

Estuaries: Life on the edge

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INTRODUCTION

On May 14, 1769, Friar Juan Crespi described his happiness upon arriving at the "splendid Harbor of San Diego," a vast bay "plentiful in very large sardines, rays, and many other fish, and a great many mussels" (Crespi and Brown 2001). Over the following months, Crespi traversed the California coastline, encountering an abundance and variety of estuar-ies. He observed "a great deal of glitter where salt must be col-lecting" in a seasonally dry lagoon, the sand-dammed Santa Ynez River where "the sea has been putting a height of sand in front of it," and finally a bay so large "that all the navies of Spain could fit in it"-California's largest estuary, the San Francisco Bay-Delta. Crespi's journal is part of a rich collec-tion of observations detailing the physical and ecological diversity of California's estuaries before modern modifica-tions, ranging from large tidal bays to intermittently closed lagoons at the mouths of small creeks (Grossinger et al. 2011). In estuaries across this spectrum early records show hetero-geneous mosaics of habitat types reflecting California's geo-logic, topographic, and climatic diversity.

This diversity can be illustrated by comparing two very dif-ferent estuary types: California's largest estuary and some of its smallest (Figure 19.1). The San Francisco Bay-Delta histori-cally drained 40% of the state's area, with flows coalescing in the Sacramento and San Joaquin Rivers and meeting the tides within the estuary's inland delta. Consequently, a large por-tion of the estuary was tidal yet fresh: 66% of the estuary's 2,240 square kilometers of wetlands occurred in the fresh-water Delta (Whipple et al. 2012). Though portions of these wetlands appeared to be "covered with nothing but TULE" (Abella and Cook 1960), the landscape was also composed of 2,600 kilometers of winding tidal channels, willow-fern com-munities (Atwater 1980), sand mounds, and riparian forests along major river channels. This heterogeneity contributed to the higher observed plant diversity in the Delta as com-pared to other regions of the Bay-Delta estuary (Atwater et al. 1979, Vasey et al. 2012). Downstream, the estuary opened into a series of large bays with extensive fringing tidal flats and marshes. Open-water habitats at the seaward end of the estuarine gradient were bordered by broad tidal flats and pick-leweed-dominated salt marshes with a dense network of tidal channels.

In contrast to the Bay-Delta, the Santa Clara River mouth and associated estuaries in southern California had only sea-sonal freshwater input (Beller et al. 2011), with more limited tidal influence because the river mouth was "blocked up by sandhills" during summer (Cooper 1887) and connected to the ocean only "after the rains of winter" (Johnson 1855). A series of backbarrier lagoons marked former river mouths, sep-arated from the ocean by sand dunes that effectively blocked the tides (Reed 1871). Instead of the Delta's tules and exten-sive forests, many of these small estuaries were dominated by shallow hypersaline open-water areas, pickleweed-

dominated salt marsh, and extensive salt PANNES (Bard 1869). However, local springs brought more freshwater to other, neighboring lagoons to maintain permanent open-water areas with a compressed salinity gradient and fringing stands of tules, creating very different conditions even among adjacent systems.

These examples drawn from reconstructions of early 1800s conditions illustrate the substantial seasonal variability and diversity of forms, physical characteristics, and biological communities of these coastal ecosystems. In this chapter we describe the diversity of California's estuaries today, the processes that generate the complex patterns of variability characteristic of estuaries, the biological communities they support, the services they provide, their fast-paced transformations by human actions, and how future transformations will be influenced by choices we make. We begin with descriptions of the geographic and climatic settings of coastal California to provide the physical context for understanding why its estuaries exhibit the diversity of forms first documented in the eighteenth century and still expressed to varying extent today.

Full Text

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