

TABLE II-26

REPTILES AND AMPHIBIANS
NEAR SAN FRANCISCO BAY 1/

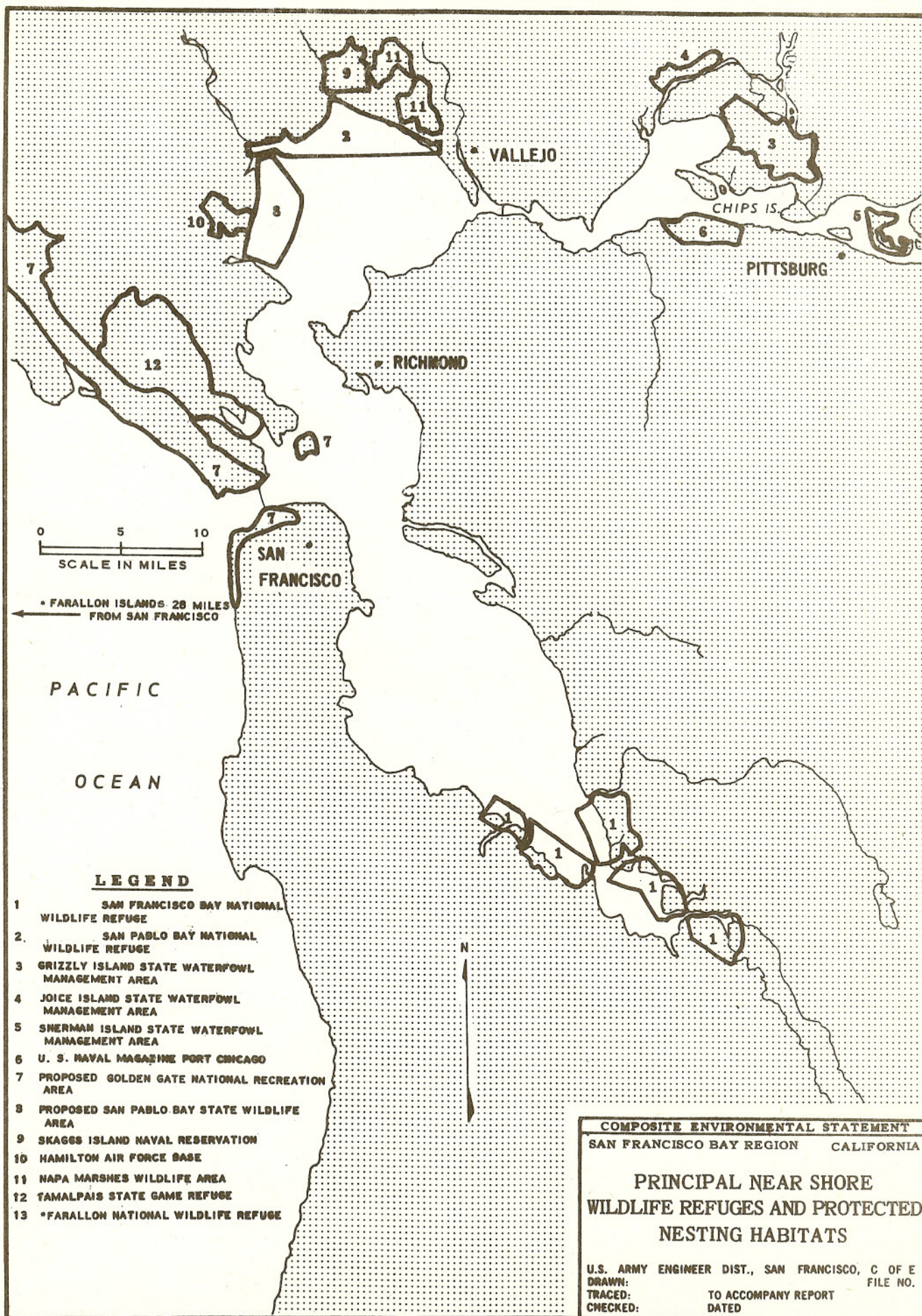
<u>Common Name</u>	<u>Scientific Name</u>	<u>Occurrence</u>
Bullfrog	<u>Rana catesbeiana</u>	Permanent resident; common; marshes
Western pond turtle	<u>Clemmys marmorata</u>	Common; marsh
Western fence lizard	<u>Sceloporus</u> <u>occidentalis</u>	Abundant; open fields and hills
Western skink	<u>Eumeces skiltonianus</u>	Fairly common; open fields and hills
Ringneck snake	<u>Diadophis punctatus</u>	Fairly common; marshes; open fields and hills
Sharp-tailed snake	<u>Contia tenuis</u>	Fairly common; open fields and hills
Racer	<u>Coluber constrictor</u>	Fairly common; open fields and hills
Common kingsnake	<u>Lampropeltis getulus</u>	Common; marshes
Western terrestrial garter snake	<u>Thamnophis elegans</u>	Common; marshes
Common garter snake	<u>Thamnophis sirtalis</u>	Common; marshes

1/ Includes most of the common and prominent species of the marshes and adjacent upland fields from San Francisco to Antioch.

SOURCE: Ruth, 1969.

b. Wildlife Refuges and Preserves.

- 2.386 (1) Introduction. The importance of wildlife habitat in the Bay Area is reflected in the number of wildlife refuges and land preserves. They are mainly in the form of existing and proposed wildlife refuges, and other managed and protected areas.
- 2.387 Plate II-44 shows the location and extent of the major near-shore refuges and land reservations, offering year-round protection of reproduction habitat for bayland wildlife in the San Francisco Bay Area. In a growing area of 4.8 million people, such habitat is critical in order to perpetuate continued enjoyment of native wildlife by the many people desiring it. In addition to resident wildlife, refuges also attract and help maintain migratory birds. Not only is this habitat indispensable in perpetuating wildlife, but it also provides the means by which a quality human environment can be maintained. All of the refuges shown contain tidelands. Tidelands with their planktonic and marsh plant growth help to purify secondary sewage effluent. Terrestrial as well as tidal portions of the refuges add to the aesthetic, open space and air quality of the Bay area, as well as offer recreational opportunities. Many of the sport and commercial fishery species in the San Francisco Bay and coastal areas are dependent on estuaries and marshes during the early stages of their biological development.
- 2.388 In addition to refuges and other public preserves, private salt ponds provide extensive shallow water feeding and resting habitat for migratory and resident water birds. Some nesting also occurs on salt pond dikes. In their present salt production usage they are relatively isolated and thus provide valuable habitat. Private salt ponds are not included on Plate II-44. Considerable salt pond acreage is included in the San Francisco Bay National Wildlife Refuge and the Napa Marshes Wildlife Area.
- 2.389 Although generally removed from the bayshores, regional and local parks and other miscellaneous areas also provide wildlife habitat.
- 2.390 (2) San Francisco Bay National Wildlife Refuge. In 1972, Congress passed PL 92-330 which directed the Secretary of the Interior to establish the San Francisco Bay National Wildlife Refuge. A local citizens group organized in 1968 was instrumental in obtaining passage of the bill. At present, 23,000 acres, mainly from the Leslie Salt Company, are being acquired for inclusion into the Refuge. Although both the San Francisco Bay and San Pablo Bay National Wildlife Refuges legally exist, most of the designated lands have not yet been actually conveyed to the refuges; thus, they are sometimes still referred to as proposed refuges.



- 2.391 San Francisco Bay National Wildlife Refuge has three major purposes. The most important of these is the preservation of the natural resources of the South Bay, which include the habitat of migratory birds, harbor seals and five endangered species: the California clapper rail, least tern, brown pelican, Peregrine falcon, and the Salt marsh harvest mouse (242). The second major purpose is to provide environmental education opportunities to Bay Area schools and residents. Third, the Refuge will ensure the protection of an important open space resource and wildlife-oriented recreation opportunities for the enjoyment of surrounding communities.
- 2.392 The South Bay, despite the continuing problem of pollution, is rich ecologically, demonstrated by the fact that some 70 percent of all shore birds using the Pacific flyway depend on the South Bay at some time during the year.
- 2.393 There are nine major habitats in the Refuge: saltmarshes, tidalflats, diked marshlands, brackish marsh, shallow water, deep water, wet salt ponds, dry salt ponds, and fill.
- 2.394 Proposed use areas include restricted use (critical habitat), conducted use (tours), controlled access and open use. Waterfowl hunting may be allowed in certain areas of open water.
- The objectives of the Refuge are to:
- (1) provide a valuable wildlife area for public enjoyment uses;
 - (2) preserve habitat for sizeable populations of birds, animals and fish;
 - (3) provide areas for marine marsh and upland wildlife and ecological studies and interpretations; and to
 - (4) maintain the open space, open water, marsh and tidal mud flats which is as essential to human welfare as it is to wildlife.
- 2.395 (3) San Pablo Bay National Wildlife Refuge. Located between the Petaluma River outlet and the City of Vallejo (Plate II-44), this 11,790-acre expanse of open water and tidelands is the winter home of some 40,000 Canvasback ducks--more than half the Canvasback population of the Pacific Flyway--along with great numbers of loons, grebes, cormorants and terns.

- 2.396 The plant and animal communities are dependent on the open water of the bay. At low tide, broad tidal flats yield marine life vital to the existence of shorebirds.
- 2.397 The refuge was authorized for acquisition in October, 1970 by the Federal Migratory Bird Conservation Commission. The majority of the acreage is being acquired in State tidal lands. A portion of Tubbs Island is being acquired from the Nature Conservancy, a national organization dedicated to protecting wildlife. Other acreage is authorized for acquisition from miscellaneous sources.
- 2.398 (4) State Wildlife Areas. Most maps still refer to most of these areas as Waterfowl Management Areas. The change in name to Wildlife Areas reflects the growing necessity for the California Department of Fish and Game to manage all wildlife rather than game species only.
- 2.399 Some 200 distinctive bird species, 43 mammals, 9 reptiles, 6 amphibians, and 26 species of fish have been identified in the Suisun Marsh. The Grizzly Island Wildlife Area in Suisun Marsh, is approximately 10 miles southeast of the City of Fairfield and comprises 10,487 acres in two units located about four miles apart. The 1,887-acre Joice Island section was acquired in 1931 with Department of Fish and Game funds, and the larger 8,600-acre Grizzly Island unit was purchased in 1950 by the Wildlife Conservation Board.
- 2.400 Primary objectives of this wildlife area are to enhance the habitat for fish and wildlife (with particular emphasis on providing adequate wintering grounds for waterfowl), to alleviate crop depredation by waterfowl, and to provide for the recreational use of these resources by the public.
- 2.401 A part of the Sacramento River estuary, the marsh is near the eastern end of the San Francisco Bay complex about 30 miles upriver from the City of San Francisco. Suisun Marsh constitutes almost 10 percent of California's remaining natural wetlands, and during midwinter it normally has a peak waterfowl population varying between 500,000 and 1,300,000 ducks. Because of its permanency, Suisun Marsh provides particularly critical habitat for waterfowl under drought conditions.

- 2.402 The Department's primary development activities on the Grizzly and Joice units consist of the construction and maintenance of levees and water controls necessary to properly manage marsh units to provide optimum conditions for wintering waterfowl. Also involved are land preparation and the planting of approximately 2,400 acres of barley on a rotation basis. The matured grain is left unharvested to be utilized by wintering waterfowl. The construction and maintenance of access bridges, ditches, roadways and buildings; posting and patrolling; and the operation and maintenance of checking stations and trash and sanitary facilities are provided to regulate and enhance public recreational use of the area.
- 2.403 Waterfowl hunting opportunities are offered for a fee during the fall and winter, normally from mid-October through mid-January. One weekend each year in January is devoted to a special jackrabbit hunt. The area is closed to all hunting from mid-January until mid-October.
- 2.404 Fishing is allowed all year on the Grizzly Island unit along with nature study, sightseeing and similar activities, but entry is restricted during the waterfowl season. Dog training is allowed.
- 2.405 To the east of Grizzly Island near Antioch in the western Delta, is located the Sherman Island Wildlife Area. Consisting of 3,100 acres, this area is open to public hunting under permit. Like the Napa Marsh area, the Sherman Island Wildlife Area has little active management. They serve as protected wildlife reproduction habitat and in addition provide recreational opportunities for the people of the Bay-Delta area.
- 2.406 The Napa Marshes Wildlife Area is managed by the California Fish and Game in cooperation with the Leslie Salt Company. Hunters are admonished not to interfere with salt operations.
- 2.407 The proposed San Pablo Bay State Wildlife Area (under Chapter 5, Art. II of the State Fish and Game Code) is to consist of about 12,000 acres on the west side of San Pablo Bay (see Plate II-44). The Area would include bay-front marshes, tidal mudflats, shallow water to a depth of about six feet, and other lowland wildlife habitat areas. Its purpose would be to preserve and maintain the marshes, tidelands and submerged lands in a natural condition for the benefit of all resident and migratory species of wildlife found there. Recreational uses would include fishing, hunting, and the observation and enjoyment of wildlife.

- 2.408 A level of Wildlife Area management that would preserve the Area in its natural condition is desired. The developments of fishing and boating facilities and other access points within the area will probably not be allowed to occur. Much of the marsh and most of the tidelands and submerged lands in the proposed Area is now owned by the State of California and is under the jurisdiction of the State Lands Commission.
- 2.409 The Mt. Tamalpais State Game Refuge consists chiefly of unincorporated portions of Marin County. This land preserve protects wildlife habitat from land development and other incompatible activities. The Pacific Coastal part of the refuge, including the Tamalpais State Park, is being conveyed to the new Golden Gate National Recreation Area. The more than 800 acre Richardson Bay portion of the Refuge is administered as a migratory waterbird sanctuary from October through March, and the nature educational center is operated year-round by the National Audubon Society.
- 2.410 (5) Golden Gate National Recreation Area. Under PL 92-589, about 35,000 acres were authorized for acquisition on October 27, 1972 for the Golden Gate Recreation Area which is administered by the U.S. National Park Service (see Plate II-44). Nearly half of the acreage is being purchased from private landowners. This extensive new area of coastline and adjacent areas, stretches from downtown San Francisco to Point Reyes National Seashore, and includes Angel and Alcatraz Islands. Administered for multi-recreational use purposes, the area encompasses considerable isolated areas valuable to wildlife. In keeping with the policies of the National Park Service, flora and fauna will be afforded protection in order to perpetuate wildlife and the other elements of the natural setting.
- 2.411 (6) Military reservations. These are included with the refuges because, while their primary purpose is not for the protection of wildlife, they do in fact afford such protection by providing a controlled, semi-permanent land preserve. Under the public law governing wildlife on military reservations (P.L. 86-797), the military cooperates with the Federal and State agencies regarding wildlife habitat management on military reservations.

- 2.412 c. Potential Land Disposal Sites. It is the eventual intent of this section to discuss the environmental setting of potential land disposal sites for five Corps dredging projects:

Dredging Projects

Redwood City Harbor
San Rafael Creek
San Leandro Marina
Suisun (Slough) Channel
New York Slough

Potential Land Disposal Sites

four areas adjacent to harbor
not yet selected
not yet selected
Suisun City & Morrow Island
not yet selected

At this time, environmental data is available only for the four areas adjacent to Redwood City Harbor. These areas are discussed below. When sufficient environmental data on other potential sites becomes available, the effects of land disposal at those sites will be discussed in a supplement to the Composite Statement, to be publicly issued at a later date.

- 2.413 Four areas adjacent to Redwood City Harbor are being considered for disposal of up to 300,000 cubic yards of dredged material (refer to Plate I-15). Site 1 is owned by the Port and is their preferred choice for disposal since it would create high ground for future port development. Site 2 is owned by the Henshaw Investment Company, and Sites 3 and 4 are owned by the Leslie Salt Company.

- 2.414 Site 1 is a 135-acre area bounded by Deepwater Slough and Redwood Creek. It is protected by dikes, with the exception of a breach in the dike on Corkscrew Slough. The site is formerly marshland with dredged material on parts of it. Over the past nine years the breach in the dike has widened to 50 feet, allowing tidal inundation which has restored a portion of the site to marshland. The site presently consists of approximately one-third terrestrial (grassland in nature), one-third sparse pickleweed too high for regular inundation, and one-third pickleweed marsh bordering Deepwater Slough. No cordgrass is apparent in the area.

- 2.415 Site 2 is a 110-acre area bounded on the north by Site 1, on the west by former salt ponds, and on the south and east by Redwood Creek. It is partially protected by dikes. This site is also formerly marshland with dredged material on parts of

it. Although no specific information is available, this site appears similar to Site 1 in terms of vegetation and wildlife habitat. The portions elevated by dredged material support upland grasses, other portions are sparsely vegetated, and still other portions are marsh.

2.416 Site 3 is a 100-acre area of which about 20 acres are covered by a salt pile. The remainder of the site is dry, sparsely vegetated land.

2.417 Site 4 is a 90-acre salt pond which is being phased out by Leslie Salt Company. The pond is surrounded by dikes and is adjacent to other salt ponds. There is no vegetation or wildlife at this site.

2.418 Four rare and endangered wildlife species inhabit the vicinity of Redwood City Harbor: the California brown pelican, the California clapper rail, the California least tern, and the Salt marsh harvest mouse. Brown pelicans have been observed on a spit of land created by cement waste on Redwood Creek north of the port. A nesting survey of the California clapper rail, performed by the State Department of Fish and Game in 1971, located primary habitat and breeding evidences along Corkscrew Slough and Bair Island's outer bay margin, and secondary habitat on lands between Deepwater Slough and Corkscrew Slough. Greco Island offers both primary and secondary habitat for the clapper rail (62). California least terns nests have been located in 1969 on Bair Island on levees within inactive salt ponds, and the birds are seen over these lands. A trapping study of the Salt marsh harvest mouse in 1971 revealed its presence on Bair Island marshlands north and west of Corkscrew Slough and on Greco Island nearby (165). A current study will survey the present population status on these lands as well as on lands which lie between Deepwater and Corkscrew Sloughs, proposed to be included in the San Francisco Bay National Wildlife Refuge (99).

2.419 The habitat of Site 1 is suitable for passerine birds such as meadowlarks and others which are equally common; for nesting of both song and savannah sparrows in the lower pickleweed area; for partial foraging by Short-eared owls, White-tailed kites, and Marsh hawks; and possibly for limited habitat extension of the Salt marsh harvest mouse, although the more aggressive meadow mouse (neither rare nor endangered) occupies all terrestrial portions of Site 1 (105).

2.420

A small, apparently resident colony of Harbor seals has been observed in Corkscrew Slough during pupping season from April through June (the period of greatest sensitivity to stress) and at other times of the year. No pups have been observed along the slough, and it is unknown whether this colony overlaps that of Greco Island where pupping numbers have been reduced by human activities. They are protected from dogs and motorcycles (for example) on Bair Island. Harbor seals in the Bay are further discussed elsewhere in Section II.

2.421

In general, the potential disposal sites at Redwood City Harbor are ecologically sensitive and warrant close examination.

3. Endangered and Rare Species.

2.422

According to the California Department of Fish and Game (24, 28) and the U.S. Fish and Wildlife Service (243) eleven endangered or rare vertebrate species or sub-species inhabit a portion of the Bay Area covered by this Composite Environmental Statement. Endangered species are specifically protected by both State and Federal law; whereas, rare species, have a somewhat less critical status and are protected by State law only.

2.423

If any of the following conditions apply to a species (or sub-species) it is considered endangered (24).

(1) The mortality rate consistently exceeds the reproduction rate.

(2) It is incapable of adapting to environmental change.

(3) Its habitat is threatened by destruction or serious disturbance.

(4) Its survival is threatened by the unwanted introduction of other species through predation, competition, or disease.

(5) Environmental pollution is threatening its survival.

If any of the following conditions apply to a species (or sub-species) it is considered rare (24).

(1) It is confined to a relatively small and specialized habitat, and is incapable of adapting to different environmental conditions.

(2) Although found in other parts of the world, it is nowhere abundant.

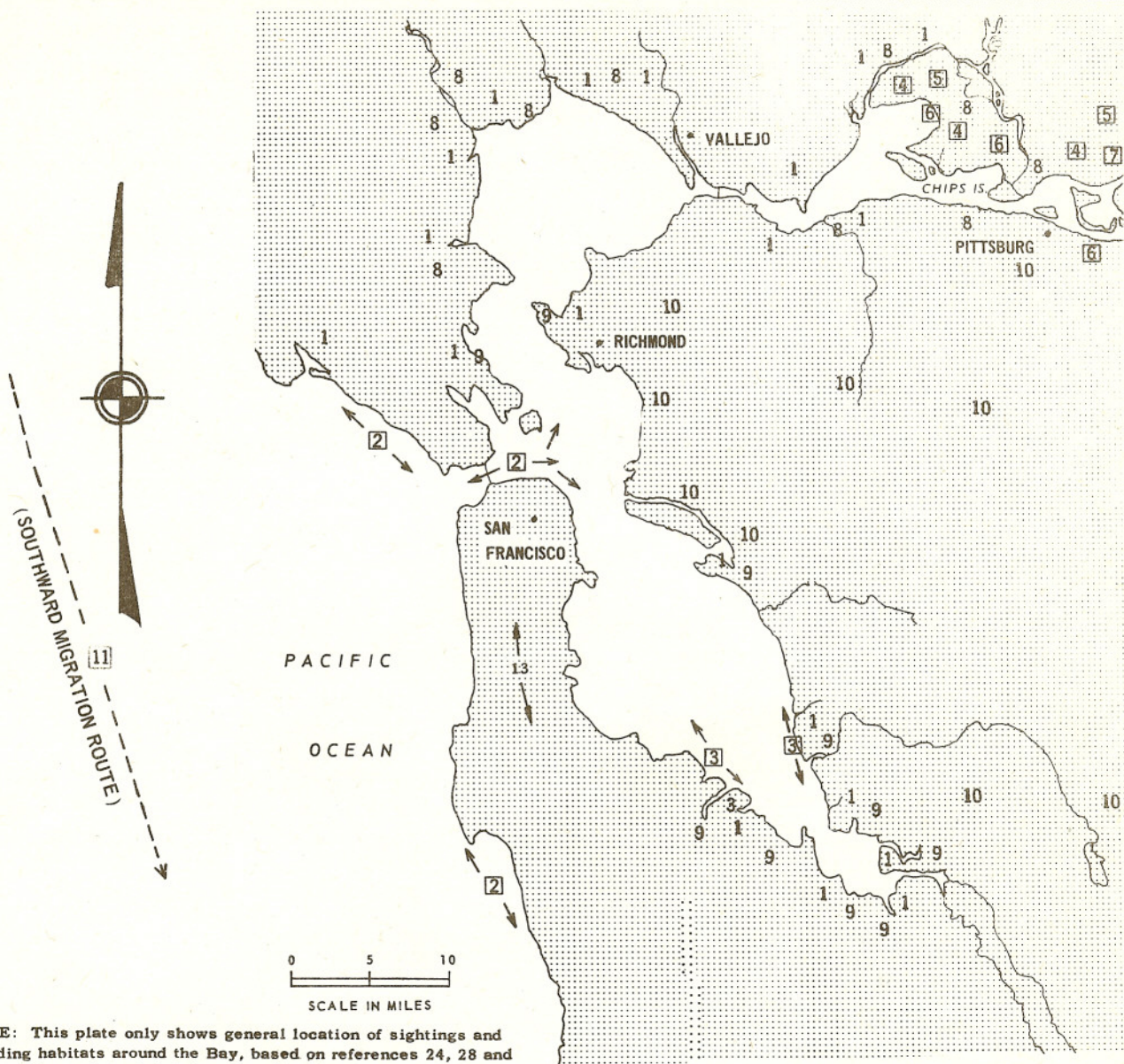
(3) It is so limited that any appreciable reduction in range, numbers or habitat would cause it to become endangered.

(4) If current management and protection programs were diminished in any degree, it would become endangered.

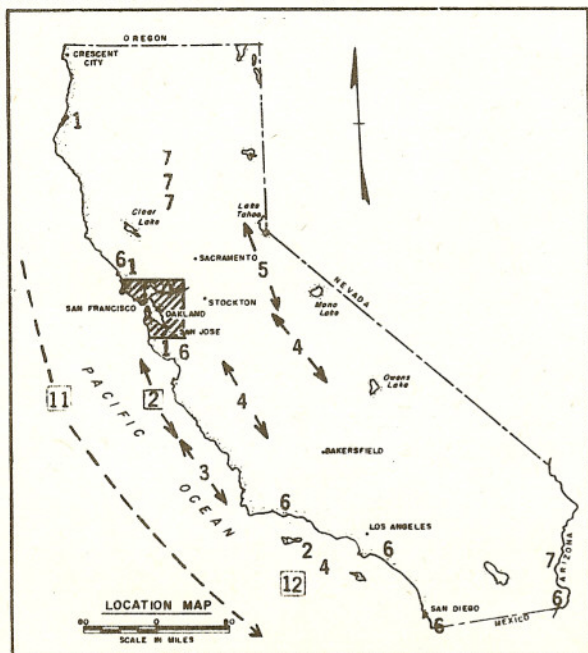
2.424

Plate II-45 shows some of the known breeding areas and sightings of the eleven Endangered and Rare Species discussed in this report. This plate is not meant to be complete but only to give one a relative idea of where some sightings have occurred and known breeding habitats are located based on references 24, 28 and 342. The eleven species are briefly described below.

- .425 The California Clapper Rail (Rallus longirostris obsoletus) is endangered. It is a resident of a few northern Californian salt marshes. Fill, drainage and industrial pollution have threatened its existence. It is highly specialized and apparently incapable of adapting to environmental change. Major populations occur in salt marshes bordering south San Francisco Bay while smaller populations inhabit San Pablo Bay and Elkhorn Slough (Monterey County). The establishment of the San Francisco Bay National Wildlife Refuge is a significant action toward the possible removal of the rail from endangerment in the future.
- .426 The Brown Pelican (Pelecanus occidentalis) is also endangered. California's only remnant nesting colony, numbers 300 pairs on Anacapa Island off northern California. Reproduction failure due to collapse of thinshelled eggs is attributed to the effects of pollutants. Only seven young were produced in 1971. Although the population is still failing to maintain itself, nesting success is beginning to show signs of recovery.
- .427 The California Least Tern (Sterna albifrons browni) is endangered. Habitat destruction, disturbance, and predation threaten this subspecies with extinction. Successful nesting requires sand beaches free from human disturbance and vegetation. Camp Pendleton's habitat protection program in southern California has increased nesting success. Smallest of the terns, it is easily recognized by its white body with black tipped wings and black capped head. Wintering in the southern hemisphere, it breeds along the coast from Baja California to South San Francisco Bay. South Bay area breeding sites have been reported at Bair Island, and Bay Farm Island (24).
- .428 The Peregrine Falcon (Falco peregrinus anatum) is endangered because mortality exceeds recruitment, its food chain organisms are contaminated with pesticides and other human disturbances. Commonly called the duck hawk, this is a medium sized blue-gray hawk with long pointed wings. Numerous fall and winter sightings have been made in Suisun Marsh which is used as feeding habitat by migrant Peregrine Falcons.
- .429 The Southern Bald Eagle (Haliaeetus leucocephalus leucocephalus) is endangered. Irresponsible shooting, removal of nest trees, other human encroachment and pesticides are among the causes of the decline. Once abundant along the coast nesting in California is now limited to the Sierra Nevada, Cascade and Klamath Mountains.



NOTE: This plate only shows general location of sightings and breeding habitats around the Bay, based on references 24, 28 and 243, and is not intended to be comprehensive.



KEY

- 3 Known breeding habitat
- 4 Sighting only.

- 1. California Clapper Rail.
- 2. California Brown Pelican.
- 3. California Least Tern.
- 4. Peregrine Falcon.
- 5. Southern Bald Eagle.
- 6. California Black Rail.
- 7. California Yellow Billed Cuckoo.
- 8. Salt Marsh Harvest Mouse.
- 9. Red Bellied Harvest Mouse.
- 10. Alameda Striped Racer.
- 11. California Gray Whale.
- 12. Guadalupe Fur Seal.
- 13. San Francisco Bay Garter Snake.

COMPOSITE ENVIRONMENTAL STATEMENT

SAN FRANCISCO BAY REGION CALIFORNIA

ENDANGERED AND RARE SPECIES

U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
 DRAWN:
 TRACED:
 CHECKED:

TO ACCOMPANY REPORT
 DATED

FILE NO.

- 2.430 The California Black Rail (Laterallus jamaicensis coturniculus) is rare. Destruction of coastal and inland wetlands by filling and drainage threatens habitat vital to its existence. Pickleweed strands are its preferred habitat, but, because of its secretive nature, it is rarely seen. Two sightings were made by State wildlife biologists on Joice Island in October 1973. It is sparrow-sized, blackish with white specks and bars.
- 2.431 The California Yellow-billed Cuckoo (Coccyzus americanus occidentalis) is rare and probably was never very abundant near the Bay system (24). Its habitat of dense fresh-water and streamside plant growth has been greatly decreased by land and water use changes which have occurred throughout most of California.
- 2.432 The Salt Marsh Harvest Mouse (Reithrodontomys raviventris halicoetes) is an endangered rodent. It is one of two subspecies of harvest mice unique to the Bay Area, and inhabits the northern and eastern portions of San Francisco Bay. Continual destruction of salt marsh habitat by bay fill and diking is the major cause of the decline. Recognized by its rich brown back and whitish underparts, it is one of the few mammals able to drink salt water, and lives its entire life cycle within salt or brackish marsh.
- 2.433 The Red-bellied Harvest Mouse (Reithrodontomys raviventris raviventris) is endangered. It inhabits the central and southern portions of the Bay. The reasons for its endangerment are the same as for the other sub-species described above. It has cinnamon rather than whitish underparts.
- 2.434 The Alameda Striped Racer (Masticophis lateralis euryxanthus) is classified as a rare snake. It has undergone a reduction in habitat in recent years because of construction and development. It inhabits the grassy hillsides of Contra Costa County and a few individuals may inhabit upland areas bordering the Suisun Bay area. Reaching a length of three to four feet, this is a fast moving snake with a distinct orange stripe along each side of its dark body.
- 2.435 The San Francisco Garter Snake (Thamnophis sirtalis tetrataenia) is endangered with fewer than 20 populations known (24). This species favors habitats with vegetation bordering ponds and lakes and is presently limited to the western part of San Francisco peninsula in San Mateo and Santa Clara counties. Less than five percent of its present habitat is on protected land. According to the Golden Gate Audubon Society, the San Francisco Garter Snake frequents the intertidal areas of South Bay (273).
- 2.436 Endangered marine mammals are discussed under Marine Biological Characteristics off the Central California Coast.

C. OCEANOGRAPHIC CONDITIONS OUTSIDE THE GOLDEN GATE

2.437 Since there is one Corps maintained channel outside the Golden Gate - and an important one at that because it is the only deep water channel leading into San Francisco Bay - and a 100-Fathom dredge disposal site southwest of the Farallon Islands, it is pertinent to discuss the physical and biological oceanographic conditions of these two general areas, and to see how these conditions are affected by ocean dredge/disposal activities and vice versa.

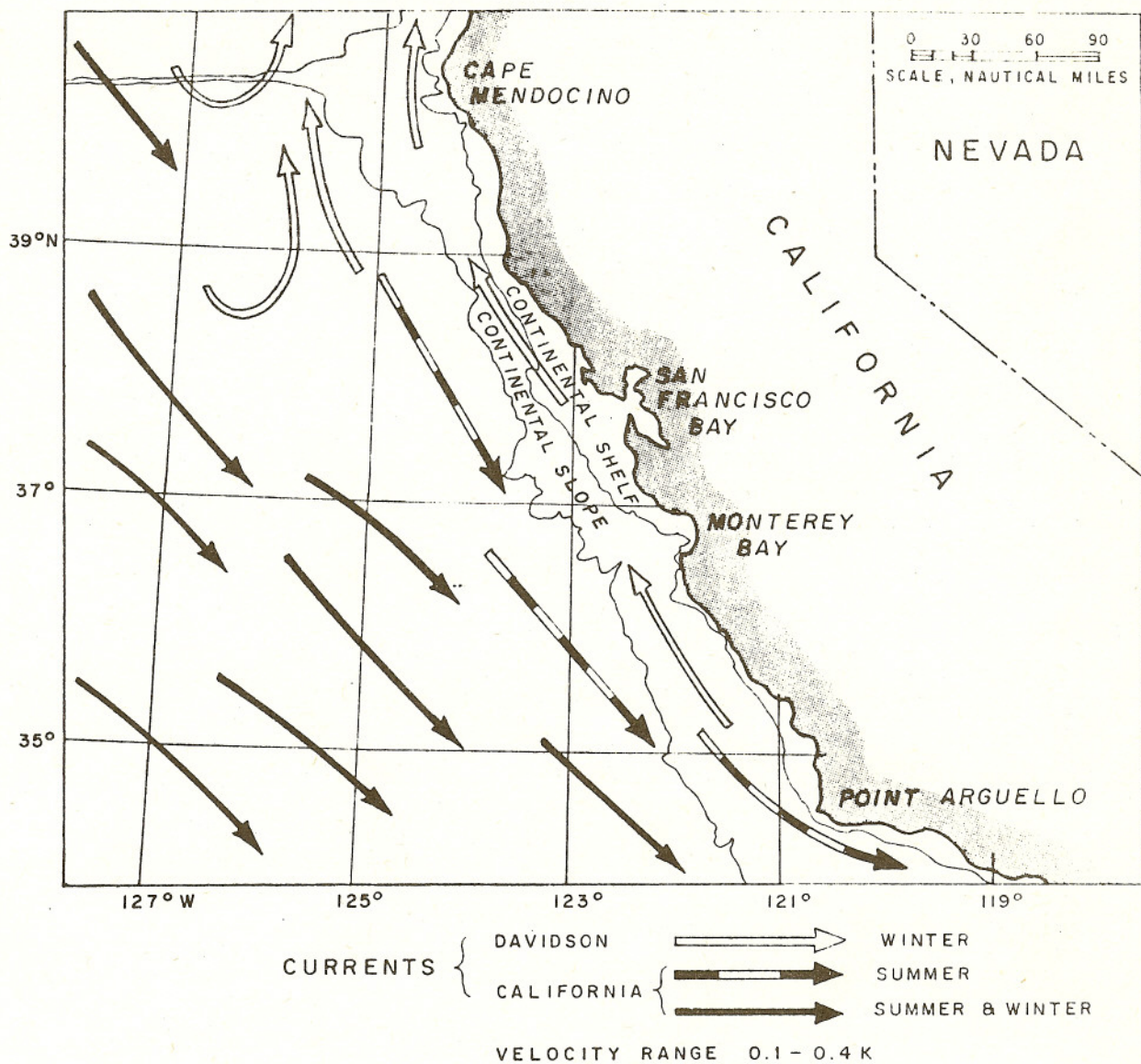
1. Physical Oceanographic Conditions off the Central California Coast.

2.438 a. Oceanographic Seasons. The physical conditions outside the Golden Gate are quite different from that of the Bay estuary. Certain physical factors of insignificant influence in an estuary become magnified in the great expanse of the ocean. For example, the subtlety of the earth's rotation and the flow of the trade winds normally have a minor effect on an estuary but are important in influencing the surface currents of the ocean.

2.439 The California current, an integral part of the north Pacific Ocean current gyre, is highly influenced by the above two factors. It is a broad, slow, southward moving, surface current which emanates from the North Pacific Current. It moves about 0.2 knots and passes through the Gulf of the Farallones, its width about 300 miles and depth about 600 feet, and eventually becomes a part of the North Equatorial Current that flows westward toward Japan.

2.440 The California Current is the prevailing nearshore current off the central California coast during late winter through fall. From late summer until the beginning of winter, it is particularly close to shore and this is when the surface ocean temperatures are highest for the year (around 60° F. off North Farallon Island), there is a strong vertical temperature gradient in the upper water column (known as the thermocline), the surface salinity is slightly higher than the rest of the year, and the strong westerly winds of spring and early summer have subsided. Transparency of the water averages between 33-40 feet and the dissolved oxygen ranges from 9 mg/l at the surface to 4 mg/l several hundred feet deep (87). The time period which is characterized by these events is known as the Oceanic Period and is usually the most beautiful time of the year along the northern and central California coast.

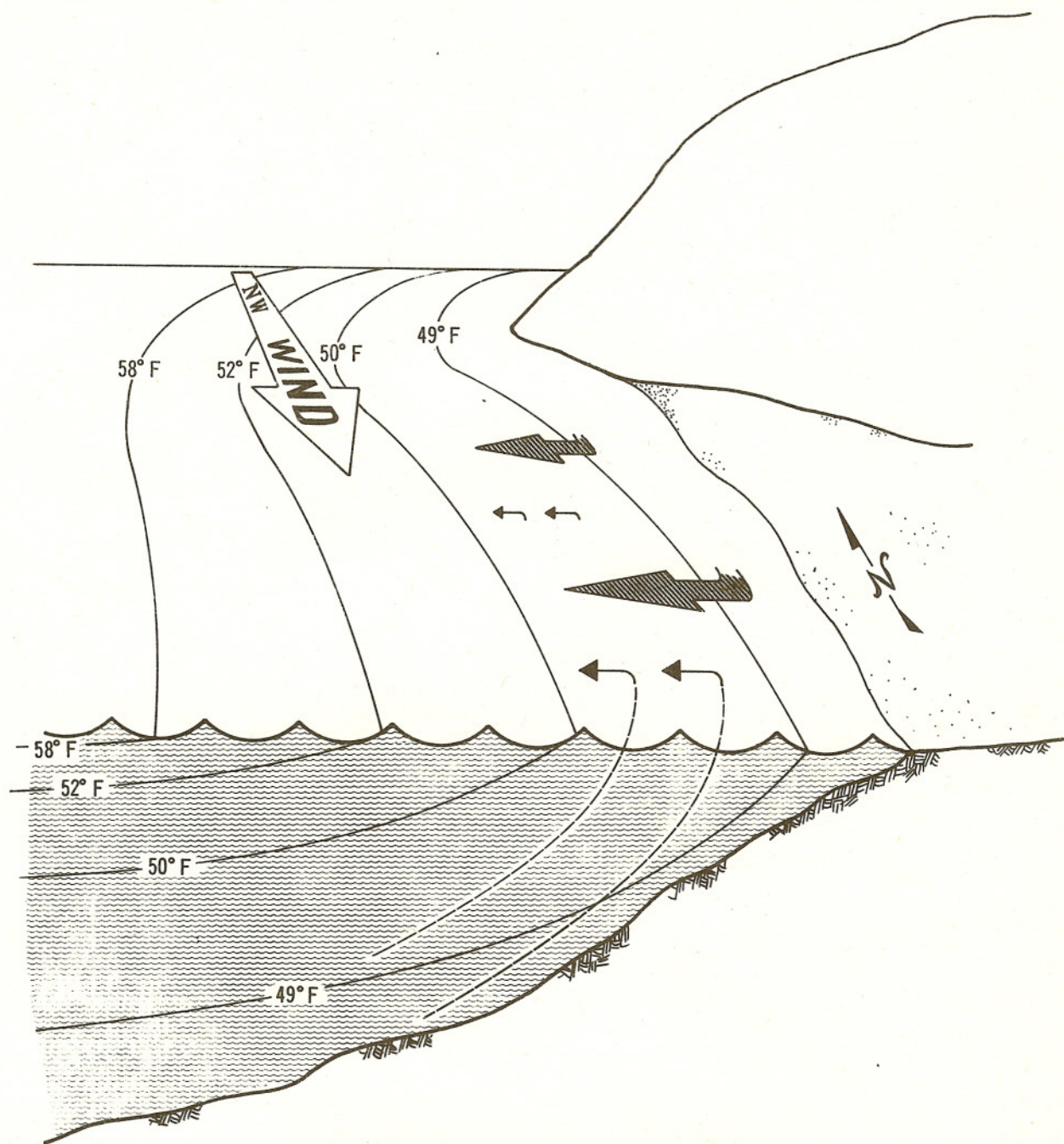
2.441 Preceding the Oceanic Period is the Upwelling Period from late winter to late summer. This time period is characterized by persistent fog which shrouds the central coast, and by a phenomenon known as upwelling. During the spring and summer prevailing winds are from the north and northwest. Due to the prevailing winds and





Prevailing Currents of the Central California Coast

SOURCE: Brown & Caldwell. 1971. A Predesign Report on Marine Waste Disposal, Vol. I.

PLATE II-46



TYPICAL SUMMER UPWELLING TEMPERATURES
OFF CENTRAL CALIFORNIA COAST

-  SURFACE WATER MOVING OFFSHORE
-  SUBSURFACE WATER MOVING UP

the rotation of the earth, surface waters at this time move offshore and are replaced by colder, subsurface water from depths of a few hundred feet--which is the reason why sea temperatures along California and Oregon are so cold during the summer. The replacement of offshore moving surface water by colder subsurface water is called upwelling, and it is this phenomenon that contributes to the richness of the fisheries off the California coast. The southward moving California Current is not as close to shore as it would be during the Oceanic Period due to upwelling. The nearshore surface water, which moves westward, pushes the California Current further offshore during this time period.

- 2.442 Between the Oceanic Period and the Upwelling Period, from November to February, there is a fast moving surface current that moves northward pushing the southward California Current off-shore. It is this northward moving current that becomes the prevalent nearshore current during the winter season and is called the Davidson Current. The Davidson Current has a minimum width of 50 miles and can attain speeds of 0.5 to 0.9 knots over distances of several hundred miles. Since this current occurs during the winter, freshwater runoff from the coast augments the northward flow.

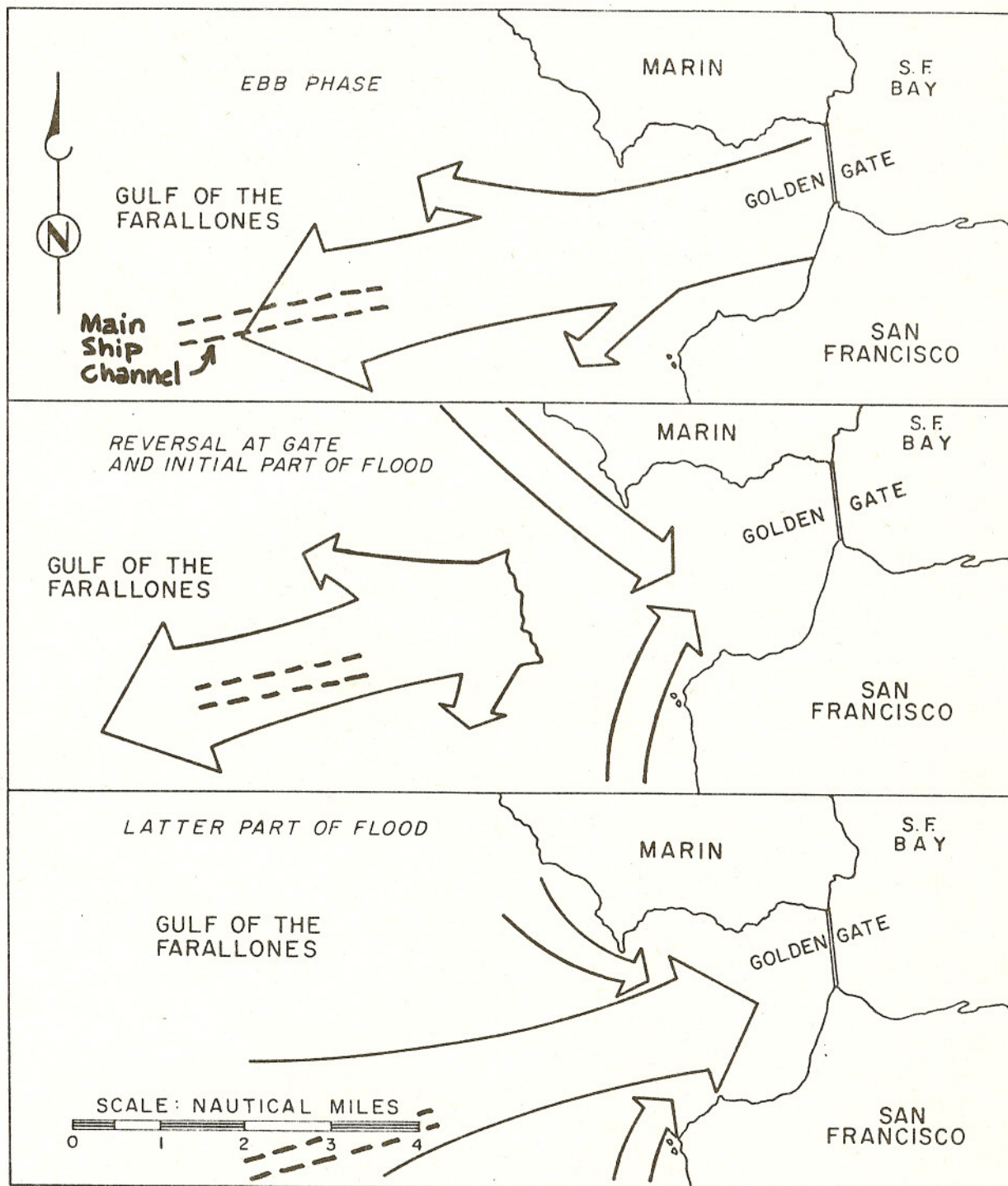
- 2.443 In summary, the three oceanographic seasons are listed below:

<u>Oceanographic Season</u>	<u>Duration</u>	<u>Median Temperature (°F) Range West of S.F.</u>
Upwelling Period	February-July	53.6 - 56.3
Oceanic Period	July-November	57.4 - 59.3
Davidson Period	November-February	59.0 - 53.6

Plate II-46 compositely shows the prevailing California and Davidson Currents off the central California coast and Plate II-47 depicts the generalized process of upwelling.

- 2.444 b. San Francisco Bar and Vicinity. From Plate I-3, one can see that there is a crescent-shaped sand bar, six fathoms or less, that surrounds the entrance to the Golden Gate. It extends from three miles south of Point Lobos (San Francisco) to eight miles seaward of the Golden Gate and then shoreward within one-half mile of Point Bonita (Marin County). There are three relatively deep channels (between six and ten fathoms) that tri-sects the natural shoal: the Bonita Channel north of Point Bonita which parallels the Marin County coastline; South Channel south of Point Lobos which parallels the Great Highway in San Francisco; and the San Francisco Bar or Main Ship Channel west of the Golden Gate. All three are natural channels through the shoal but the depth of the Main Ship Channel has been augmented by annual dredging. No dredging occurs at the other two channels.

- 2.445 The shape, extent and deposition of the shoal bar is in dynamic equilibrium, balanced by erosion due to tidal flows and accretion from sediment-laden coastal currents. Sediments brought into the bar by coastal currents are mostly derived from erosion of coastal beaches and cliffs, and outwash from streams. Net transport of sand into the bar is from the north. Very little material on the bar is actually derived from the San Francisco Bay system itself (203). Sediment outflow from the Bay is probably conveyed into deeper water beyond the bar. The result is a submerged sand bank outside the Golden Gate maintained by coastal sediment transport and held offshore by the strong ebb flow from the Bay. Currents around the bar are slow enough to allow sand accretion but are also high enough to transport the finer material away from the bar.
- 2.446 The oceanographic seasons described earlier do influence the environmental conditions of the bar but their effects are subdued in comparison to the overwhelming effects of tidal ebb and flood from the San Francisco Bay system. Winter and spring runoffs from the Delta also influence the conditions around the bar.
- 2.447 The out-going tide from San Francisco Bay strongly ebbs westward and southward (Plate II-48). During the high runoff season of winter and spring, tidal outflow occurs primarily along the surface (top 15 feet) because it is less dense than ocean water; thus the water around the bar at this time is quite stratified, similar to conditions inside the Bay during this time of year. At maximum outflow, the surface flow may ebb continuously and flood tide may be greatly reduced. During maximum outflow, and depending on the tidal amplitude, surface outflow from the Bay can be detected almost to the Farallon Islands (23 miles west of Point Bonita) and south past Point San Pedro (13 miles south of Point Lobos at Pacifica) (21). Water transparency, obviously, is at a minimum during this time of year.
- 2.448 It is doubtful that during this period, ocean currents have any major effect on water movement around the bar. Upwelling, however, does affect the temperature by keeping it to a minimum which extends into the summer.
- 2.449 During the summer and fall, when runoff is at a minimum, ebb flow and ocean water inside the bar are well mixed. Ebb flow does not extend nearly as far seaward as it did during the high runoff period but it can be detected out to the Main Ship Channel and four miles south to Lake Merced (22). At flood tide, water primarily comes from the north and south through the Bonita and South Channels, which actually occurs year-round but not easily detected during the high runoff period. Water transparency reaches a maximum during the fall.



Current Patterns at the Golden Gate

SOURCE: Brown & Caldwell. 1971. A Predesign Report on Marine waste Disposal, Vol.II.