CHAPTER ONE: NATURAL, PHYSICAL, AND CULTURAL CONTEXT

INTRODUCTION

The Tijuana River National Estuarine Research Reserve (NERR) is unique in a local, regional, and national context. It offers one of the best and largest remaining examples of coastal wetlands lost to urban development or seriously degraded elsewhere in southern California. This section includes a brief description of the importance of estuarine habitats and the natural resources protected within the Reserve.

I. THE NEED TO PROTECT ESTUARIES

A. DEFINITION

Estuaries are a hydrological and biological crossroads, defined as the portion of the earth's coastal zone where there is interaction of ocean water, freshwater, land, and atmosphere.

The specific plant and animal habitats that may be supported by an estuarine system are determined by conditions in the watershed and in the adjacent ocean. The rate at which fresh water enters the estuary, the amount and type of waterborne and bottom sediments, the degree of tidal flushing, water depth (and hence temperature and degree of sunlight), all combine to produce diverse biological communities in a dynamic and complex system. A significant physical change in any of those factors can trigger traumatic changes in the estuarine biologic community, greatly enlarging or reducing the size of various species' populations.

B. ESTUARINE PRODUCTIVITY

In a healthy estuarine system, the interaction of tides, unpolluted fresh water, and sediments concentrates nutrients more densely than in any other natural system on the planet. Sheltered shallow waters and soft mud or sand flats, regularly flooded by the tides, provide ideal conditions for abundant life.

Among the most important, but least understood, estuarine species are microscopic photosynthetic organisms—phytoplankton. Phytoplankton, like green plants, make the energy of sunlight available to animals as food. Phytoplankton are consumed by microscopic and minute animals, called

zooplankton. These tiny animals include the larvae of fish, crabs, clams, and other species, and are themselves part of the food supply for adults of their own or other species.
Marsh plants and eelgrass growing in shallow estuarine waters are critically important to estuarine animal life. Marsh vegetation not only provides cover for many animals, but also, as it dies back each season, creates detritus that feeds and houses the minute species on which larger species depend. The blades of eelgrass are homes for algae, snails, and other food for larger animals. Juveniles of many commercially valuable species reach adulthood by hiding among estuarine vegetation.

In an undisturbed estuary, the wealth of food can support huge populations of immature and adult fish, crabs, shrimp, and other species. Those animals provide essential food for populations of birds and mammals, including people.

Some species spend their entire life cycles in estuaries. Other species rely on estuaries for intermittent but important life cycle stages.

C. MODIFICATION OF ESTUARIES

Estuaries—characteristically flat land that offers sheltered access to the sea, and a profusion of fish and other seafood—offer attractive conditions for human habitation, agricultural production, and transportation. Estuaries on the west coast of the U.S. supported native peoples for thousands of years and, more recently, settlers from other parts of the globe.

Prior to the 1970s, the value and finite nature of estuaries was not fully appreciated. It was not recognized that estuaries are integral to ecological and human well-being. Destruction of estuaries was disastrously affecting water quality, commercial and recreational fisheries, and overall ecosystem health. Estuary-dependent plants and animal populations began to dwindle with lost habitat, food sources, and reproductive sites. Affected species included not only salmon, crab, and clams, but also birds such as eagles and falcons, which feed on the tideflats. Increasing awareness of the value of estuaries triggered current efforts to preserve, conserve, and restore these fragile systems. Among the most significant of these efforts was passage of the Federal Coastal Zone Management Act in 1972 and the subsequent passage of the California Coastal Act in 1976.

II. THE TIJUANA RIVER NERR ENVIRONMENT

A. REGIONAL SETTING

1. Reserve Location and Boundaries

Tijuana River NERR is located at the southwest corner of the continental United States in southern San Diego County, California (Figure 1). The area within existing Reserve boundaries represents about 2,531 acres in the lower sections of the Tijuana River watershed (Figures 2).

The western boundary of the Reserve follows the Pacific Ocean shoreline from the southern tip of Seacoast Drive to the U.S. - Mexico border. Along the northern part of the Reserve, the boundary extends along Seacoast Drive, Imperial Beach Boulevard, and connecting side streets, passing south of the Navy Outlying Landing Field. The eastern part of the Reserve falls within City of San Diego limits. Saturn Avenue marks the eastern extension of the Reserve into the agricultural lands of the Tijuana Valley. The southern boundary follows Monument Road and the U.S. - Mexico border, with the City of Tijuana extending immediately south of the border.

Like most remaining wetlands in southern California, the Tijuana Estuary is located close to a large urban population. It is the only coastal lagoon in southern California that is not bisected by roads and railroads. This points to the pressures that have been and will continue to be placed on Reserve resources, but also establishes the need for information, local involvement, and educational programs aimed at increasing public awareness and compatible visitor use.

2. Regional Access

Access to the Reserve is possible from several directions. The northern and western parts of the Reserve in the National Wildlife Refuge (NWR) are most accessible to visitors. The beach and Seacoast Drive provide pedestrian and vehicular access to the western edge of the Reserve and Refuge. Access to the south is via Monument Road - the entrance to Border Field State Park. Visitors can enter the northern part of the Reserve along Imperial Beach Boulevard, at 5th and Iris, and other local roads. Elsewhere, access is restricted by the Navy Outlying Landing Field and private agricultural properties. Off-road vehicles are prohibited except for use by enforcement and public safety officials. Hiking and equestrian use is accommodated by an extensive trail system. (See Chapter 8).

3. Land Ownership

Reserve establishment brings under a single management framework a mosaic of federal, state, local, and privately owned lands. The major federal landowners are the U.S. Fish and Wildlife Service (FWS), the State of California, and the U.S. Navy (USN). FWS owns a 505-acre parcel and the USN control an additional 551

acres, part of the Imperial Beach Navy Outlying Landing Field. Under a 1984 Memorandum of Understanding, FWS manages the 551 acres of Navy property for wildlife Refuge purposes. FWS fee lands, USN lands, and tidelands leased from the California State Lands Commission are all part of Tijuana Slough NWR that comprises the northern portion of the Reserve.

The State of California owns a 418-acre parcel -- Border Field State Park -- at the southern end of the Reserve. The park is operated by California Department of Parks and Recreation (CDPR). The location of Tijuana Slough National Wildlife Refuge and Border Field State Park within the Reserve is shown in Figure 3. Both the County and the City of San Diego also own significant public land within the Reserve. A transfer of City of San Diego lands to the State of California is currently underway in an effort to consolidate land management. All lands within the Reserve boundary are held in public ownership for resource conservation, with the exception of 73 acres remaining in private ownership. The ownership of lands within Tijuana River NERR is shown in Figure 4.

B. RESERVE RESOURCES

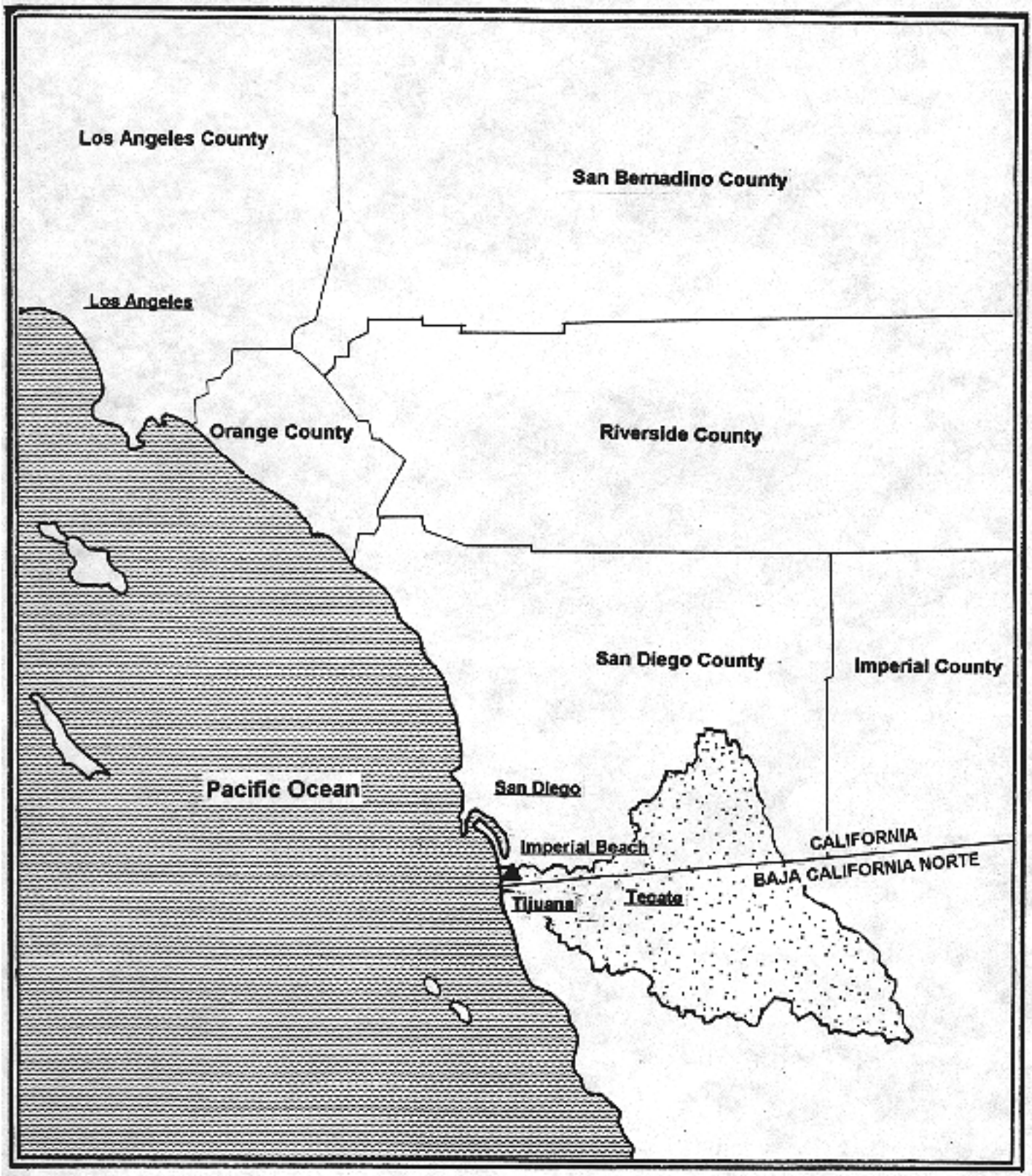
The following synopsis draws from several resource overviews compiled in the past (Williams et al, 1996; RECON 1994; Zedler et al 1992; Entrix et al, 1991; Zedler, 1982d; U.S. Department of Commerce and California Coastal Commission, 1981; California Coastal Commission, 1978; McIlwee, 1970) and highlights the environmental conditions and resources contributing to the ecological significance of the site.

1. Environmental Conditions

a. Watershed Topography, Geology, and Soils

The Tijuana River is an ephemeral stream draining a 1,731-square-mile watershed, of which 73 percent lies in Mexico. The river originates at the confluence of Arroyo del Alamar and Rio de las Palmas in Mexico. The lower Tijuana valley is a relatively wide and flat area confined to the south by high mesas and to the north by steep-sloped terraces. Several narrow canyons also drain into the lower valley. The topography of the site is shown in Figure 5.

The principal geological formations prevailing in the Reserve are quaternary and recent alluvial and slopewash deposits reaching depths of 130 feet. Sandstones, shales, and limestones underlie the unconsolidated deposits. Recent beach sand deposits occur along the shoreward length of the estuary. The lower valley is bound to the north, east, and south by sandstone and conglomerates that account

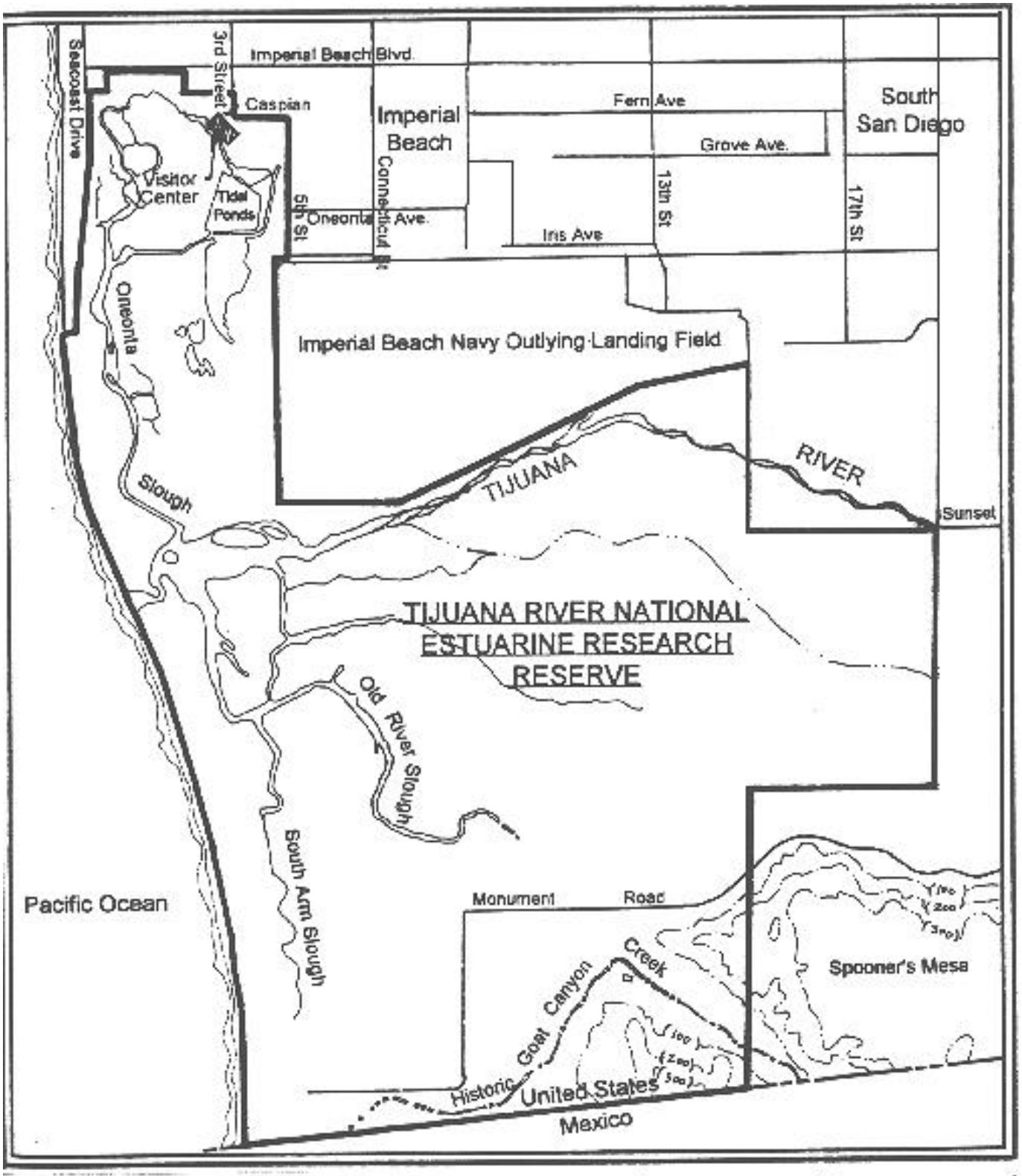


TIJUANA RIVER NATIONAL ESTUARINE RESEARCH RESERVE

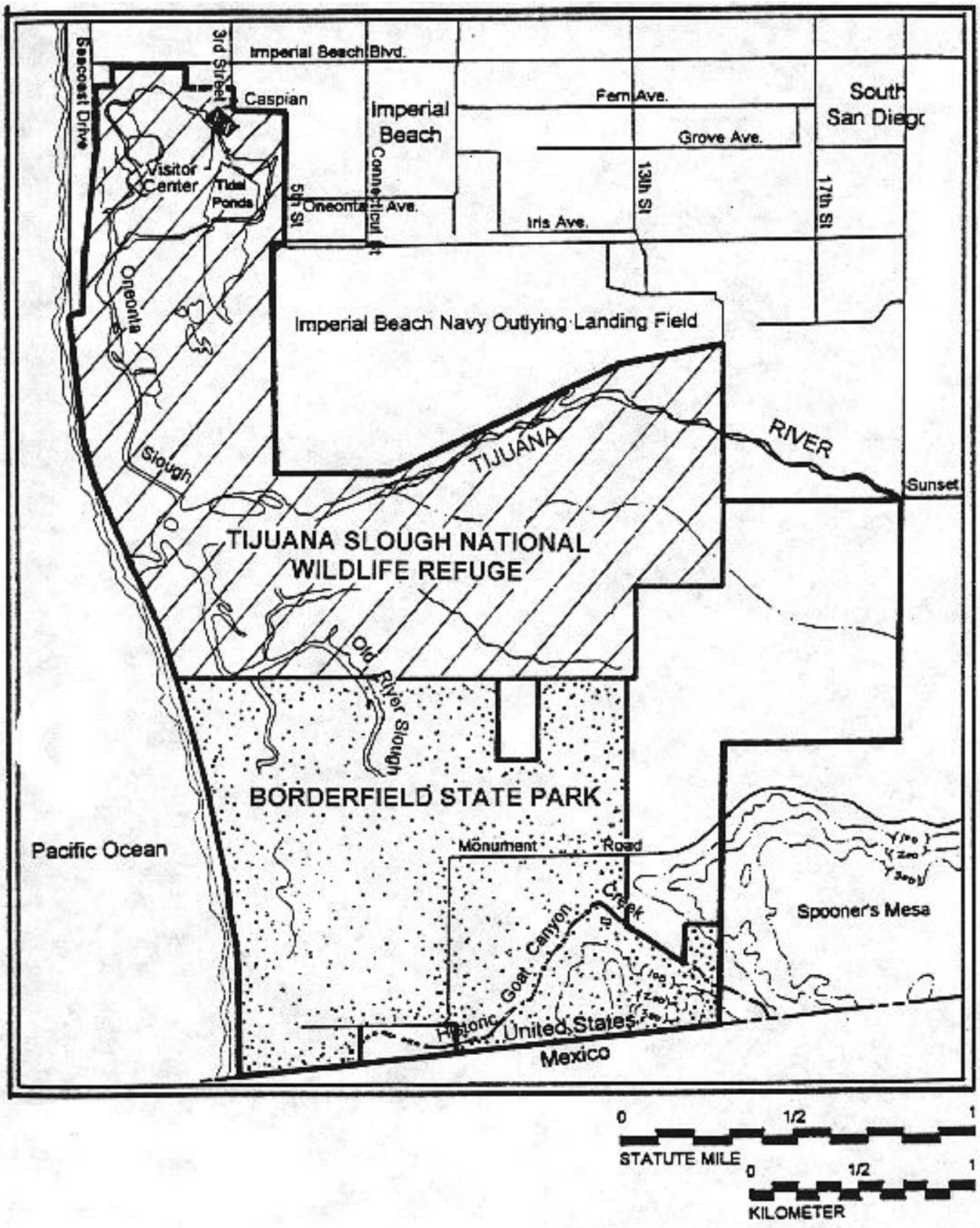
APPROXIMATE WATERSHED

REGIONAL SETTING OF TRNERR

FIGURE 1

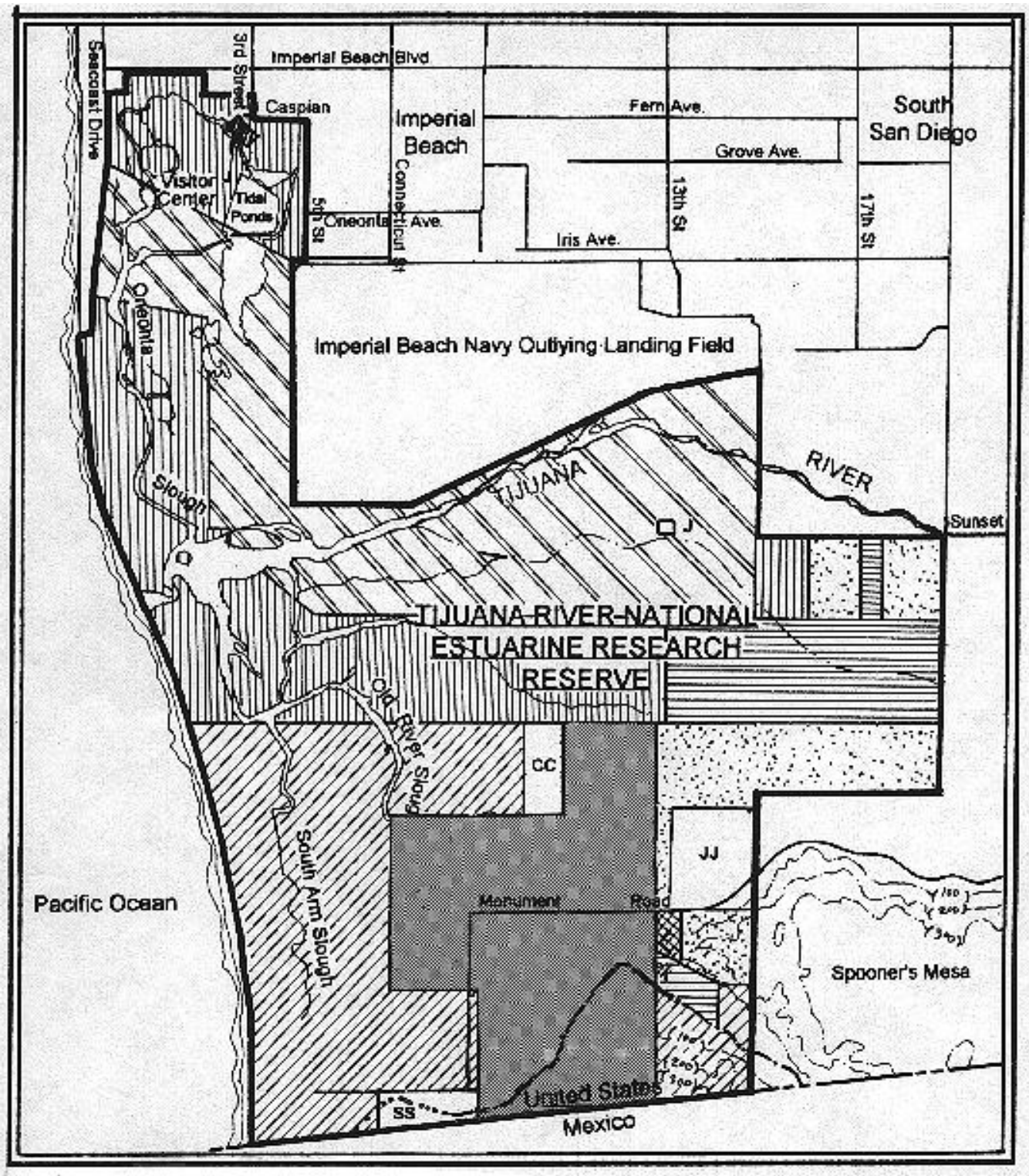


TRNERR RESERVE BOUNDARY
FIGURE 2



LOCATION OF TIJUANA SLOUGH NWR AND BORDER FIELD STATE PARK

FIGURE 3



U.S. Navy Lands

National Wildlife Refuge

Border Field State Park

County of San Diego

City of San Diego

JJ Private Parcels

IBWC

City of San Diego Lands to be transfered to Border Field State Park

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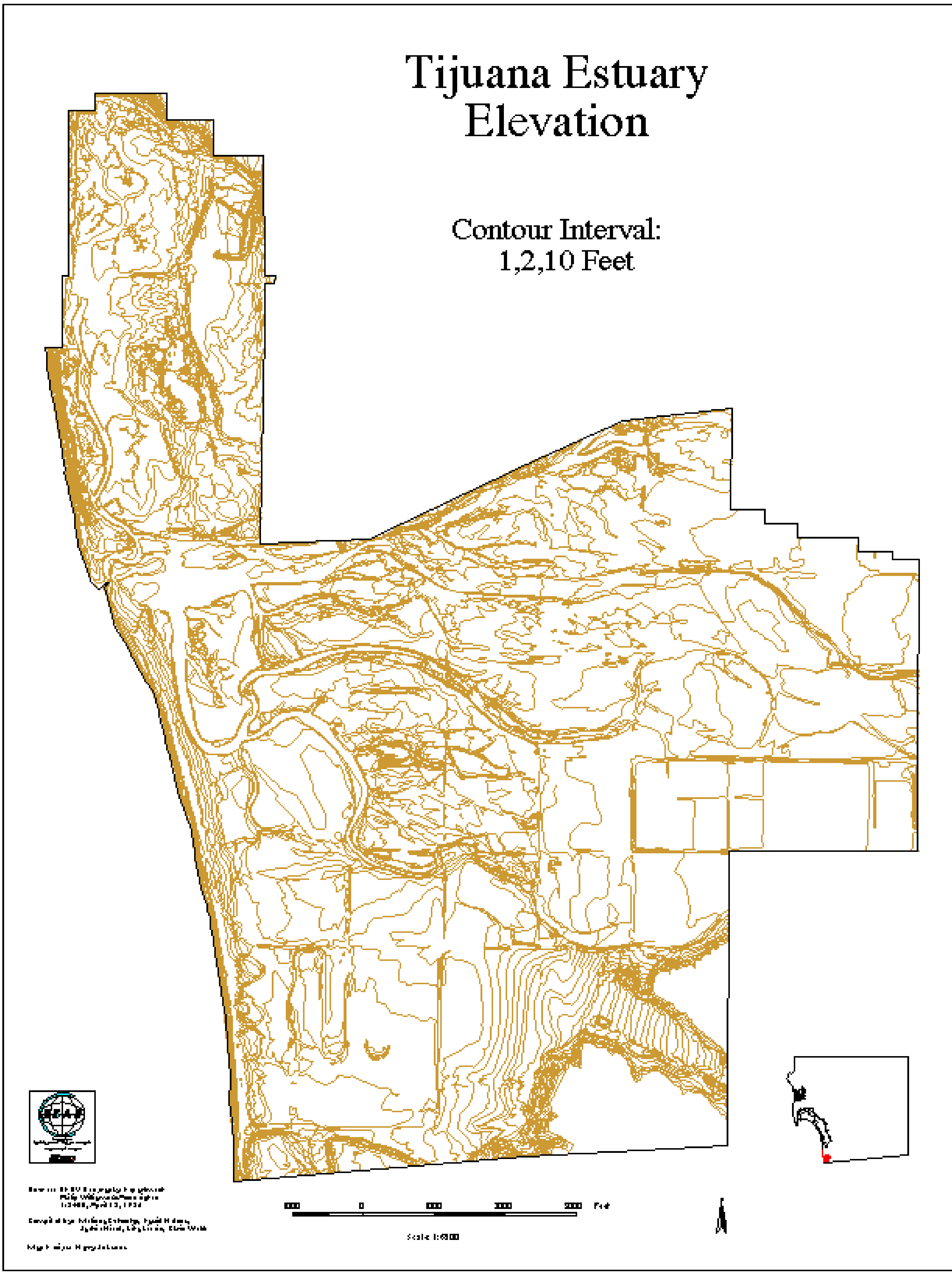
STATUTE MILE

0 1/2 1

KILOMETER

TRNERR OWNERSHIP

FIGURE 4


Tijuana Estuary
Elevation
Contour Interval:
1,2,10 Feet

for the mesa topography (City of San Diego, 1979; U.S. Department of Commerce and California Coastal Commission, 1981).

Over the past few years, the low marsh areas have had consistent mean soil salinities that range from 40 to 44 ppt. High marsh areas appear to be more dependent on annual tide levels and weather patterns, causing the salinities to fluctuate from year to year (Williams et al, 1996). The mudflats at the mouth and lower parts of the estuary are occasionally covered by sands transported during storms from the beach. The saline Chino silt loams, considered highly erodable but suitable for agriculture, occur upstream from the flats. To the south, the fine sandy loams blanketing the mesas and terraces are also considered highly erodable and are probably contributing substantially to downstream sedimentation (City of San Diego, 1979).

b. Climate

Weather conditions are generally typical of a Mediterranean climate. Annual rainfall averages nine to ten inches. Recent studies have shown that the amounts and times of rainfall and stream flow in the entire watershed are more important for estuarine dynamics than total precipitation (Zedler et al, 1992). In general, most rains fall from January to March. Average temperatures reach annual lows of 52°F (11°C) in winter and rise to 68°F (20°C) in July (California Department of Parks and Recreation, 1974). Prevailing winds come from the northwest in winter and from the southwest in summer.

c. Hydrology

As in many southern California rivers, annual streamflows of the Tijuana River can vary dramatically with observations representing anywhere from 10 percent to 400 percent mean annual flow (Zedler and Koenigs, unpub.). Mean annual discharge for 44 years are based on upstream gauge readings of 29.1 cubic feet per second (cfs) (U.S. Department of Commerce and California Coastal Commission, 1981). The greatest peak flow on record was 75,000 cfs in 1916. In comparison, peak flows during the 1993 winter storms were 32,500 cfs. Based on records going back to 1973, the Tijuana River experiences low and high flows as frequently as intermediate class flows and thus has a regime very distinct from rivers such as the San Diego River (Zedler, Koenigs, and Magdych, 1984). The hydrography and estimated floodplain of the Reserve are shown in Figures 6 and 7, respectively (not yet available on the internet).

The Tijuana River is also distinct in that it experiences many months with no flow. It has highly variable year-to-year and month-to-month flow. As a result, the Tijuana Estuary is seasonally marine-dominated—though this state can last

for several years—and occasionally fresh during flood events (Zedler et al, 1992). Any proposal that increases freshwater inflows could cause significant shifts in species composition (Zedler 1982). The flow of the Tijuana River is also regulated by three structures: the Morena reservoir, the Barrett reservoir, and the Rodriguez dam on Rio de las Palmas.

Despite low flows that occur frequently during the summer, the Tijuana River mouth has generally remained open throughout the year (Zedler, Winfield, and Mauriello, 1978). This is considered a unique and important characteristic of the Reserve, since all other southern California estuaries are bisected by highways and railroads that have decreased tidal exchange and resulted in frequently or continuously blocked entrances (Zedler, 1983b). At the Tijuana site, the main river channel and the northern channel are normally flushed by mixed tides twice daily.

Heavy ocean storm surges during the 1982-83 winter dramatically affected channel circulation and tidal exchange in the estuary. Waves washed beach sand into the tidal channels, closing off the southern channel during those winters, and reducing the opening of the northern channel. This has reduced tidal circulation within the northern channel, preventing the tides from flushing sediments out of the estuary, and apparently causing more frequent closures of the estuary's mouth including occurrences in the spring and summer of 1984. These closures present serious management problems for the estuary. However, since the dredging and opening of the mouth in December 1984, the estuary mouth has remained open.

Between 1852 and 1986, the estuary lost 80 percent of its diurnal tidal prisms (Williams and Swanson, 1987). Efforts to increase the tidal prism and help combat the sedimentation are described in Chapter 5.

d. Water Chemistry and Quality

Water chemistry in the open water channels of the Reserve is normally similar to the chemical composition of the ocean because of the small volumes of freshwater discharged from the Tijuana River during the spring, summer, and fall. During the winter, rains and releases from upstream storage and water treatment facilities can reduce the salinity in the estuary.

Deteriorated water quality represents a significant problem for the Tijuana Estuary, particularly in the river channel and along the ocean beach, and has necessitated short-term closure of parts of the Reserve for public health and safety. Effects of the sewage discharges on the estuary have not yet been fully

investigated and have been difficult to evaluate due to two other environmental problems: heavy siltation and excessive amounts of fresh water.

Sewage from the Tijuana River basin is directed to a pump station in central Tijuana adjacent to the international border. This station pumps wastewater along a canal to a treatment plant and then discharges it 5.6 miles south of the border. With only one sewage main and one canal, any maintenance shutdowns cause spillage into the river. Spillage also occurs due to frequent breakdowns of the force main. There are collector sites at both Goat Canyon and Smugglers Gulch (Matadero), and both have a history of main breakages and overflows which have led to significant wastewater flows into the Tijuana Estuary.

The International Wastewater Treatment Plant (IWTP) is currently being constructed in the United States directly north of Mexico's pump station. Primary treatment will average 25 million gallons per day (mgd) with peak flows up to 75 mgd. Mexico's pump station will collect wastewater from both eastern and central Tijuana and direct it to either the IWTP or the San Antonio de los Buenos plant in Mexico. If breakdowns occur at the pump station or Mexico's conveyance station, all flows will be directed to the IWTP for treatment.

Discharge of the advanced primary treated effluent will be through the already constructed South Bay Land Outfall and the South Bay Ocean Outfall (SBOO) under construction and scheduled for completion in 1998. The SBOO will run 200 feet below Border Field State Park in the southern end of the reserve and discharge 3.3 miles (5.7 km) offshore. This outfall -- to be used by the IWTP and the future City of San Diego Otay and South Bay treatment works -- will have a carrying capacity of 333 mgd. Though this project has gone through multiple environmental reviews, it is uncertain what the final impact on the estuary will be.

2. Living Resources

The tidal flushing of the Tijuana Estuary maintains a variety of habitats, which in turn support a broad range of organisms. A listing of plant and animal species with state or federal listing as threatened or endangered is provided in Appendix 4. The following provides an overview of habitats and describes the status of regionally significant resources.

a. Habitat Overview

The Tijuana River National Estuarine Research Reserve includes the following coastal habitats (McIlwee, 1970):

- Sand dunes and beaches - Sand dunes and beaches represent about 80 acres of the total Reserve area. Sand deposits are continually shifted during floods and sea storms, thus creating relatively unstable habitat. In recent years, the dune system has become very unstable, allowing sand to be blown into the tidal channels.

- Open tidal channels and mudflats - The estuary includes 100-147 acres of open-water channels. Sand, silty clay, and mixed substrates create a variety of subtidal habitats and intertidal mudflats (Zedler, Winfield, and Mauriello, 1978).

- Salt marshes - Salt marshes amount to about 410 acres, of which 67 acres are classified as "low marsh," 133 acres as "middle marsh," and 210 acres as "high marsh." These classes correspond to the shifts in species composition, community structure, soil salinity and texture, and tidal conditions that occur along the one-meter elevation gradient.

- Fresh-brackish marshes - Freshwater brackish marshes occur throughout the Reserve and are dominated by bulrushes and cattails**.**

- Riparian habitats - The riparian areas of the Reserve cover approximately 400 acres. These encompass the entire span of habitats upstream from mean high tide, including freshwater marshes and upland areas.

- Coastal sage scrub - The bluffs adjacent to the international border along the southern boundary of the Reserve are classified as coastal sage scrub. This community is considered sensitive habitat throughout San Diego County and Southern California.

- Vernal pools - A few small vernal pools can be found in the Reserve. These shallow pools, which hold a few inches of water during the wet months, host the San Diego fairy shrimp, a federally endangered species.

Vegetation communities are shown in Figure 8a. A key to vegetation communities is provide in Figure 8b. (Maps are not yet available on the web.)

The northwestern part of the Reserve is generally considered to be healthier than the southern or eastern regions. Tidal exchange in the north is generally better and sizable areas of mudflats are exposed at low tide at the northern end (U.S. Department of Commerce and California Coastal Commission, 1981). In contrast, channel banks are steep, tidal flushing is restricted, and low elevation communities are absent from the Reserve's southern end (Zedler, Winfield, and Mauriello, 1978).

b. Vegetation

The estuary's vegetation communities were important in the designation of the Reserve (U.S. Department of Commerce and California Coastal Commission, 1981). In addition to having regionally significant species, the Tijuana Estuary includes most of the plant communities found in other southern California wetlands (Zedler, l982).

Distributions of species at Tijuana Estuary are similar to those found in large marshes in southern California, such as Sweetwater Marsh (Mudie, 1970), Mission Bay (Macdonald, 1967), Upper Newport Bay (Vogl, 1966; Massey and Zembal, 1979), Anaheim Bay (Massey and Zembal, 1979), and Mugu Lagoon. The vegetation communities of the southern salt marshes are considered distinct from marshes north of Point Conception, including Elkhorn Slough, California's other National Estuarine Research Reserve, because of much more limited rainfall and hypersaline soils affecting plant growth rates and species composition (Zedler, 1983a).

Cordgrass (*Spartina foliosa*) forms robust stands along tidal channels in the northern reaches of the Reserve. Large stands of this species are rare in the other more disturbed southern California wetlands. Because of the importance of cordgrass as habitat for the endangered light-footed clapper rail (Jorgensen, 1975), considerable attention has been given to the artificial germination of this species (Zedler, 1982d). Above the cordgrass-dominated community are found several succulents, including annual pickleweed (*Salicornia bigelovii*) and saltwort (*Batis maritime*) as dominants, and pickleweed (*Salicornia virginica*) and sea blite (*Suaeda californica*). At higher elevations, these succulents grade into a dense matted cover of shoregrass (*Monanthochloe littoralis*). At the highest elevations, another species of pickleweed (*Salicornia subterminalis*) becomes co-dominant with shoregrass.

The low-growing, open canopies of vascular plants in southern California marshes allow light penetration to the soil surface and subsequent development of lush algal mats (Zedler, 1982d). Filamentous bluegreen and green algae and dozens of species of diatoms form mats up to one centimeter thick on moist soils. These occur at all intertidal elevations. The early studies on the composition of these marsh algal mats were performed at Tijuana River Estuary in the 1970s. These algal mats are about as productive as the overstory salt marsh plants (Zedler, 1980) and actually play a more important role as a food source in the estuarine food chain (Williams, 1981; Zedler, 1982c).

Reduced tidal circulation, natural flooding, prolonged excessive freshwater input, compaction by off-road vehicles, and the introduction of exotic species can cause changes in both salt marsh community structure and function (Zedler, 1982d). Salt marsh bird's beak (*Cordylanthus maritimus*) was once a common plant of the upper marsh but is now listed as endangered under the Federal Endangered Species Act. This plant likely owes its endangered status to the filling and destruction of upper marsh habitat in California. At the Tijuana River Estuary, salt marsh bird's beak occurs near areas with slightly disturbed soil surfaces, such as along the edges of paths and roads, sparsely vegetated openings, and depressions.

Another important source of disturbance to sensitive salt marsh vegetation is the large number of illegal or undocumented aliens from Mexico that enter the U.S. via the estuary. Until the mid-1990s, hundreds and occasionally thousands of individuals crossed the estuary every day, trampling the vegetation and creating numerous unnecessary trails. Although increased efforts by the U.S. Border Patrol have diminished the foot traffic through the Reserve, the patrols have created a number of new roads, particularly in the southern portion. Some of these roads pass through some of the most sensitive habitat areas. Areas disturbed by foot or vehicle traffic are slow to recover.

c. Invertebrates

Invertebrates, which include intertidal organisms such as aquatic insects, worms, clams, and crabs, and terrestrial insects and spiders, are likely major consumers in the salt marsh food chain and in turn are an important food source for the fishes and birds of the marsh (Zedler, 1982d).

Crabs are perhaps the most conspicuous invertebrates in southern California coastal salt marshes. This is also true of the Tijuana Estuary. Burrows of several species of crab occur throughout the lower marsh. Another common and relatively conspicuous inhabitant of the estuary's tidal channels is the hornsnail. Many other invertebrate species are just as numerous but less obvious because of their size or location within the sediments. These include several species of clams and mud worms.

Recent studies have helped characterize the benthic community at the Tijuana Estuary, and a sampling project in the northern arm will help define the structure of the benthos. The northern arm of the estuary has a healthier benthic community than the southern arm (Entrix, 1991). This difference may be a result of the hydrology differences of the channels. The species composition and dominance change with the distance from the River’s mouth. Captellid and Spinoid polycheates are found in both the estuary’s northern and southern arms.

Protothaca staminea and *Tagelus californianus* are the most common bivalves in the tidal channels (Williams et al 1996). California horn snail (*Cerithidea calfiorniensis*) is abundant especially in the winter.

Relatively little research has been done on the terrestrial invertebrates of the estuary and their ecological role. As in other salt marshes, some insects here probably feed on vascular plants, algae, and decaying plants, while others are carnivores. They serve as a food source for birds and other marsh vertebrates. Marsh insects are also important to the pollination of marsh flowering plants. The endangered salt marsh bird's beak, for example, is pollinated by bees (Zedler, 1982d).

Rove beetles (*Staphylinidae*) burrow in mud and salt flats. They are abundant in the estuary and appear to play a role in aerating soils and in reversing soil compaction resulting from off-road vehicles. Recent investigations suggest that the largest population of the wandering skipper (*Panoquina errans*) in the United States may be at the Tijuana Estuary (Zedler, 1982d). The estuary also supports a diverse and abundant population of coastal tiger beetles (*Cicindela sp.*), of which four species may be threatened (U.S. Fish and Wildlife Service, 1982). The Reserve is also a location for the globose dune beetle (*Coelus globosus*), a federal Category 2 species.

A distribution study (Williams et al, 1989) compared the arthropod community in different habitats within the Reserve. Wandering skippers were shown to be more abundant in the northern portion of Oneonta Slough, near the northern tidal pond, and in the southern arm of the estuary than in areas closer to the mouth. Globose dune beetles were only found south of the river mouth. However, considerable insect diversity was found throughout the estuary. The eradication of non-native plant species is essential to the management of these rare insects (Williams, K. et al, 1989).

Eleven species of salt marsh mosquitoes breed in the saline and brackish pools of the estuary (U.S. Fish and Wildlife Service, California Department of Parks and Recreation, and Department of the Navy, 1983). Three species (*Aedes taeniorhynchus*, *Anopheles hermsi*, and *Culex tarsalis*) are of particular concern because of their potential as pests and possible disease vectors. Currently, chemical control methods are being used to combat larvae and adults in areas where there is a high concentration of these mosquitoes.

d. Fish

The small tidal creeks and channels of the estuary support a relatively diverse population of fish including 29 species representing 19 families (U.S. Department

of Commerce and California Coastal Commission, 1981; US. Fish and Wildlife Service, 1982). For the past ten years, fish assemblages have been sampled in the estuary. In 1995 the catches were dominated by topsmelt (*Atherinops affinis*), longjaw mudsucker (*Gillichthys mirabilis*), arrow goby (*Clevelandia ios*), and California killifish (*Fundulus parvipinnis*). Adult striped mullet (*Mugil cepalus*) are also common. Abundance varies widely from year to year, but total density peaks in the summer and declines in the winter. The 1995 catch was the smallest to date, and populations of two of the most abundant species—arrow gobies and topsmelt—were down. Declines in arrow goby may be attributed to increases in winter flooding, while rises in longjaw mudsuckers may be due to macroalgal blooms after the freshwater surge (Williams et al., 1996).

The tidal channels were shown to function as a nursery for important recreational fish, such as the diamond turbot and California halibut**.** Nordby (1982) found abundant eggs of the croaker family, topsmelt, and northern anchovy. Hence, the estuary appears to be providing nursery habitat for marine fishes and may therefore be important for sport and commercial fisheries. Game fish such as kelp and sand bass, opaleye, and white croaker have also been found in the estuary (U.S. Department of Commerce and California Coastal Commission, 1981).

e. Reptiles and Amphibians

Relatively little is known about the use of the Reserve by reptiles and amphibians. Espinoza (1991) found 13 species of herptofauna in the estuary. Four species of frogs, six species of lizards, and three species of snakes were found, including the San Diego horned lizard (*Phrynosoma coronatum blainvillei*), and the Coronado skink (*Eumeces skiltonianus interparietalis*). Both are species of special concern.

California kingsnakes (*Lampropeltis getulus californiae*) and San Diego gopher snakes (*Pituophis melanoleucus annectens*) are common in transition habitats, but are also found in the drier areas of the salt marsh. Side blotched lizards (*Uta stansburiana*) are abundant on dry ground, like the reconstructed dunes and other sandy areas. Dunes are also home to the San Diego horned lizard and silvery legless lizard (*Anniella pulchra pulchra*).

Riparian area and freshwater ponds are home to the California toad (*Bufo boreas halophilus*) and the Pacific tree frog (*Hyla regilla*). Coastal sage scrub is habitat for the San Diego alligator lizard (*Gerrhonotus multicarinatus webbi*) and the Great Basin fence lizard (*Sceloporus occidentalis biseriatus*).

Management of reptiles and amphibians focuses on protecting the remaining open space in the Reserve and restricting horse, vehicle, and foot traffic to designated areas. The maintenance of the few freshwater ponds is important to the life cycles of the amphibians (Espinoza 1991). More information on populations and the presence of reptiles and amphibians is needed. Another survey of reptiles and amphibians is currently being planned (Young pers. comm.).

f. Birds

Bird populations have been an important factor in the special protective status attributed to the Tijuana Estuary. A total of 370 bird species are reported for the area. Birds use the wide array of habitats present in the lower and upper estuary, including the ocean beach and dunes, mudflats, mudbanks, salt marshes, and riparian areas. A complete list of birds observed at the Reserve is provided in Appendix 5.

Seven federally listed threatened or endangered birds occur regularly in the Reserve: the light-footed clapper rail (*Rallus longirostris levipes*), the California least tern (*Sterna antillarum browni*), least Bell's vireo (*Vireo belli pusillus*), the California gnatcatcher, the western snowy plover (*Charadrius alexandrinus nivosus*), the California brown pelican (*Pelecanus occidentalis californicus*), and the peregrine falcon (*Falco peregrinus anatum*). Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) is listed as endangered in the State of California. Other regionally or locally rare species include the elegant tern, black skimmer, and northern harrier. The light-footed clapper rail, California least tern, western snowy plover, least Bell's vireo, and Belding's savannah sparrow nest in the estuary. Their requirements and status are discussed further since these are the species most likely to be affected by management of the Reserve.

The decline of the light-footed clapper rail population in southern California is associated with the encroachment and destruction of coastal salt marshes. The use of the estuary by this species has been described by Jorgensen (1975, 1980) and summarized by the U.S. Fish and Wildlife Service (1982) and Zedler (1982d). Recent censuses indicate that the entire U.S. population of this subspecies may be as low as 325. In 1996, 77 pairs were recorded at Tijuana Estuary, making it the second largest population of this endangered species in the United States.

A total of 303 California least tern nests were reported in the Reserve for 1996. Fences and temporary enclosures have been built to protect the nesting areas. However, nests and fledglings are vulnerable to vehicle, horse, and foot traffic on the beach. Tern reproduction can be severely impacted by predation from an array of predator species.

A small number of western snowy plover also nest in the river mouth areas and dunes from mid-March to mid-September. Peak nesting occurs from April through June. A total of 15 nests were attempted in 1996, a slight increase from 11 nests in 1995. Nest success, formerly reduced by trampling by undocumented immigrant traffic, is now limited by avian predators (Powell, pers. comm.).

Belding's Savannah sparrow uses the higher salt marsh habitats, particularly pickleweed communities, for nesting. Nesting occurs anywhere from March to August (Massey, 1979). With incomplete coverage in the survey in the southern portion of the Reserve, 250 pairs of sparrows were found in 1996. The long breeding season of this species, coupled with its sensitivity to disturbance, requires that human activities in the upper marsh be restricted for most of the year to avoid further declines in the population (Zedler, 1982b).

Least Bell's vireo nests in the riparian vegetation adjacent to intermittent streams and channels of the Tijuana River. Willow thickets are the main territorial sites both in the southern and eastern portions of the Reserve. In 1995, there were approximately 54 least Bell's vireo territories in the estuary.

The Tijuana River Estuary is located along the Pacific flyway and is used for migration and wintering habitat for a variety of waterfowl and shorebirds. Wintering waterfowl include pintail, cinnamon teal, American widgeon, surf scoter, and ruddy duck. Reserve wetlands are important habitats for a large number of shorebirds (shorebirds account for the majority of the migratory bird population). While about 20 species occur regularly along the sandflats and mudflats of the estuary, four species -- willet, dowitcher, western sandpiper, and marbled godwit -- account for most of the shorebird population throughout the year (Boland, 1981). Abundance and species composition fluctuate seasonally. Intertidal sand and mudflats support the largest numbers of individuals and species.

g. Mammals

The estuary supports a small mammal population typical of fields and lowland habitats. Rodents, including mice, the California ground squirrel, and rabbits, are most common, providing an important food source for the raptor population of the upper estuary. Coyotes, striped skunks, and the long-tailed weasel are also present in the Reserve (Taylor and Tiszler, 1989). The San Diego black-tailed jackrabbit, a California species of special concern, inhabits the southern portion of the Reserve.

3. Cultural Resources

A limited number of historical and archaelogical sites exist in the lower Tijuana River Valley. Local records document about 16 archaeological sites in the nearby Border highlands area and along the coastal shore. An additional ten prehistoric sites have also been reported in a reconnaissance survey of Spooner's Mesa (City of San Diego, 1981). Excavations have uncovered three archaeological sites within the Reserve (California Department of Parks and Recreation, 1974). Sites identified indicate past use by San Dieguito, La Jolla, and Yuman cultural groups.

Identified sites in Goat Canyon and Otay Mesa include a 4,000-year-old shell midden site in excellent condition, prehistoric quarries where stone was collected for the production of tools, and a habitation site. These sites show a range of human activities from thousands of years ago and are the best prehistoric lagoon occupations for this time period (Gallegos, 1992). The interpretive value of the midden site is very high as it can be used to discuss the range of biological life, prehistoric occupation at a coastal lagoon, and prehistoric occupation across Otay Mesa and southern California.

An early Spanish explorer observed a native village located in the valley in 1769, but the exact location of the village was not recorded. In addition, Smuggler's Gulch is believed to be the site of a camp made by Father Junipero Serra in the 1700s (City of San Diego, 1981).

The Reserve encompasses many recorded paleontological localities associated with two fossil-containing formations: the San Diego formation and unnamed Pleistocene terrace deposits (Demere, 1984). The most significant aspect of these paleontological sites is the excellent preservation of the fossils. This is especially true for fossils from the San Diego Formation, which are preserved as original shell material. Some forms even retain color. Another significant aspect of these sites is that they are still available for field studies. This contrasts with other sites in the San Diego area, which have either been covered over or completely destroyed by urban development. The San Diego Formation (as studied in Chula Vista) also has a high potential for yielding important remains of fossil marine vertebrates, especially marine mammals. Marine mammal fossils are poorly known, and any sites containing such remains should be considered potentially significant and thus protected (Demere, 1984).