THE ECOLOGY OF TIJUANA ESTUARY

A NATIONAL ESTUARINE RESEARCH RESERVE

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PREFACE

The Nation's estuaries are heterogeneous in size, physiography, watershed interactions, chemistry, and biota. In this Profile, we point out how the various properties of Tijuana Estuary compare to those of other estuaries within the region as well as within the nation. The designation of Tijuana Estuary as one of the National Oceanic and Atmospheric Administration's National Estuarine Research Reserves shows that it is one of a class of ecosystems worthy of research and education, yet different enough to warrant selection as a regional type.

What makes Tijuana Estuary eligible for national recognition? It functions as a coastal water body that is influenced by both marine and river waters. It supports a range of natural plant and animal communities that are especially adapted to withstand the variable salinities that occur when sea and fresh waters mix. It has persisted through human history as an ecosystem that retains many of its natural qualities despite disturbance from urban and agricultural land uses. Unique to Tijuana Estuary is its international setting, with three-fourths of its watershed in Mexico; its diversity of ecological communities, which provide habitat for a variety of rare and endangered species; and its history of ecological study, with extensive data from years with and without catastrophic disturbances.

What sets California's estuaries apart from others in the nation is the degree of variability in the physical environment. During most of the year, they are marine-dominated systems, i.e., extensions of the ocean. During the winter rainy season, they may become completely fresh. In addition, there is substantial annual variation from years with no streamflow to years with major floods. The extremely variable nature of southern California's coastal habitats is not evident from short-term observation. Indeed, many visitors enjoy weeks of warm, cloud-free days and deny that we even have "weather." But from over a decade of study, there have been repeated opportunities to witness extreme events within Tijuana Estuary, ranging from catastrophic flooding to tidal closure and drought. These events have in turn allowed us to identify how physical factors influence biotic communities, and to quantify the dynamics of estuarine organisms as they respond to environmental extremes.

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Research funds for Tijuana Estuary have come from the California Sea Grant College and the California State Resources Agency for a variety of projects, beginning in 1976. Sea Grant-sponsored research has in turn led to additional projects that have had specific application to a variety of management agencies. The Sanctuaries and Reserves Division of NOAA has funded monitoring programs and supported graduate research on several reserve management issues. The U.S. Fish and Wildlife Service and the U.S. Navy both funded work on habitat characteristics for the endangered light-footed clapper rail. The California Water Resources Control Board, through funding from the Environmental Protection Agency's Water Quality Program, supported studies of the estuary's hydrological qualities and potential impacts of wastewater discharge.

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CHAPTER 1

INTRODUCTION TO THE TIJUANA RIVER NATIONAL ESTUARINE RESEARCH RESERVE

The story of Tijuana Estuary is complex. Ecologically, it has been influenced by its highly variable environment. Historically, it has shifted from a natural to a highly modified system. Politically, its fate has been hotly debated, and competing interests continue to influence its management.

This is an attempt to synthesize and interpret a growing data base on the estuary's diverse biota -- its vegetation, algae, birds, fishes, and invertebrates. Because so many changes have occurred in response to catastrophic events, we describe how each aspect of the estuary appeared before 1980 and how it has responded to several perturbations. The experimental tests of these cause-effect relationships have not been completed, and there is little reason to expect that environmental conditions have stabilized or that new types of disturbances won't occur. Thus, this profile should be viewed as a stage in the process of understanding Tijuana Estuary. Like the estuary itself, our knowledge is continuously evolving.

1.1 THE INTERNATIONAL SETTING

Tijuana Estuary is entirely within San Diego County, California, although three-fourths of its watershed is in Mexico (Figure 1.1). The Tijuana River originates in the mountains of Baja California. Water from the United States portion of its watershed flows down Cottonwood Creek and joins the Tijuana River in Mexico. The river then crosses the border just north of the city of Tijuana, Baja California.

On old maps, Tijuana Estuary is called Oneonta Lagoon or Slough. The Tijuana River, which feeds it, has been variously called Rio Tecate, Rio Tijuana, Tia Juana River, and Tijuana River. In 1968, the U.S. Board on Geographic Names approved the name Tijuana River (D. Orth, Executive Secretary, U.S. Board on Geographic Names, letter). Somewhat later, the name Tijuana began to replace Oneonta, but not everyone recognizes it as an "estuary." Yet, is does fit the most widely used definition, namely, "a semi-enclosed coastal body of water" that is "measurably diluted by fresh water..." (Pritchard 1967). Because of its location as the south-westernmost corner of the continental United States, it has both national and international significance.

As discussed throughout this profile, the estuary is very much a function of its watershed. The land uses and management practices on both sides of the border greatly influence the quantity and quality of water entering Tijuana Estuary. Thus, it is important to characterize the regional environmental conditions that have shaped and continue to shape this international estuary (Chapter 2 and Chapter 3, respectively).

1.2 ESTUARY TYPE CHARACTERIZATION

Pritchard (1967) developed an estuarine classification scheme based on geologic origin and physiography. In this frame of reference, Tijuana Estuary is very much like most of the world's estuaries, because it is a flooded river valley, also known as a coastal plain estuary. As sea level rose during the last postglacial

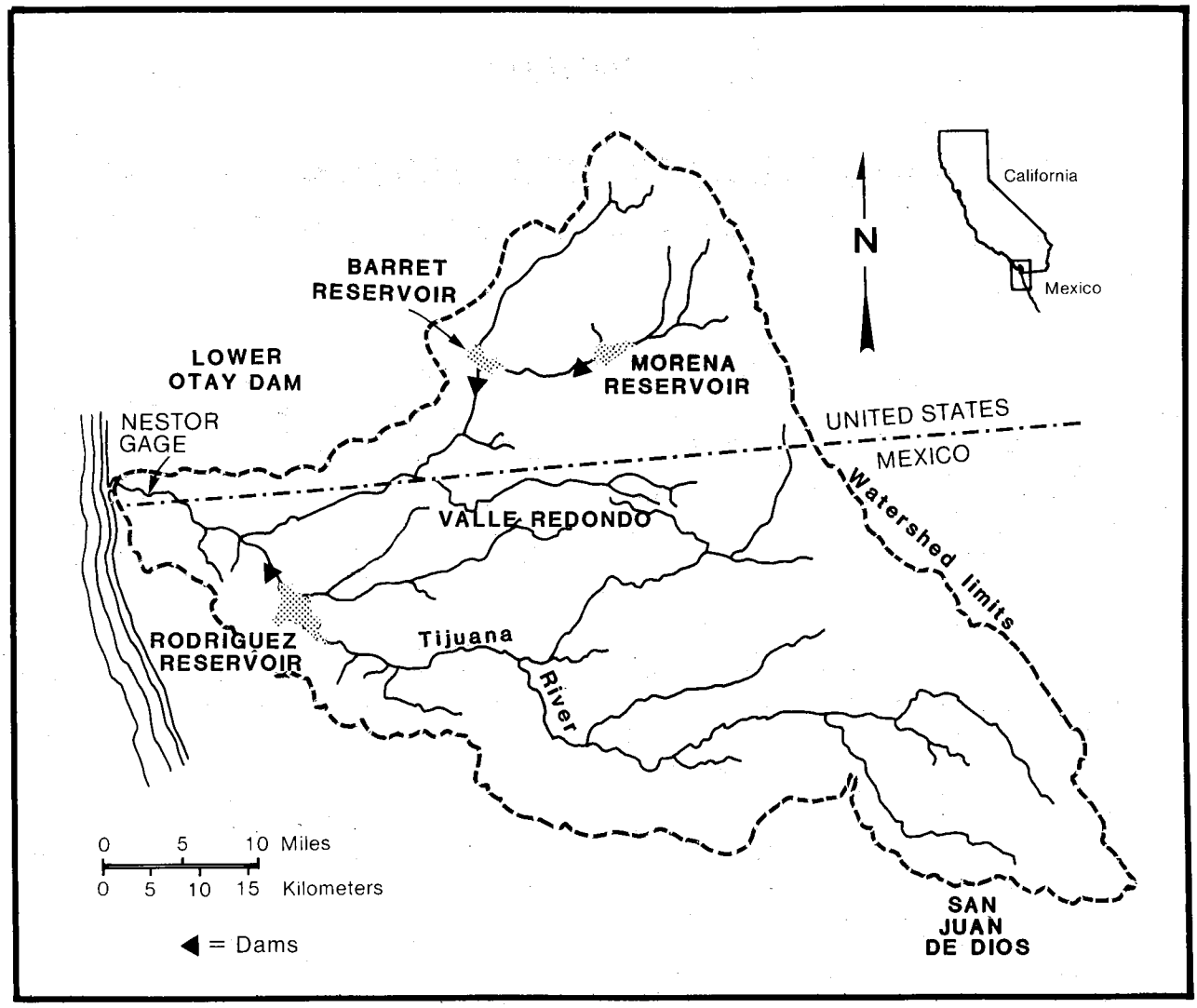

Figure 1.1. Location of Tijuana Estuary and map of watershed. Stations are indicated where rainfall and precipitation were measured (from IBWC 1983).

period, marine waters submerged the Tijuana River valley. Sediments that were brought downstream from the watershed spread out between the coastal mountains to create a small but well-defined coastal plain (Figure 1.2). The action of wind and waves gradually built up a sandbar and dune system parallel to the coast, and formed a semi-enclosed body of water. The area where marine waters are intermittently mixed with fresh water from Tijuana River is a small estuary immediately adjacent to the coast.

In other respects, Tijuana Estuary is very different from most of the world's estuaries. It does not fit well within the salinity characterization schemes that have been developed to describe estuarine embayments (Davis 1978). Estuaries can be divided into salt-wedge (river-dominated), partially mixed (salinity gradient downstream), or vertically homogeneous (brackish water throughout) types. They can also be distinguished by their salinity profiles as either positive (fresh water floating over saline water) or negative (warm saline water floating over cool fresh water). As we