closely related to the rare Solano grass. Agricultural development and heavy grazing have destroyed much of the historic habitat of this California endemic (CNPS 1994).

Distribution

A healthy stand of several thousand plants grows in east Olcott Lake at the Jepson Prairie Preserve, Solano County (The Nature Conservancy, 1992). Colusa grass is also known to a few sites in Merced, Madera, and Stanislaus counties in the San Joaquin Valley; and historically to Colusa County (CNPS 1994; NDDB 1994).

Habitat Salinity Conditions

There are vernal pool and alkali playa lake complexes flanking the north east base of the Potrero Hills between Hill Slough/Union Creek and Luco Slough/Denverton Creek in northeastern Suisun Marsh. Searches for Colusa grass have not been made in these areas. However, the water source to these seasonally inundated habitats is rainfall. Tidal channel water does not influence these sensitive habitats. Therefore, the proposed salinity standards are not expected to impact this endangered plant.

Tiburon Paintbrush,
Castilleja affinis ssp. *neglecta* Zeile

Status

Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta* Zeile) is a Category 1 federal candidate species which has been proposed for listing. This species is listed as threatened in the State of California. CNPS includes it on List 1B of their rare plant inventory, indicating a species which is rare, threatened, or endangered in California or elsewhere.

Habitat Requirements

Tiburon paintbrush is limited to ultramafic, serpentine substrates of open foothill grassland slopes.

Distribution

Tiburon paintbrush is a member of the Scrophulariaceae (Castilleja) commonly known as the figwort family. This rare plant is known only from the Tiburon Peninsula and American Canyon. It is threatened by urban development and mining activities.

Habitat Salinity Conditions

There is no suitable habitat for this species in the wetlands of Suisun Marsh. The closest known population is in the Napa County foothills of American Canyon approximately six miles west of the project area. The proposed standards are not expected to impact Tiburon paintbrush.

CANDIDATE SPECIES

CANDIDATE REPTILES AND AMPHIBIANS

Northwestern Pond Turtle,
Clemmys marmorata marmorata

Status

The western pond turtle (*Clemmys marmorata*) includes two subspecies, the northwestern pond turtle (*Clemmys marmorata marmorata*) and the southwestern pond turtle (*Clemmys marmorata pallida*). Both subspecies were petitioned for federal listing as endangered or threatened on January 29, 1992. On October 5, 1992, the USFWS announced its 90-day finding stating that the petition presented sufficient information to indicate that listing may be warranted. The formal review process was initiated. In 1993, the USFWS determined that there was insufficient information to propose listing of the species. The western pond turtle is still a category 2 federal candidate species. The California Department of Fish and Game considers the western pond turtle to be a species of special concern.

Habitat Requirements

The western pond turtle is found in water that ranges fresh to brackish to seawater (Holland 1991). Pond turtles are found near a wide variety of wetlands, including ponds, marshes, lakes, streams, irrigation ditches, and vernal pools. Aquatic habitats with adequate vegetative cover and exposed basking sites are utilized. They are omnivorous generalists and opportunistic predators, eating small insects, aquatic invertebrates, fish, frogs, snakes, birds, and mammals.

Pond turtles may live for 30 to 40 years, grow slowly, and may take up to 8 years to reach sexual maturity. Mating occurs in April and May, after which females build nests along wetland margins or in adjacent uplands (Rathbun et al 1991). Oviposition requires soil which is at least 10 cm deep, and usually takes place in a southern exposure at a site which will not flood. Females leave the watercourse in late afternoon and evening, and travel into adjacent uplands to build nests. Oviposition occurs in July and August, with hatchlings emerging in approximately 12 weeks.

Distribution

The western pond turtle occurs in suitable aquatic habitats throughout California west of the

Sierra Nevada and in parts of Oregon and Washington. The northwestern pond turtle is found north of San Francisco Bay, while the southwestern pond turtle is found south of San Francisco Bay. There is evidence to suggest that the two subspecies may intergrade between the San Francisco Bay region and the San Joaquin Valley. USFWS has indicated the northwestern pond turtle to be the subspecies of concern in Suisun Marsh (Simons, 1993).

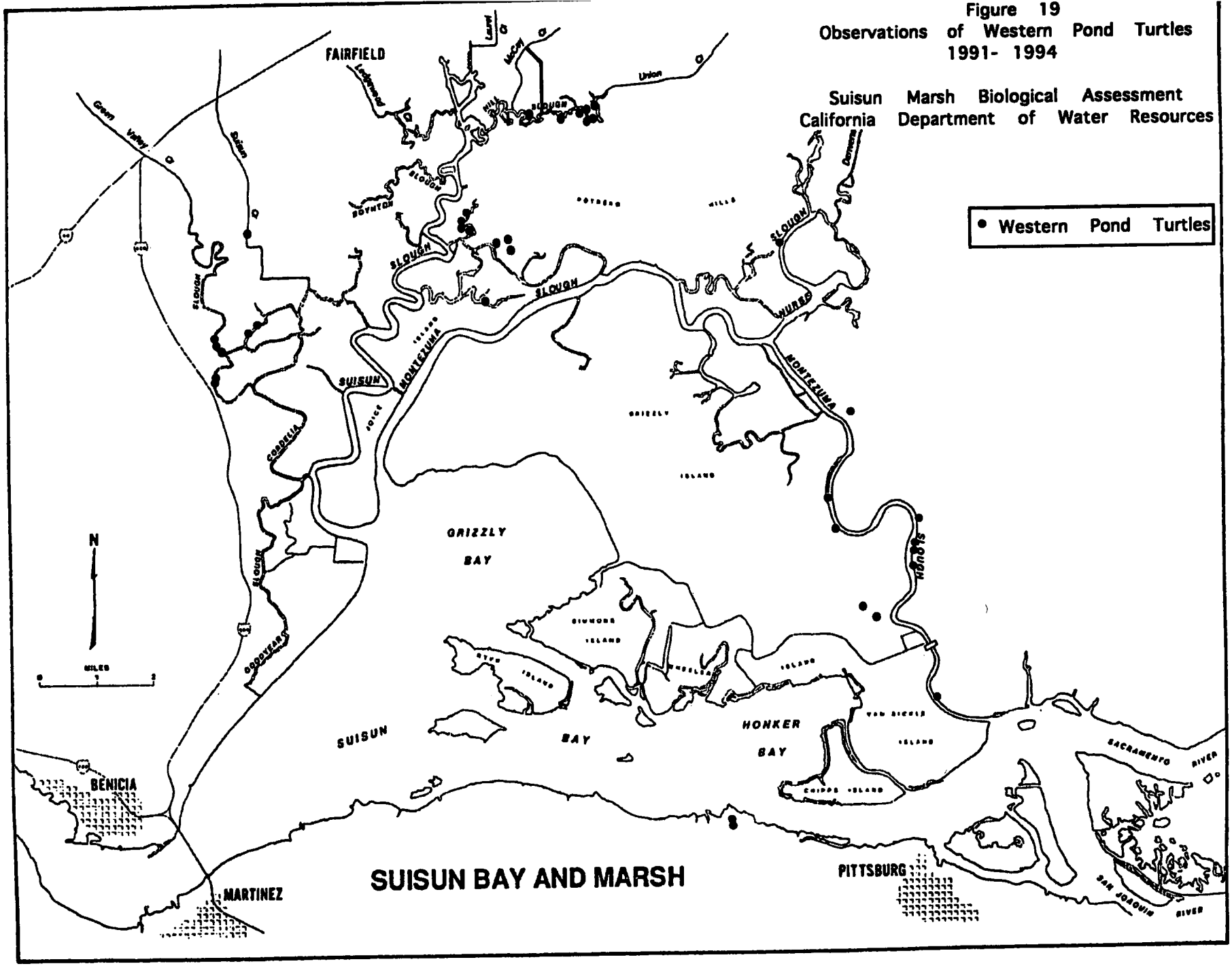
Systematic boat surveys of sensitive species habitat have been conducted by Department of Water Resources staff throughout Suisun Marsh since 1991. These surveys have focused on the detection of sensitive plant and bird species. The presence or absence of basking western pond turtles has been incidental to these other specialized surveys, but observations of pond turtles have been recorded. Western pond turtles are present in Suisun Marsh. Pond turtles bask of the water side of natural tidal marsh channel banks at low tides which correspond with sunlight exposure hours. Western pond turtles have been observed basking on mud banks adjacent to Hill Slough, Nurse Slough, Cutoff Slough, First Mallard Branch, Second Mallard Branch, Boynton Slough, Peytonia Slough, Frank Horan Slough, and Cordelia Slough (Figure 19).

Habitat Salinity Conditions

The proposed salinity standards will not result in a loss of habitat for western pond turtles, and are not expected to change the distribution of the species.

Figure 19
Observations of Western Pond Turtles
1991- 1994

Suisun Marsh Biological Assessment
California Department of Water Resources



California Tiger Salamander,
Ambystoma californiense

Status

The California tiger salamander (*Ambystoma californiense*) is a Category 2 federal candidate species, and is designated a California species of special concern.

Habitat Requirements

California tiger salamanders occupy annual grasslands and occasionally open woodlands. Large vernal pools are required for breeding and larval development (Feaver, 1971). Rodent burrows or other underground cavities are required for shelter in adjacent uplands. California tiger salamanders are absent from waters containing fish (Shaffer and Fisher 1990).
No critical habitat has been designated for the species, but annual grasslands with vernal pools are prime habitat.

Distribution

The range of the tiger salamander includes the Central Valley of California and low foothills from the Dunnigan Hills of western Yolo County south to Kern County, and coastal lowlands from Sonoma County into Santa Barbara County.

Habitat Salinity Conditions

California tiger salamander habitat is not present in the tidal wetlands of Suisun Marsh. The tidal sloughs, and permanent and seasonal wetlands in the project area all support fish, and these salamanders do not coexist with fish. The closest confirmed population is approximately 26 kilometers northeast of the project area at The Nature Conservancy/University of California Jepson Prairie Preserve.

Western Spadefoot Toad,
Scaphiopus hammondi hammondi

Status

The western spadefoot toad (*Scaphiopus hammondi hammondi*) has been recommended for Category 2 federal candidate species status. It is designated as a Species of Special Concern by the California Department of Fish and Game.

Habitat Requirements

Western spadefoot toads occupy valley and foothill grasslands, open chaparral, and pine-oak woodlands where temporary pools are present. Open grasslands with shallow temporary pools are considered to be ideal habitat.

Distribution

The western spadefoot toad is found throughout the Central Valley and surrounding foothills from near sea level to the 4500 foot elevation. Individuals have been observed in the Sacramento Valley to the northeast of the Delta near Sloughhouse and to the northwest near Dunnigan. The nearest documented population to Suisun Marsh is approximately 26 kilometers northeast at The Nature Conservancy/University of California Jepson Prairie Preserve.

Habitat Salinity Conditions

Potential habitat for the western spadefoot toad is not present in the areas of Suisun Marsh influenced by tidal channels. This species is not expected to be impacted by the proposed salinity standards.

CANDIDATE AVIAN SPECIES

Suisun Song Sparrow,
Melospiza melodia maxillaris

Status

The Suisun song sparrow (*Melospiza melodia maxillaris*) is a Category 2 candidate species for protection under the federal law. The Suisun song sparrow was recently considered by the California Fish and Game Commission for possible state listing as threatened, but no action was taken (Larsen, 1989).

Habitat Requirements

The Suisun song sparrow subspecies prefers tall emergent vegetation (tules, cattails, and sedges) that grows in brackish conditions. The birds breed earlier than upland subspecies which helps avoid nest flooding during the highest spring tides; occupy and nest in bulrush and cattails with stems 7.6 to 10 centimeters apart; and feed on invertebrates and seeds directly on the surface of mud exposed at low tides (Larsen, 1989).

Territories are typically associated with undiked tidal marshes along tidal sloughs, creeks, or the bayshore. There is no evidence that they occupy managed marsh areas marsh areas that are not subjected to unimpeded daily tidal fluctuations (Larsen, 1989). These small passerines are highly sedentary throughout there lifespan. Young disperse within approximately 200 meters from nests; adult breeding territories shift less than 16 meters from centers from year to year; and the birds rarely move a distance of approximately 10 meters away from channel-edge tule cover into open marsh (Marshall 1948).

Distribution

The Suisun song sparrow is one of three subspecies of song sparrows resident to the tidal and brackish marshes of the Bay Region (Marshall 1948, Marshall and Dedrick 1993). The Alameda (salt marsh) song sparrow occurs in the South Bay north to Redwood City on the west and Albany on the east; the San Pablo (Samuel's) song sparrow occurs in the marshes of Marin County and San Pablo Bay; and the Suisun song sparrow is endemic to the brackish tidal marsh habitat along the shoreline of Suisun Bay and in Suisun Marsh from Benicia upstream to the Delta. The Suisun song sparrow is particularly vulnerable to changes in salinity regimes, because it nests only in tidal tule marshes in Suisun Bay and Suisun Marsh (Scollon 1993).

Habitat Salinity Conditions

Suisun song sparrows are endemic to the brackish tidal marshes of Suisun Marsh. The birds are physiologically adapted to allow direct consumption of brackish water and are dependent on water in this salinity range (Bartholomew and Cade 1963). This adaptation to salinity serves to isolates the subspecies from upland subspecies which only tolerate freshwater (Basham and Mewaldt 1987). Increases in salinity could adversely affect the Suisun song sparrow, as they cannot maintain body weight on seawater. Brackish salinity levels in tidal marsh channels should be maintained to avoid changes in marsh vegetation which could result from increased soil salinity (Granholm and Bobker 1994). A goal of the proposed salinity standards is to maintain a natural gradient of brackish channel water conditions in throughout Suisun Marsh. Therefore, the standards should maintain channel salinity conditions required by the Suisun song sparrow, and should not pose a threat to this species.

Salt Marsh Common Yellowthroat,
Geothylpis trichos sinuosa

Status

The salt marsh common yellowthroat (*Geothlypis trichas sinuosa*) is a Category 2 candidate species for protection under the federal law. The species is not listed under the California Endangered Species Act.

Habitat Requirements

Salt marsh yellowthroats utilize dense vegetative growth associated with wetland conditions and high densities of insects. The plant communities preferred by yellowthroats for breeding include brackish marsh, freshwater marsh, and woody swamp areas with dense, tangled vegetation for constant concealment. The birds are most often observed in coyote bush (Baccharis pilularis) or emergent tule (Scirpus) and cattail (Typha) stands close to the water.

Birds arrive in their breeding territories in mid-March. Nest building activities begin in mid to late April. Nest form is variable depending on vegetation composition of the breeding habitat, and nests are often built in tall tules over the water. Both adults care for the nestlings and fledglings, and a second brood is often produced. Courtship and territories are re-established for the second brood, and second clutches are usually fledged by mid-July.

Distribution

The common yellowthroat (Geotyhylpis trichos) is a small, marsh-dwelling warbler. There are twelve subspecies of this parulid warbler, with three subspecies known to the western states (AOU 1957). The salt marsh subspecies (sinuosa) was first described as being smaller, dorsally and laterally darker, and with shorter wing length than the other subspecies (Grinnell 1901). The plumage differences between subspecies can only be distinguished during post-breeding season molt which occurs between July and September.

The salt marsh yellowthroat is found year-round in the San Francisco Bay region. The subspecies is believed to winter in coastal marshes as far south as San Diego County. It breeds in fresh and brackish marshes around the inland margins of San Francisco Bay east to Carquinez Straits, and in coastal marshes from Tomales Bay to Pescadero Marsh (Foster 1977). Salt marsh yellowthroats migrate from fresh to brackish marsh breeding sites to bayward salt marshes in the fall when seasonal emergent marsh vegetation dies back (Foster 1977).

Hobson, et al (1985) recorded a total of 569 breeding pairs of salt marsh yellowthroats at 23

locations throughout the Estuary. Breeding pairs were detected in Alameda, Santa Clara, San Mateo, San Francisco, Marin, Sonoma, and Napa Counties. Birds were mist-netted and banded at Joice Island in Suisun Marsh, the Suisun Bay shoreline near Benicia, and the Benicia State Recreation Area to determine the subspecific identity of yellowthroats in Suisun Marsh and the Carquinez Straits (Hobson et al 1985). The results of these surveys were inconclusive. To date, the breeding range of the salt marsh yellowthroat subspecies is undefined (Marshall and Dedrick 1993).

Habitat Salinity Conditions

Reductions in freshwater inflow to estuarine marshes are believed to negatively affect the salt marsh yellowthroat through reduced abundance of vegetation and insects (Foster 1977). Breeding season surveys during the 1970's drought encountered low numbers of breeding pairs. The intent of the salinity standards proposed for Suisun Marsh is to maintain the historic brackish conditions in this region. The salinity standards are not expected to impact salt marsh common yellowthroats.

Ferruginous hawk,
Buteo regalis

Status

Ferruginous hawk (*Buteo regalis*) is designated a species of special concern by the California Department of Fish and Game. The USFWS qualified it for Category 2 candidacy based on the fact that data indicates the possible appropriateness of listing, but the Service feels that further information is still needed.

Habitat Requirements

This large buteo requires dry, open country with an abundant prey base of small mammals. This raptor perches on trees, on poles, or on the ground.

Distribution

Ferruginous hawks are known to the western United States. Breeding populations are present in the Great Plains. California is within the winter range of the species.

Winter observations of ferruginous hawks in the vicinity of Suisun Marsh have been recorded by Department of Water Resources biologists (Grewell, 1993). Observations are not common, and have been limited to the upland areas of the Potrero Hills, open grasslands along the Birds Landing - Collinsville Road in the Montezuma Hills, grassland areas west of the Fairfield/Cordelia urban development along Green Valley Creek, and in the upland pheasant hunting areas adjacent to Chadbourne Road. Christmas bird count records of the Napa - Solano Audubon Society have consistently recorded ferruginous hawks in the American Canyon, I-80 corridor near Cordelia, Chadbourne Road region, and along the Luther Gibson Highway west of Suisun Marsh (Leong, Personal Communication, 1994).

Habitat Salinity Conditions

Ferruginous hawks are known to winter and forage along the upland edges surrounding the wetland areas of Suisun Marsh. Water salinity standards proposed for the Estuary are not expected to impact this species.

CANDIDATE MAMMAL SPECIES

Suisun Ornate Shrew,
Sorex ornatus sinuosus

Status

The Suisun ornate shrew (*Sorex ornatus sinuosus)* is a Category 1 candidate species for federal protection. This small mammal is designated a Species of Special Concern by DFG.

The Suisun ornate shrew was originally considered a distinct species, Sorex sinuosus, and was thought to be restricted to Grizzly Island. Cromosomal comparisons have been used to determine that two subspecies of shrew, no hybrids, and no full species occupy the north Bay (Brown and Rudd 1981).

Habitat Requirements

Suisun ornate shrews occupy salt to brackish tidal marshes characterized by cordgrass, gumplant, California bulrush, and common cattails (Williams 1986). They require dense, low-lying cover, and an abundance of invertebrate food sources. Driftwood and other tide "wrack" or litter above the mean high tide line is essential for forage and nesting sites. Upland habitats contiguous with tidal marshes may offer refuge from extreme high tides. Hays (1990) found Suisun ornate shrews using pickleweed, jaumea, and arrowgrass plant associations on the Rush Ranch of Suisun Marsh. The density of shrews varied throughout the trapping study in the Cutoff Slough tidal marshes, from 10 per hectare to 100 per hectare. The aggregation of the species did not semm to be correlated with a specific vegetation type (Hays 1990).

Suisun ornate shrews inhabitat a smaller area, and are more restricted in the habiats they occupy than Salt marsh harvest mice. Suisun ornate shrews feed on insects, small crustaceans and amphipods (WECO, 1986; Hays 1990). Diked marshes which experience muted tidal action through water control structures may not be able to support enough invertebrate food sources for Suisun ornate shrews (WESCO 1986). Recent studies on invertebrate food sources for waterfowl in diked pickleweed marshes of Suisun Marsh suggest that Suisun ornate shrews could possibly occupy these habitat types (Batzer et al. 1993). A species status report prepared for DFG also recognized this possibility, and recommended that marshland management practices and plans be reviewed to determine their impact on populations of Suisun ornate shrews (Willliams, 1986).

Distribution

Suisun ornate shrew is known to fragmented, isolated relict tidal salt and brackish marshes associated with San Pablo Bay, the tidal reach of the Petaluma and Napa Rivers, and Suisun Marsh (WESCO, 1986). The western boundary of the range of the species is Tubbs Island and the tidal reach of Sonoma Creek in Sonoma County. The eastern boundary is Grizzly Island in Suisun Marsh. Historically, Suisun ornate shrews were found as far north as Suisun City in Suisun Marsh (Rudd, 1955).

Very few investigations into the occurrence of this species can be found in the literature. Most of the documentation of presence in Suisun Marsh occurred before the 1984 Plan of Protection. A thesis project by Hays (1990) at the Rush Ranch resulted in recent documentation of species presence in Suisun Marsh. The only other known trapping effort since 1984 was by WESCO in 1986. The results of these efforts are shown in Figure 20. Trapping efforts detected Suisun ornate shrews in the tidal marshes of Rush Ranch associated with Cutoff Slough. A single record from the Volanti Duck Club at Suisun Slough south of Cutoff Slough was reported by WESCO (1986). Trapping efforts near Hill Slough, Luco Slough, Denverton Slough, Nurse Slough, Morrow Island, and Grizzly Island did not detect the presence of Suisun ornate shrew (WESCO 1986).

Estuary wide distribution of the species is shown in Figure 21. The only modern record for Suisun ornate shrew outside of Suisun Marsh is from Mare Island at the Carquinez Strait (NDDB 1994).

Habitat Salinity Conditions

Channel water salinity in Cutoff Slough is known to be directly influenced by the Suisun Marsh Salinity Control Gates. Brackish water salinity regimes are present in this area (DWR 1994). Channel water salinity data is not available for the Mare Island population. However, it is assumed to be more saline than salinity observed upstream within Suisun Marsh. The present distribution of this species suggests that proposed SMPA salinity standards for Suisun Marsh would not be limiting to the Suisun ornate shrew.

Figure 20
Observations of Suisun Ornate Shrew
1986 and 1990
(WESCO, 1986 and Hayes, 1990)

Suisun Marsh Biological Assessment
California Department of Water Resources

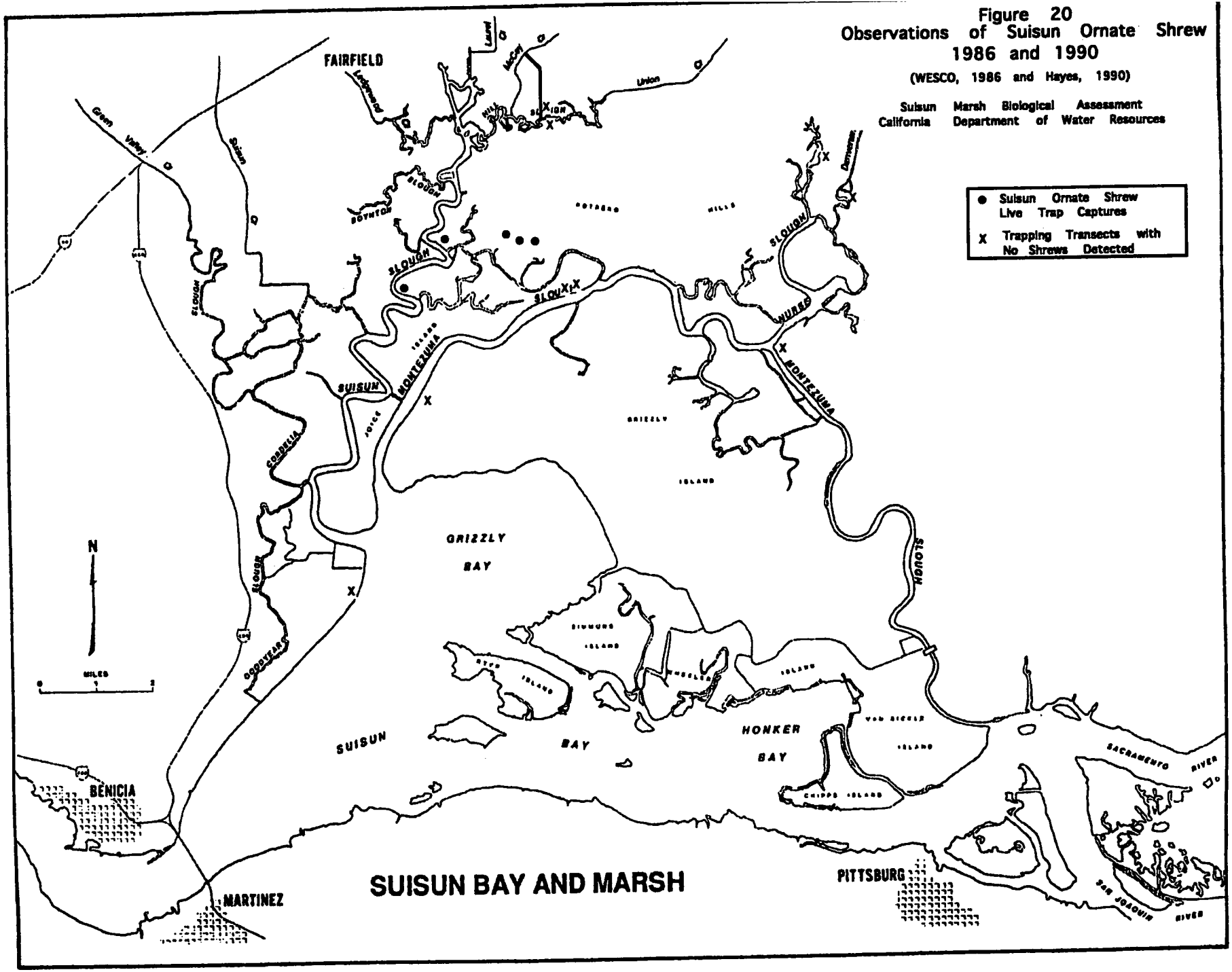
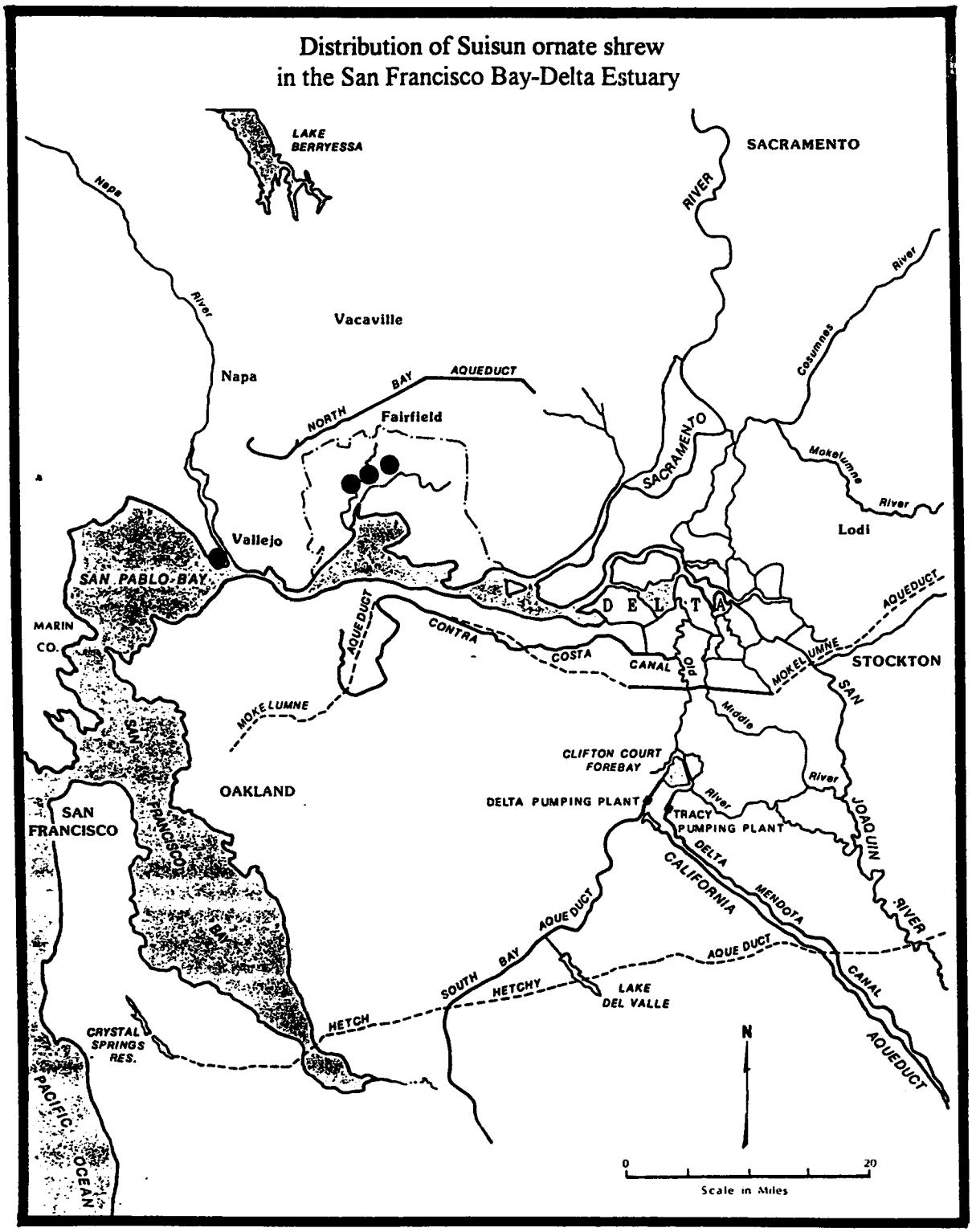


Figure 21


Distribution of Suisun ornate shrew
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
Vallejo
SAN PABLO BAY
MARIN CO.
SACRAMENTO RIVER
SACRAMENTO
Cosumnes River
Mokelumne River
Lodi
D E L T A
AQUEDUCT
CONTRA COSTA CANAL
Old
MOKELUMNE AQUEDUCT
STOCKTON
SAN
Middle
River
JOAQUIN
RIVER
MOKELUMNE AQUEDUCT
CLIFTON COURT FOREBAY
DELTA PUMPING PLANT
TRACY PUMPING PLANT
DELTA MENDOTA CANAL
CALIFORNIA AQUEDUCT
OAKLAND
SAN FRANCISCO
SAN FRANCISCO BAY
SOUTH BAY AQUEDUCT
HETCHY AQUE DUCT
LAKE DEL VALLE
HETCH HETCHY
CRYSTAL SPRINGS RES.
PACIFIC OCEAN
N
0
20
Scale in Miles

POTENTIAL IMPACTS TO CANDIDATE PLANT SPECIES

Suisun Thistle,
Cirsium hydrophilum var. *hydrophilum*

Status

Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) is a Category 1 candidate species for federal protection. It is on the CNPS 1B list of plants which are rare, threatened, or endangered in California or elsewhere.

Habitat Requirements

Suisun thistle is a member of the Asteraceae. This biennial species is limited to the banks of small first order tidal channels in the upper elevational zones of undiked natural tidal marsh habitat. It is also found along mosquito recirculation ditches in high marsh zones. Potential threats to the species include conversion of wetland type from undiked natural tidal marsh to diked seasonal wetlands, water development projects such as tide gate structures which alter the natural tidal hydrologic regime, urban encroachment on sensitive marsh habitat, vehicular and mechanical equipment operations associated with mosquito abatement activities, and cattle grazing in tidal marsh areas.

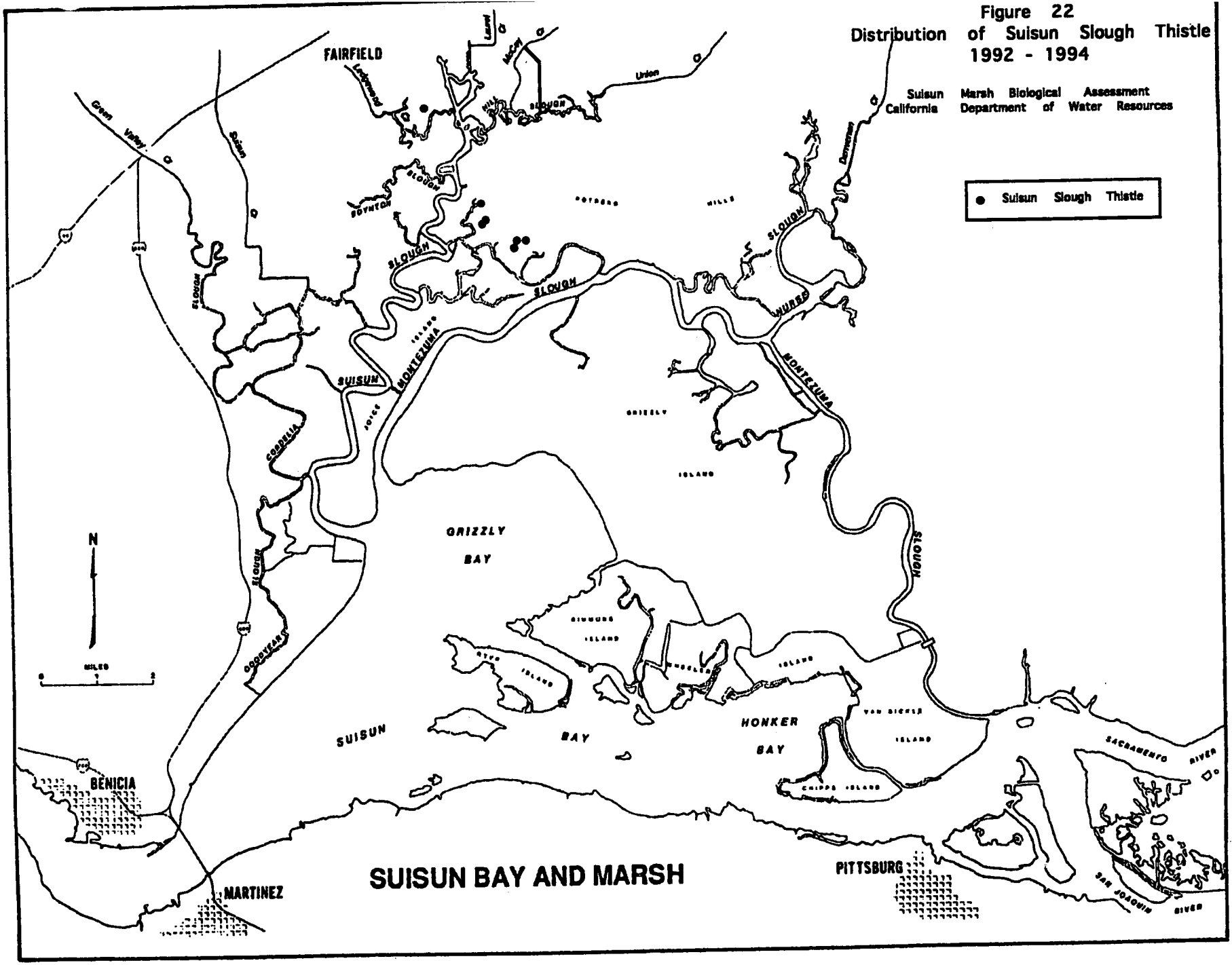
Distribution

Suisun thistle is historically known only to Suisun Marsh. It was at one time thought to be extinct due to hybridization with the introduced bull thistle (*C. vulgare*). Department of Water Resources rare plant surveys in Suisun Marsh have documented the presence of two populations of Suisun thistle (Figure 22). Extensive searches for this plant have been made in suitable undiked tidal wetland habitat throughout the marsh. There is very little relict undiked tidal marsh habitat remaining in the western Suisun Marsh. Most of the historic tidal marshes have been converted to managed seasonal wetlands. The narrow fringe marshes on the outboard sides of the levees do not harbor the natural elevations zones of the historic tidal marshes. Floristic surveys have been conducted through the seasons along every fringe marsh of the western Suisun Marsh tidal sloughs. This plant appears to be the rarest sensitive species known to Suisun Marsh.

The largest population is in the high marsh zones of the Rush Ranch tidal marsh. This population has been observed in 1991, 1992, 1993, and 1994. In 1992, a second population was

Figure 22
Distribution of Suisun Slough Thistle
1992 - 1994

Suisun Marsh Biological Assessment
California Department of Water Resources



SUISUN BAY AND MARSH

documented in the Peytonia Slough Ecological Reserve south of Suisun City. This Peytonia Slough population has been observed in 1992, 1993, and 1994. These are also the only populations known to the Estuary as a whole (Figure 23).

Habitat Salinity Conditions

Suisun thistle is known to tidal wetlands influenced by channel salinity in Peytonia Slough and Cutoff Slough. These populations are in the northern region of Suisun Marsh. The closest channel salinity recording stations to the populations are Suisun Slough at Volanti (S-42), Montezuma Slough at Beldon's Landing (S-49), and Hill Slough at Grizzly Island Road (S-4) (DWR, 1994). These populations may also be influenced by seasonal freshwater inflows from Ledgewood Creek, Union Creek, and McCoy Creek. These watersheds flow through the urban Fairfield area and carry precipitation and urban runoff into Suisun Marsh. McCoy Creek is also a wasteway for the Putah South Canal.

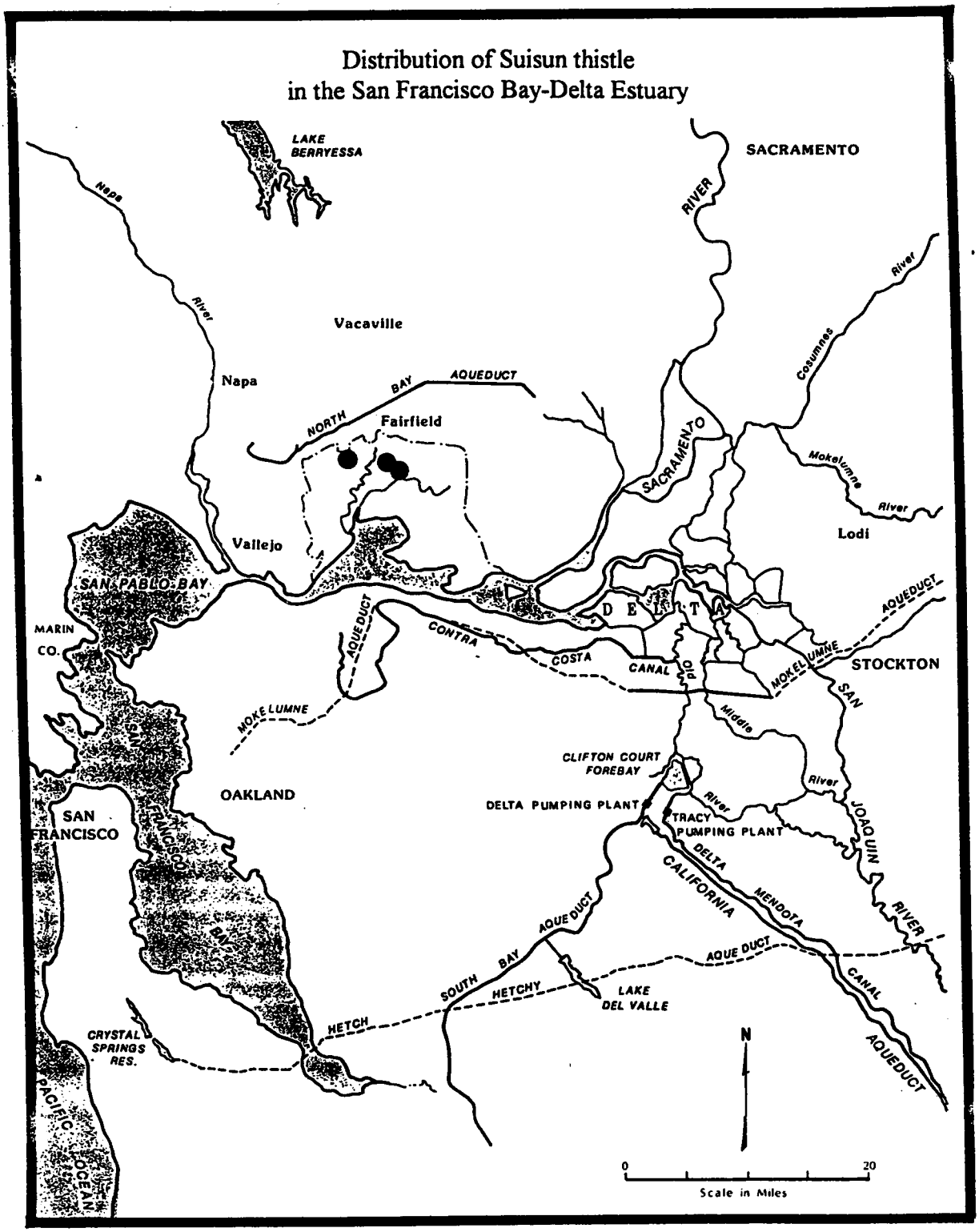
Mean daily specific conductance recorded in Montezuma Slough at Beldon's Landing ranged from 864 - 18,733 mS in water year 1991; 1,484 - 19,807 mS in water year 1992; and 616 - 19,689 mS in water year 1993 (Table 2). Mean daily specific conductance recorded in Suisun Slough at Volanti ranged from 2,867 - 17,726 mS in water year 1991; 2,814 - 18,975 mS in water year 1992; and 1,385 - 18,669 mS in water year 1993 (Table 2). The salinity trend recorded at the Hill Slough station ranged from 2,348 - 14,558 mS in 1991; 1,844 - 16,349 mS in 1992; and 698 - 16,012 mS in 1993 (Table 2). Salinity trends at these stations during the survey years are presented in Figures 2 - 4. The Beldon's Landing and Hill Slough stations are reflective of eastern marsh salinity conditions, and are influenced by the Suisun Marsh Salinity Control Gates. The Suisun Slough at Volanti recording station is representative of salinity conditions in the western marsh (DWR 1994).

Salinity measured as monthly high tide predicted daily mean specific conductance (compliance measurement) is calculated for the Beldon's Landing (S-49)and Suisun Slough at Volanti (S-42) stations. These data are not generated for the Hill Slough station, because it is not a compliance station.

Salinity observed in Montezuma Slough at Beldon's Landing exceeded D-1485 target salinity levels in February of the 1991 water year (DWR 1994). Salinity was within D-1485 target objectives at this site during the 1992 and 1993 water years (DWR 1994). Salinity measured as monthly high tide pdm specific conductance were below target SMPA deficiency standards in all survey years (DWR, 1994).

Channel water salinity at western Marsh stations such as Suisun Slough at Volanti station (S-42) have generally been below D-1485 and SMPA deficiency target objectives in wet years or water years following wet periods, such as 1985, 1986, 1987, and 1994. However, during prolonged dry or critically dry periods, salinity in the western Marsh stations is often above these objectives

Figure 23


Distribution of Suisun thistle
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
SACRAMENTO RIVER
SACRAMENTO
Cosumnes River
Mokelumne River
Lodi
Vallejo
SAN PABLO BAY
MARIN CO.
AQUEDUCT
CONTRA COSTA CANAL
D E L T A
Old
MOKELUMNE AQUEDUCT
STOCKTON
SAN
Middle
MOKELUMNE
CLIFTON COURT FOREBAY
River
OAKLAND
DELTA PUMPING PLANT
TRACY PUMPING PLANT
JOAQUIN RIVER
SAN FRANCISCO
SAN FRANCISCO BAY
DELTA CALIFORNIA MENDOTA CANAL
AQUEDUCT
SOUTH BAY AQUEDUCT
HETCHY AQUE DUCT
LAKE DEL VALLE
HETCH HETCHY
CRYSTAL SPRINGS RES.
PACIFIC OCEAN
N
0
20
Scale in Miles

(DWR 1994).

Suisun thistle site checks in 1994 showed size increases over population sizes observed in previous years. It is possible that the increases were a response to channel water salinity freshening in the above normal 1993 water year. There is very limited information available regarding this species. Populations should be closely monitored in the coming years to establish habitat relationships.

Suisun Marsh Aster,
Aster lentus [Greene]

Status

Suisun marsh aster (*Aster lentus* [Greene]) is a Category 2 candidate species for federal listing. The plant has no state status, but the California Native Plant Society (CNPS) includes it on List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere. USFWS uses the name *Aster chilensis* var. *lentus* for this species as described in Munz & Keck (1968). Nomenclature according to the Jepson taxonomy is *Aster lentus*, and the species is known to grade into *A. chilensis* (Hickman, 1993).

Habitat Requirements

Suisun marsh aster is known to brackish and freshwater marshes. It occurs along brackish sloughs and riverbanks affected by tidal fluctuations. Associated plant species include other species that occur in wetlands including bulrushes, cattails, and rushes. The plants are most commonly found at or near the water's edge on the water side of Delta and marsh levees. Suisun marsh aster has also been observed on the landward side of channel levees along irrigation and drainage ditches in the Delta, and along duck club water distribution ditches in Suisun Marsh.

Distribution

Suisun marsh aster is a member of the Asteraceae (sunflower family) which is the largest family of dicotyledon plants in California and the world. This fall-blooming perennial has many violet-colored ray flowers. It is known from several locations in the Sacramento - San Joaquin Delta, Suisun Bay, Suisun Marsh, and the marshes associated with the Napa River north of San Pablo Bay. Populations have been documented in Sacramento, San Joaquin, Solano, Contra Costa, and Napa counties (CNPS 1994; NDD 1994).

Detailed surveys for Suisun marsh aster were conducted in October 1991 , October 1992, and October 1993 during the peak bloom period of this species. Department of Water Resources and Department of Fish and Game survey teams inspected all channel banks in the Western Salinity Control Project areas from shallow draft boats. In addition, transects were walked through tidal marsh areas which were not visible from the channel. A marsh-wide survey for the species was conducted in 1992 for the Suisun Marsh Biological Assessment for the SWRCB.

Department of Water Resources and Department of Fish and Game survey teams conducted Suisun marsh aster surveys throughout Suisun Marsh from shallow draft boats. Both channel banks of western marsh channels including Cordelia Slough, Goodyear Slough, Ibis Cut, Frank

Horan Slough, and Suisun Slough from Hunter Cut to Goodyear Slough were surveyed for this fall blooming species in October of 1991, 1992, and 1993 in support of the Western Suisun Marsh Salinity Control Project.

An intensive marsh-wide survey for the species was conducted in October 1992 as part of the Suisun Marsh Biological Assessment. The 1992 survey included the fringe tidal marshes along the levees all interior Suisun Marsh channels, and the bayshores of Suisun Bay, Grizzly Bay, Honker Bay, and Little Honker Bay. The larger contiguous undiked tidal marshes were also surveyed. All navigable tidal reaches of Suisun Slough, Peytonia Slough, Hill Slough, Boynton Slough, Sheldrake Slough, Cutoff Slough, First Mallard Branch, Second Mallard Branch, Wells Slough, Roos Cut, Hunter Cut, Goodyear Slough, Cordelia Slough, Ibis Cut, Frank Horan Slough, Chadbourne Slough, Montezuma Slough, Tree Slough, Cross Slough, Frost Slough, Hastings Slough, Nurse Slough, Luco Slough, Denverton Slough, Frost Slough, Kirby Hill Branch, Sacramento River confluence east to Collinsville, Spoonbill Creek, and Suisun Cutoff were surveyed. The entire shoreline of Ryer Island, Roe Island, Seal Island, Freeman Island, Snag Island, Brown's Island, Chipps Island, and Chain Island were surveyed.

Incidental sighting of Suisun marsh aster have been observed along perimeter water distribution ditches of private managed duck clubs within Suisun Marsh. These sightings are not common, but the species does appear along some ditches where year round water is present. This is the only sensitive plant species which has been observed within the diked managed wetlands. The landward side of these channel levees of these private lands were not surveyed. All surveys were conducted on public land, and from public waterways.

Care was taken to inspect all populations at close range to confirm presence of the species of concern. A second fall-blooming aster, *Aster subulatus* var. *ligulatus* (*A. exilis,* Elliott) is also a common annual aster in Suisun Marsh, and could be mistaken for the sensitive perennial aster. Species distribution, population size, and associated species were recorded.

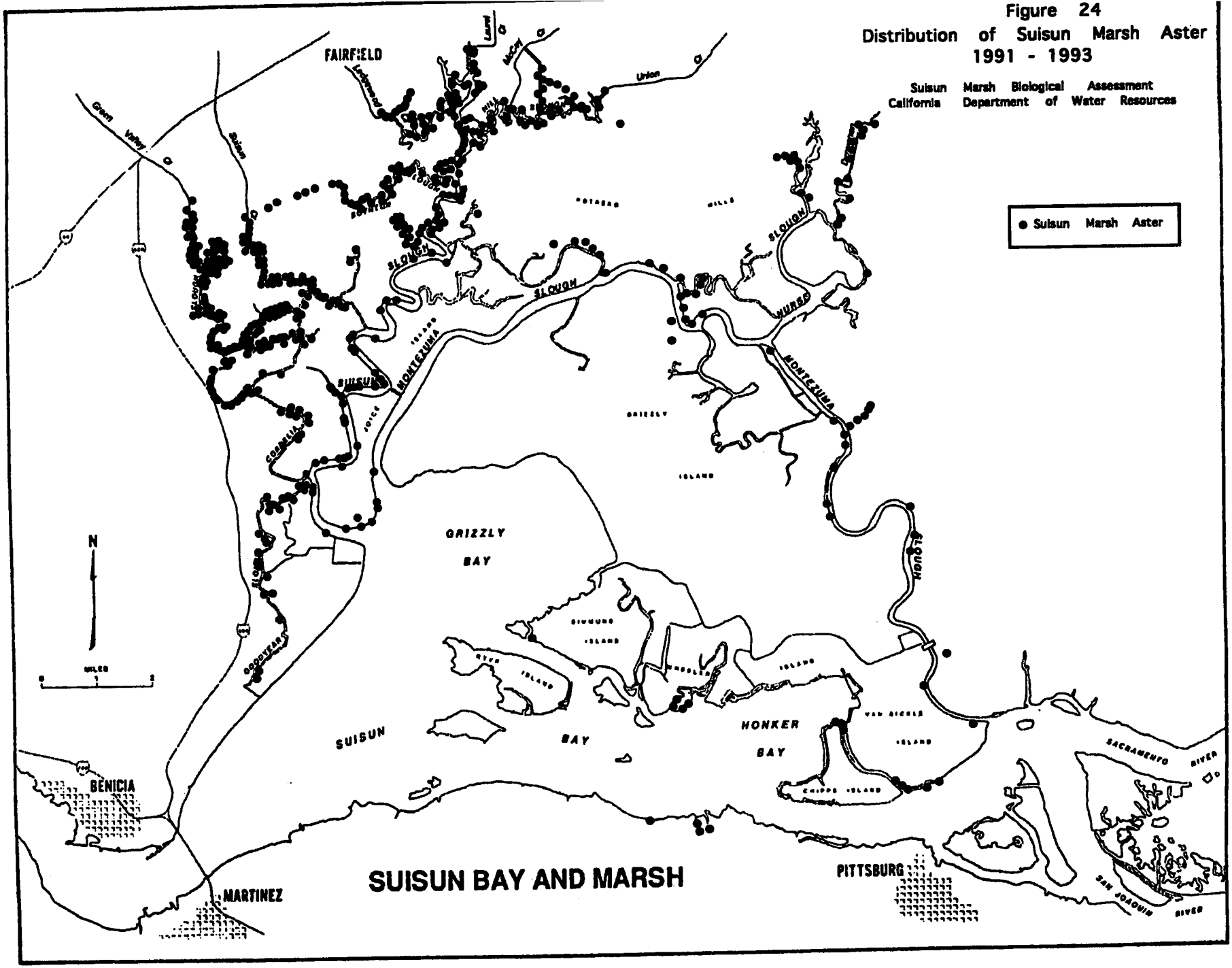
Suisun marsh aster is named for, and endemic to Suisun Marsh. The plant is still present throughout Suisun Marsh (Figure 24). Field surveys have located this species throughout most regions of the marsh. The purple blossoms of this fall blooming member of the sunflower family are a common October sight along northwestern Suisun marsh channels were population densities are greatest.

Surveys for Suisun marsh aster were limited to the Western Salinity Control Project study area in western Suisun Marsh during October 1993. Suisun aster was observed on the water side of the levees of Cordelia Slough, Ibis Cut, Frank Horan Slough, Chadbourne Slough, Suisun Slough, Goodyear Slough, Wells Slough, Boynton Slough, and the Golden Gate Club slough.

An intensive marsh-wide floristic survey conducted September 21 - October 22, 1992 documented populaitons of Suisun marsh aster along Luco Slough, Denverton Slough, Suisun Cutoff, Spoonbill Creek, Honker Bay shoreline, Contra Costa shoreline between Stake Point and

Figure 24
Distribution of Suisun Marsh Aster
1991 - 1993

Suisun Marsh Biological Assessment
California Department of Water Resources



Mallard Slough, Chipps Island, Suisun Bay shoreline at Van Sickle Island, Montezuma Slough, Spinner Island, Cross Slough, Peytonia Slough, Suisun Slough, Roos Cut, Wells Slough, Chadbourne Slough, Hill Slough, McCoy Creek, Sheldrake Slough, and Deadman Island.

DWR and DFG teams conducted floristic surveys for Suisun Marsh aster in the western marsh from October 22 - November 4, 1991. Suisun Marsh aster was recorded at Cordelia Slough, Frank Horan Slough, Ibis Cut, Cordelia Slough, Goodyear Slough, and Suisun Creek.

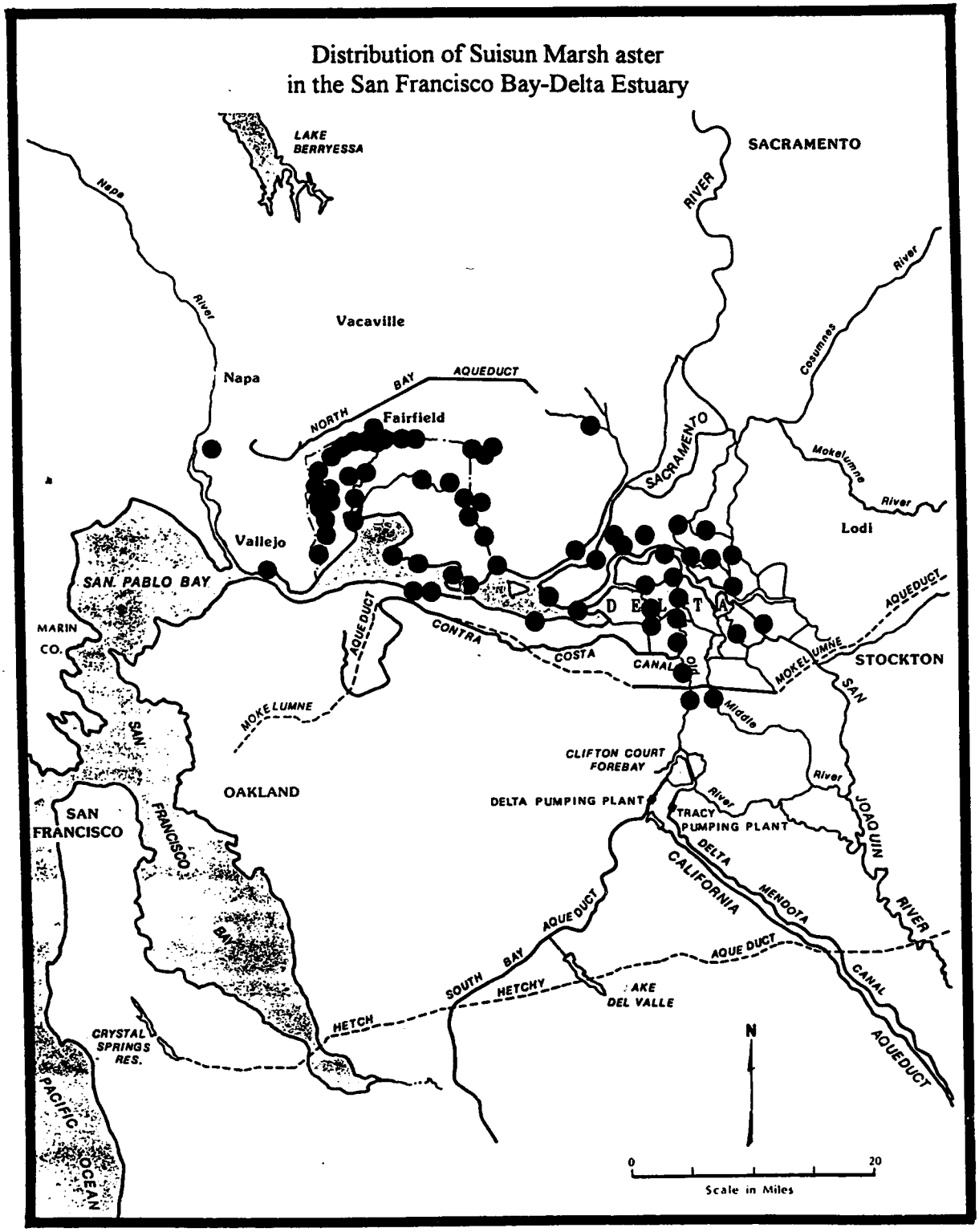
Suisun Marsh aster is annual species. The distribution of the species mapped at locations surveyed in all three years was compared for shifts in distribution. Some changes were noted, but the overall distribution was essentially the same in the western Marsh during three years of surveys.

A literature search was conducted to document the Estuary wide distribution of the species (Figure 25). Occurrences of Suisun Marsh aster were reported in NDDB (1994), Miriam Green Associates (1993a and b), Jones & Stokes (1990), ECOS (1990a and b), and O'Neil (1988). Suisun marsh aster is present throughout the western, central, and south Sacramento - San Joaquin Delta (Figure 25). The species has also been observed in the Southhampton Marsh near Benicia, and in the Fagan Slough Ecological Preserve associated with the Napa River. There are no documented occurrences from San Pablo Bay or San Francisco Bay.

Habitat Salinity Conditions

Suisun marsh aster is threatened by loss of wetland habitat and levee maintenance activities. Placement of riprap and/or dredge material on the outboard levees along tidal sloughs could directly impact the plants. The channel salinity regime resulting from all proposed standards is within the range of what influenced the species during these recent surveys. In fact, species in the southwestern Suisun Marsh along Goodyear Slough and lower Cordelia Slough were observed in vigorous conditions during years which salinity regimes exceeded proposed SMPA deficiency standards (DWR 1994). The occurrence of the species throughout freshwater marshes of the Delta suggests that freshwater conditions are also not limiting to this species. However, the Suisun marsh aster is absent in the salt marshes of San Pablo and San Francisco Bay. Maintaining brackish water salinity conditions should enhance the habitat conditions for Suisun marsh aster in critical water years.

Figure 25


Distribution of Suisun Marsh aster
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa River
Napa
Vacaville
NORTH BAY AQUEDUCT
Fairfield
Vallejo
SAN PABLO BAY
MARIN CO.
SAN FRANCISCO BAY
SAN FRANCISCO
OAKLAND
CRYSTAL SPRINGS RES.
PACIFIC OCEAN
HETCH HETCHY AQUEDUCT
SOUTH BAY AQUEDUCT
LAKE DEL VALLE
MOKELUMNE AQUEDUCT
CONTRA COSTA CANAL
SACRAMENTO RIVER
SACRAMENTO
Cosumnes River
Mokelumne River
Lodi
DELTA
STOCKTON
SAN JOAQUIN RIVER
Middle River
CLIFTON COURT FOREBAY
DELTA PUMPING PLANT
TRACY PUMPING PLANT
DELTA MENDOTA CANAL
CALIFORNIA AQUEDUCT
N
0
20
Scale in Miles

Delta Tule Pea,
Lathyrus jepsonii Greene ssp. *jepsonii*

Status

Delta tule pea (*Lathyrus jepsonii* Greene ssp. *jepsonii*) is classified as a Category 2 candidate species for federal protection under the Endangered Species Act. It has no state of California status. The California Native Plant Society includes Delta tule pea on List 1B: Plants rare, threatened, or endangered in California and elsewhere.

Habitat Requirements

Delta tule pea is a member of the Fabaceae (legume family). This perennial wild pea is native to freshwater and brackish marshes. This robust perennial occurs along sloughs, riverbanks, and levees affected by tidal fluctuations. The species is most commonly observed near the water's edge on the outboard side of tidal slough levees. It also occupies channel banks of undiked tidal marshes. Suisun Marsh populations are often observed partially inundated at high tide.

Distribution

Delta tule pea occurs on the Delta islands of the lower Sacramento and San Joaquin Rivers and westward through Suisun Bay, Suisun Marsh, Napa River marshes, and the wetlands around south San Francisco Bay. The plant has also been reported in San Benito and Fresno counties (CNPS, 1994).

Department of Water Resources and Department of Fish and Game teams have conducted floristic surveys in the Western Salinity Control Project area in 1991, 1992, and 1993. A marsh-wide survey for the species was conducted in 1992 as part of the Suisun Marsh Biological Assessment for SWRCB. Surveys for Delta tule pea were conducted during the May bloom period. Fringe tidal marshes along the outboard side of levees were surveyed from shallow-draft boats. Parallel transects were walked for extensive coverage of the larger undiked tidal marshes.

A pilot survey was conducted along Boynton Slough in 1990 to support the evaluation of the proposed Boynton-Cordelia Ditch. Both channel banks of western marsh channels including Cordelia Slough, Goodyear Slough, Ibis Cut, Frank Horan Slough, and Suisun Slough from Hunter Cut to Goodyear Slough were surveyed for this diminutive species in 1991, 1992, and 1993 in support of the Western Suisun Marsh Salinity Control Project. An intensive marsh-wide survey for the species was conducted in 1992 as part of the Suisun Marsh Biological Assessment. The 1992 survey included the low tide exposed intertidal zone of all interior Suisun Marsh

channels, and the bayshores of Suisun Bay, Grizzly Bay, Honker Bay, and Little Honker Bay. All navigable tidal reaches of Suisun Slough, Peytonia Slough, Hill Slough, Boynton Slough, Sheldrake Slough, Cutoff Slough, First Mallard Branch, Second Mallard Branch, Wells Slough, Roos Cut, Hunter Cut, Goodyear Slough, Cordelia Slough, Ibis Cut, Frank Horan Slough, Chadbourne Slough, Montezuma Slough, Tree Slough, Cross Slough, Frost Slough, Hastings Slough, Nurse Slough, Luco Slough, Denverton Slough, Frost Slough, Kirby Hill Branch, Sacramento River confluence east to Collinsville, Spoonbill Creek, and Suisun Cutoff were surveyed. The entire shoreline of Ryer Island, Roe Island, Seal Island, Freeman Island, Snag Island, Brown's Island, Chipps Island, and Chain Island were also surveyed.

Delta tule pea is present throughout the Suisun Marsh (Figure 26). Field surveys have located this species throughout most interior regions of the marsh. The species was mapped along Boynton Slough in 1990. Spring floristic surveys in 1991 documented occurences along Boynton Slough, Cordelia Slough, and Lower Joice Island.

Floristic surveys conducted from May 5, 1992 through June 26, 1992 throughout Suisun Bay and Marsh established population locations along Hill Slough, Peytonia Slough, Suisun Slough, Deadman Island, Goat Island, Sheldrake Slough, Roos Cut, Hunter Cut, Montezuma Slough, Cross Sloough, Frost Slough, Little Honker Bay, Chipps Island, and the Suisun Bay shoreline from Spoonbill Creek to Collinsville. Floristic surveys repeated in May 1993 covered the western Marsh area, where several physical facilities have been proposed in the Western Salinity Control Project (DWR and USBR 1993). Delta tule pea was present along Goodyear Slough, Frank Horan Slough, Cordelia Slough, Wells Slough, and Chadbourne Slough. The mapped distribution of this perennial species was nearly identical in the 1991 - 1993 surveys. These results suggest that yearly surveys may not required to establish the distribution of the species.

A literature search was conducted to establish the Estuary wide range of Delta tule pea (Figure 27). Occurences are most abundant, and have been reported throughout Suisun Marsh . Scattered records are also reported throughout the Delta (NDDB 1994; Miriam Green Associates 1993a and b; Jones & Stokes 1990; and ECOS 1990a and b). A few records have been reported from the Napa marshes, and an occurrence was reported a Southhampton Marsh near Benicia. A population was also reported from a brackish reach of a tidal creek in South San Francisco Bay.

Habitat Salinity Conditions

Delta tule pea is known to occupy habitat in freshwater marshes of the Delta. These populations are subject to lower channel salinity than is proposed in all Suisun Marsh salinity standards. Delta tule pea is also known to the brackish marshes of Suisun and Napa marshes. The populations of Delta tule pea observed in Suisun Marsh were fairly evenly distributed throughout the eastern and western marsh. This suggests a tolerance to a wide range of brackish salinity regimes. The

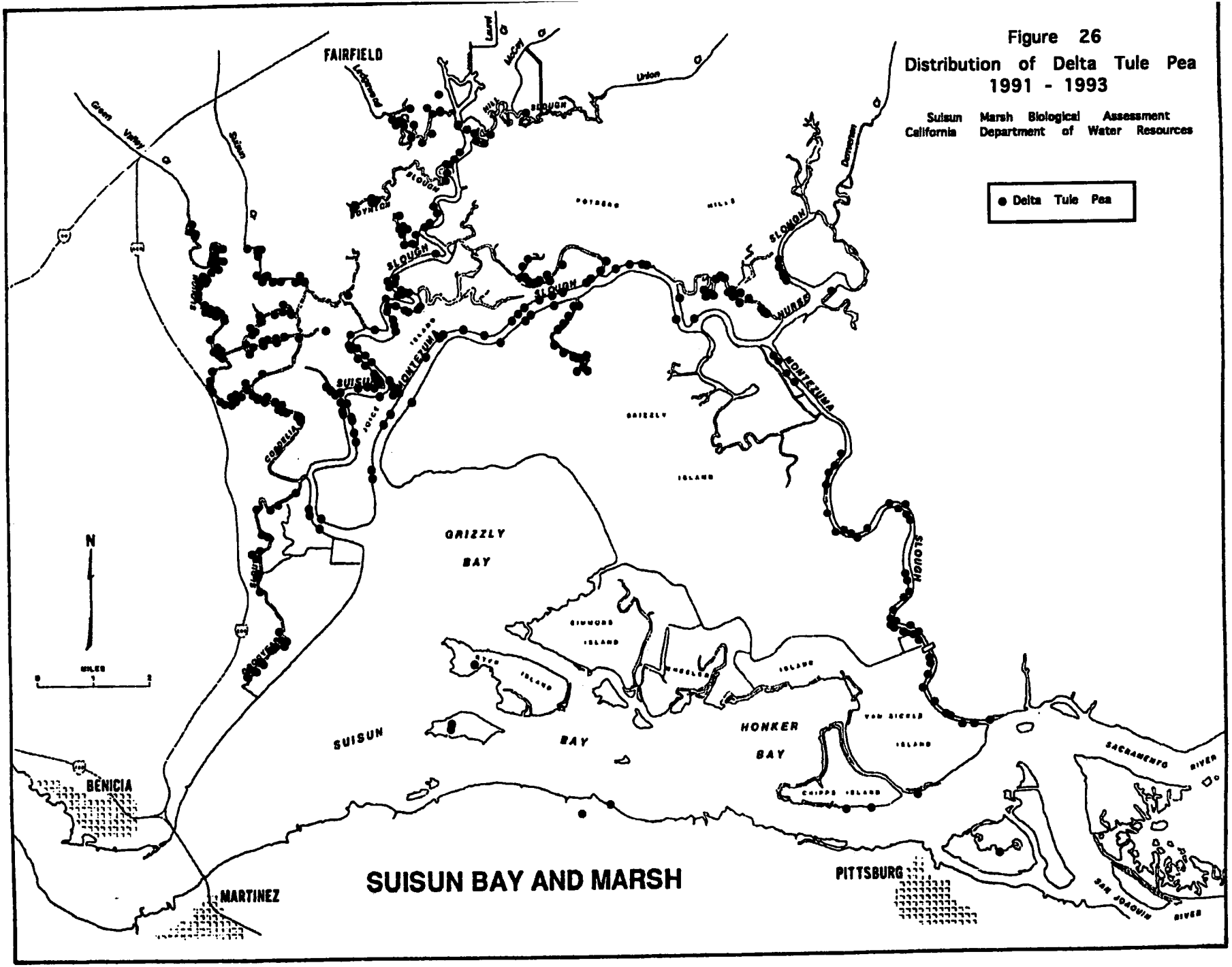
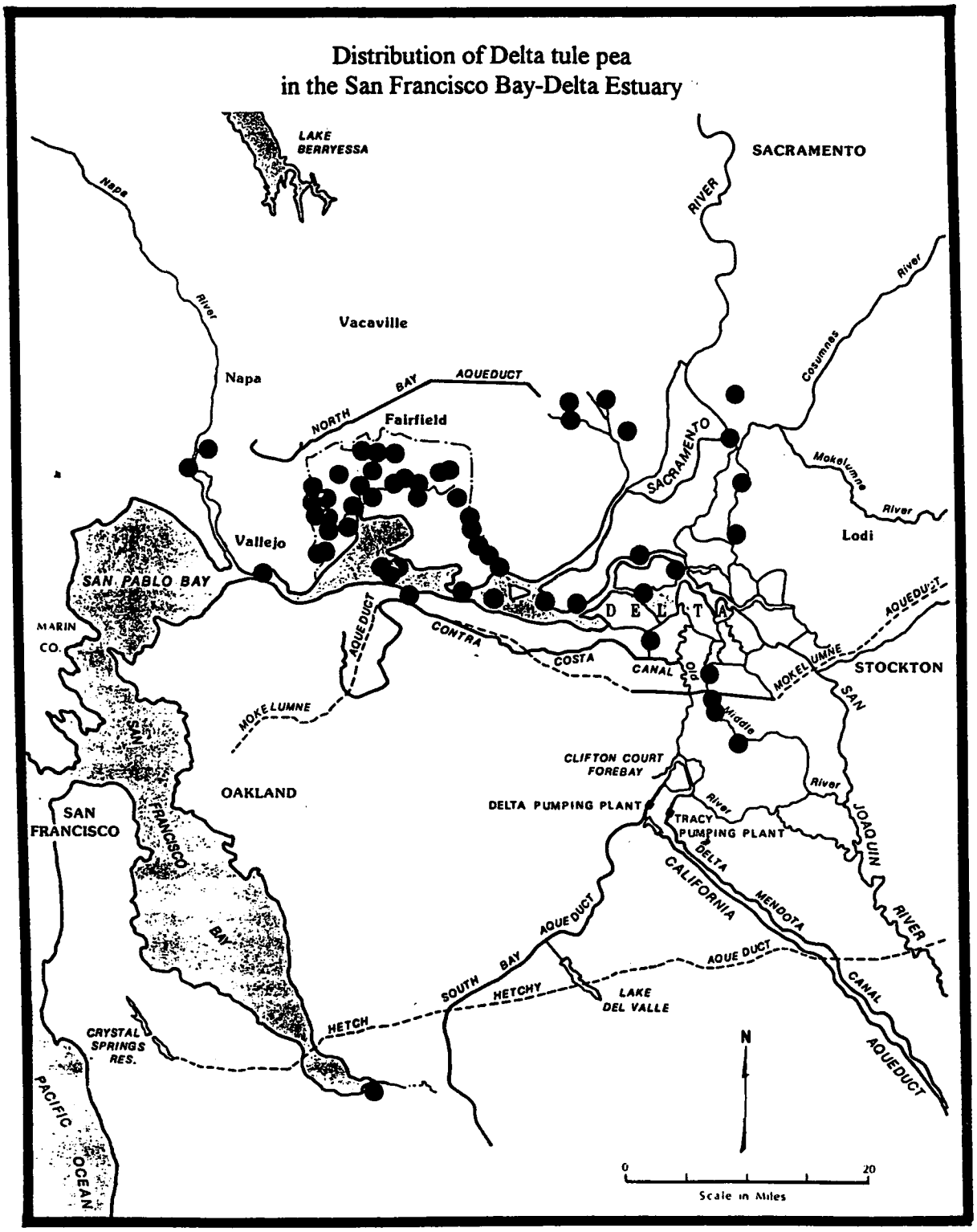

FAIRFIELD
Green Valley
Suisun
Lagoon
Union
Denverton
SLOUGH
SUISUN
CORDELIA
JOICE
ISLAND
MONTEZUMA
HUNTER
GRIZZLY
BAY
SIMMONS
ISLAND
RYER
ISLAND
HONKER
BAY
VAN SICKLE
ISLAND
CHIPPS ISLAND
SUISUN
BAY
BENICIA
MARTINEZ
PITTSBURG
SACRAMENTO
RIVER
SAN JOAQUIN
RIVER
N
MILES
SUISUN BAY AND MARSH
Figure 26
Distribution of Delta Tule Pea
1991 - 1993
Suisun Marsh Biological Assessment
California Department of Water Resources
Delta Tule Pea

Figure 27


Distribution of Delta tule pea
in the San Francisco Bay-Delta Estuary
LAKE BERRYESSA
Napa River
Vacaville
Napa
NORTH BAY AQUEDUCT
Fairfield
Vallejo
SAN PABLO BAY
MARIN CO.
SAN FRANCISCO BAY
SAN FRANCISCO
OAKLAND
PACIFIC OCEAN
CRYSTAL SPRINGS RES.
HETCH HETCHY AQUEDUCT
SOUTH BAY AQUEDUCT
LAKE DEL VALLE
MOKELUMNE AQUEDUCT
CONTRA COSTA CANAL
SACRAMENTO RIVER
SACRAMENTO
Cosumnes River
Mokelumne River
Lodi
D E L T A
STOCKTON
SAN JOAQUIN RIVER
Middle River
CLIFTON COURT FOREBAY
DELTA PUMPING PLANT
TRACY PUMPING PLANT
DELTA MENDOTA CANAL
CALIFORNIA AQUEDUCT
N
0
20
Scale in Miles

Contra Costa Goldfields,
Lasthenia conjugens Greene

Status

Contra costa goldfields (*Lasthenia conjugens* Greene) is a Category 1 candidate species for federal listing under the Endangered Species Act. This plant has no protective status under the California Endangered Species Act, but is on the CNPS List 1B of plants considered to be rare, threatened, or endangered in California and elsewhere.

Habitat Requirements

Contra costa goldfields grows in shallow vernal pools in valley grasslands at site less than 300 feet above mean sea level (Hickman 1993). Common plant associates include other species of goldfields as most Lasthenia are self-incompatible (cross-pollinated). Populations observed in the Suisun Marsh area bloom in April, and the rare goldfields has been observed with *Lasthenia glabrata*, *Lasthenia glaberrima*, and *Lasthenia fremontii*.

Distribution

Contra Costa goldfields is a member of the Asteraceae (sunflower) family. The historic distribution of the species included coastal California from Point Arena in Mendocino County south to Santa Barbara, southern San Francisco Bay, and around the base of the Diablo Range in Contra Costa county and the inner coast range around San Pablo Bay, Suisun Bay, and the western Delta (CNPS 1988, NDDB 1993). Current range is limited to Napa and Solano counties. Many historic locations have been extirpated by urban development and grazing pressure.

Contra Costa goldfields is present in the greater Suisun Marsh area. Floristic surveys conducted by Department of Water Resources staff have recorded occurrences east of Emmington Road near the north flank of the Potrero Hills, and in a small vernal drainage area west of Grizzly Island Road where it traverses the Potrero Hills. There were historic populations known to The Ledgewood Creek area north of Cordelia Road, and a vernal drainage pool area south of Fairfield near the junction of Pennsylvania and Cordelia Roads (NDDB 1994). These occurrences are all at elevations above the influence of tidal channels.

Habitat Salinity Conditions

Contra Costa goldfields is a vernal pool species. Habitat for this species is not in hydrologic connection to tidal marsh channels. Therefore, Contra Costa goldfields is not expected to be impacted by the proposed salinity standards.

Heartscale,
Atriplex cordulata Jeps.

Status

Heartscale or "heartleaf saltbush" (*Atriplex cordulata* Jeps.) is a Category 2 candidate species for federal protection under the Endangered Species Act. The plant has no state protective status. CNPS considers this to be a List 3 species, which means additional data are needed before considering this plant rare, threatened, or endangered.

Habitat Requirements

Heartscale is limited to alkaline or saline soils, and is found in alkali grasslands, alkaline seasonal wetlands, and valley sink scrub vegetation communities. It is most commonly associated with barren, sparsely vegetated sites.

Distribution

Heartscale is a member of the Chenopodiaceae (goosefoot family). It is an annual saltbush known to the Sacramento Valley and San Joaquin Valley at elevations less than 200 meters. The plant has been reported in Tulare, Fresno, Madera, Merced, Stanislaus, San Joaquin, Contra Costa, Solano, and Glenn counties (CNPS, 1994). There are no known populations of heartscale within the greater Suisun Marsh area. The closest known populations are west of Clifton Court Forebay in Contra Costa County. The decline of this species is related to urbanization and agricultural development.

Habitat Salinity Conditions

There are no known populations of heartscale in Suisun Marsh wetlands. The proposed standards are not expected to impact this species.

Hispid's Bird's-beak
Cordylanthus mollis Gray ssp. *hispidus* (Penn.) Chuang & Heckard

Status

Hispid bird's beak (*Cordylanthus mollis* Gray ssp. *hispidus* (Penn.) Chuang & Heckard) is a Category 2 federal candidate species. It has no state status, but is on CNPS List 1B of plants considered to be rare, threatened, or endangered in California and elsewhere.

Habitat Requirements

Hispid bird's beak occupies alkaline meadows and seeps under 9 meters above mean sea level.

Distribution

Hispid bird's beak is a member of the Scrophulariaceae (figwort family). It was historically known to Alameda, Kern, Merced, Placer, and Solano counties (CNPS, 1988). It has been extirpated from much of the lower San Joaquin Valley due to agricultural land conversion. The closest known population is in a vernal drainage area associated with upper Denverton Creek. This population is due east of Travis Air Force Base approximately 21 kilometers northeast of the Suisun Marsh.

Habitat Salinity Conditions

Hispid bird's beak is not known to the Suisun Marsh. Potential habitat for hispid bird's beak is not present in areas influenced by channel water salinity. Therefore, the proposed standards are not expected to impact hispbid bird's beak.

Legenere,

Legenere limosa [Greene] McVaugh

Status

Legenere (*Legenere limosa* [Greene] McVaugh) is classified as a Category 2 candidate species for federal protection under the Endangered Species Act. The plant has no state of California protective status, but CNPS includes it on List 1B: Plants that are rare, threatened, or endangered in California and elsewhere.

Habitat Requirements

Legenere is found in beds of vernal pools and in open wet meadows at less than 450 feet above mean sea level (Hickman 1993; Mason 1957). It is found in the bottom of hogwallows at the Jepson Prairie Preserve (The Nature Conservancy 1992).

Distribution

Legenere is a member of the Campanulaceae. This tiny bluebell occurs at scattered the lower Sacramento and upper San Joaquin Valleys. Specific locations have been documented in Lake, Napa, Placer, Sacramento, Solano, Sonoma, and Stanislaus counties (CNPS 1994). The closest known population is north of the Suisun Marsh wetlands along the railroad tracks east of the intersection of Sunset Avenue and Railroad Avenue in Suisun City (NDD 1994) . Solano County occurrences are also known to vernal pool beds near Denverton Creek northeast of Suisun Marsh, and to the Jepson Prairie Preserve northeast of Fairfield (NDD 1994).

Habitat Salinity Conditions

Water from the channels which will be influenced by this flow augmentation will not be naturally or artificially applied to any areas with vernal pools. There is no suitable habitat for Legenere in the immediate project area. Therefore, the proposed standards are not expected to impact this rare plant.

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