Appendix 7: Salt Flats in Southern California Coastal Wetlands

of the *Wetlands on the Edge: The Future of Southern California's Wetlands Regional Strategy 2018*

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Introduction

Salt flats are a type of seasonal wetland that is characteristic of arid, semi-arid, and mediterranean-climate coastal environments such as Southern California. They are subject to intermittent flooding due to tidal or freshwater influence and remain unvegetated due to salt concentration, with soil salinities often exceeding 100-200 ppt (Pennings and Bertness 2001). They are extremely dynamic features, experiencing large fluctuations in salinity and inundation. They were widespread historically and are present in many Southern California estuaries today, providing an array of ecosystem functions for resident and migratory wildlife. However, little is known about the formative processes, historical and contemporary distribution, and ecosystem functions and services of salt flats in the region relative to other estuarine habitat types. As a result, we currently lack sufficient information to identify appropriate regional objectives for salt flat management.

While specific regional objectives for estuarine salt flat management are outside the scope of this document, we recognize salt flats as an important component of overall estuarine and transition zone habitat diversity in Southern California. We suggest these features have the potential to provide important ecological functions and services, appear to be under-represented in current systems compared to historical conditions, and merit consideration as part of regional habitat mosaics. Here, we provide background context on salt flat characteristics; a preliminary assessment of their historical distribution, ecosystem functions and services; and typologies in Southern California.

What is a Salt Flat?

Salt flats – also known as salt pans (or pannes), *salinas*, alkali flats, playas, and sabkhas, among other terms – are unvegetated seasonal wetlands that fluctuate between dry, hypersaline conditions and shallow freshwater and/or tidal inundation (Briere 2000, Yechieli and Wood 2002). In estuaries, they often occur where evaporation seasonally exceeds inflow, as well as in systems with low rainfall, strong seasonal variation in precipitation, and/or irregular tidal inundation (Pennings and Callaway 1992, Largier et al. 1997, Pennings and Bertness 1999). We distinguish salt flats (which can be quite extensive, covering hundreds of acres) from the small salt pannes that occur in areas with limited drainage within many salt marshes (Boston 1983, Pennings and Bertness 2001).

The presence of estuarine salt flats indicates some degree of disconnectivity from regular tidal inundation that would allow for desiccation, either due to elevation (e.g., above Mean Higher High Water where inundation is infrequent) or a physical barrier such as sand dunes or inlet closure. As a result, salt flat conditions and dynamics (including shape and landscape position, inundation regime, soil and water salinity, sediment dynamics) are variable from year to year and feature to feature.

Methods

We performed three initial tasks to enhance our understanding of historical spatial distribution, change over time, and ecosystem functions and services of Southern California salt flats. First, we synthesized information on the key ecosystem functions based on expert opinion from the Science Advisory Panel, reports, and papers and performed an initial review of historical ecosystem services based on existing research (Beller et al. 2014). This was not intended to be comprehensive, but instead provide an overview of some of the core functions and services provided by salt flats. Second, we used existing historical habitat type mapping derived from U.S. Coast Survey T-sheets (Stein et al. 2014) to document the historical distribution of salt flats in Southern California prior to major Euro-American modifications (circa mid-19th century). Finally, we developed a preliminary historical typology of Southern California salt flats based on visual assessment of their landscape position and ecological context.

Ecosystem Functions and Services

Due to their dynamic nature, salt flats can provide a broad array of wildlife support functions varying by landscape position (e.g., supratidal or intertidal) and degree of inundation (Table 1). Some of these functions are coincident with those provided by estuarine lagoons and ponds (when flooded) or sand dunes (when dry); others are more unique to salt flats (e.g., habitat for tiger beetles and rove beetles) (Zedler et al 1992). When flooded, for example, salt flats can support foraging for resident and migratory birds: dabbling ducks and shorebirds can feed on invertebrates, invertebrate larvae, and the occasional small fish (Schaffner 1986, Williams, Desmond & Zedler 1998), while diving birds such as grebes, cormorants, and ruddy ducks can feed in deeper water (Beller et al. 2014). Drying salt flats can provide breeding habitat for the state- and federally endangered California least tern and federally threatened western snowy plover, in addition to resident birds such as black-necked stilts and American avocets. When dry, salt flats can support roosting and refuge for birds able to congregate safely in the large open space, as well as corridors for traveling mammals and habitat for invertebrates such as tiger and rove beetles and micro-crustacean and aquatic insects such as water boatman and brine flies.

Ecosystem services have not been robustly documented for salt flats in the contemporary landscape, but historically included salt production by indigenous and Euro-American residents, transit (since the dry margins of salt flats provided convenient travel routes), and recreational activities (including use as racetracks when dry, and boating and swimming while flooded).

Table 1. Salt flat ecosystem functions.

Ecological function	Supratidal salt flats	Intertidal salt flats
Dry season (or dry margins)		
Roosting and refuge for shore birds, terns, and gulls	✓	✓
Breeding habitat for resident and migratory birds	✓	✓
Habitat for invertebrates (e.g., tiger and rove beetles, micro-crustacean and aquatic insects)	✓	✓
Corridors for travelling mammals	✓	✓
Wet season/flooded		
Foraging for resident and migratory birds (e.g., for dabbling ducks and shorebirds)	✓	✓
Tidewater goby habitat?		✓
Southern California steelhead?	✓	✓

Historical Salt Flat Distribution and Typology

Salt flats were historically present in approximately one-quarter of Southern California 104 estuarine systems (cf. Stein et al. 2014; Figures 1 & 2). They were found across the Bight, from Goleta Slough to the Tijuana River estuary, and covered more than 3,000 acres in total (~10% of total estuarine habitat area excluding subtidal open water; Stein et al. 2014). Salt flat size, shape, landscape position, and ecological context varied across systems, with salt flats ranging in size from less than one acre to well over 1,000 acres (flanking either side of the San Gabriel River as it entered what is now Los Angeles Harbor). Other than the Los Angeles Harbor area, the largest salt flats (between 150 and 1,000 acres) were found in northern San Diego County (Batiquitos, San Elijo, Buena Vista, and Agua Hedionda lagoons, ranging from 160 to 475 acres), at Goleta (~200 acres), and Mugu Lagoon (largest salt flat ~180 acres; 250 acres total). Other notable salt flat complexes were found at Ballona (135 ac) and Seal Beach (135 ac). Preliminary analysis based on Stein et al. (2014) suggests that approximately 95% of estuarine salt flats in the Bight were found in these nine systems. (Note, however, that this does not account for salt flats documented by local historical analyses in other systems such as Los Peñasquitos Lagoon; cf. Beller et al. 2014).

Based on an initial visual assessment, we suggest two broad categories for Southern California salt flats historically distinguished by position in the wetland complex and presumed degree of tidal and freshwater influence: **supratidal salt flats** and **intertidal salt flats** (Figures 1 & 2). Supratidal salt flats occurred at elevations above Mean Higher High Water, and as a result were subject to only infrequent tidal overflow (e.g., during storm surges or spring tides, or during inlet closure with net inflow of water from watershed and by wave overwash). These salt flats were located above the marsh plain, as part of the transition zone between tidal and terrestrial habitats. Examples include the salt flats formerly found at Goleta and the Los Angeles River (Figure 1). In contrast, intertidal salt flats occurred at elevations between Mean High Water and Mean Higher High Water, and desiccated due to disconnection from tidal waters due to inlet closure with net loss of water through evaporation (and perhaps owing to other physical barriers). Examples include the extensive, seasonally flooded lagoons formerly found in northern San Diego County (Beller et al. 2014; Figure 2).

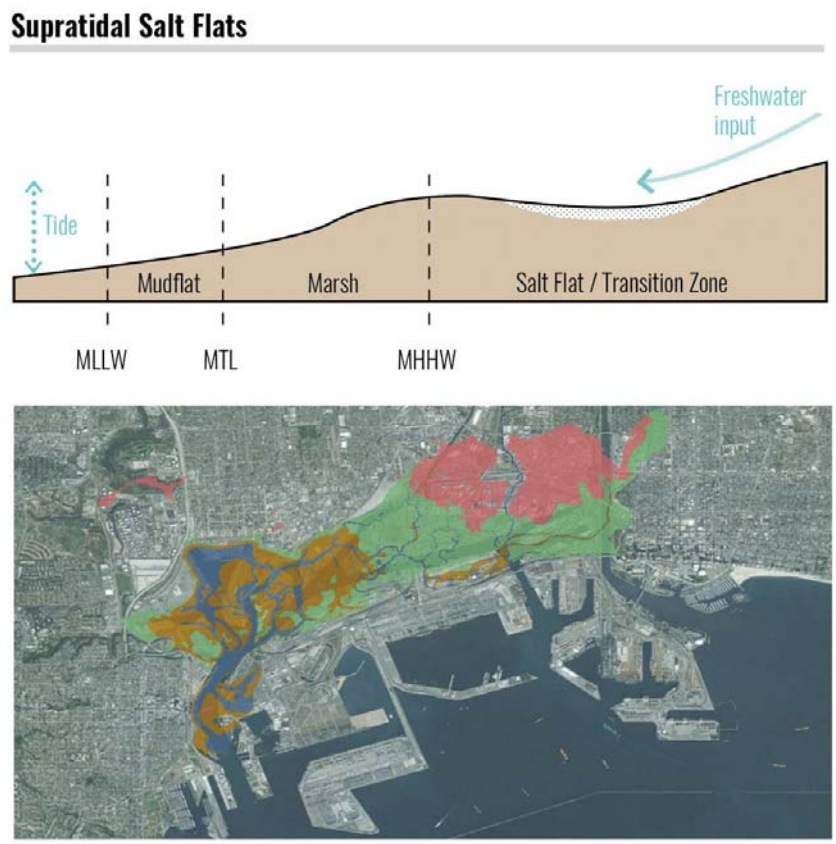

Figure 1. The top panel shows a cross section for historical supratidal salt flats. Historical salt flats (pink) in the Los Angeles area were generally supratidal in nature (historical habitat types, modern aerial).

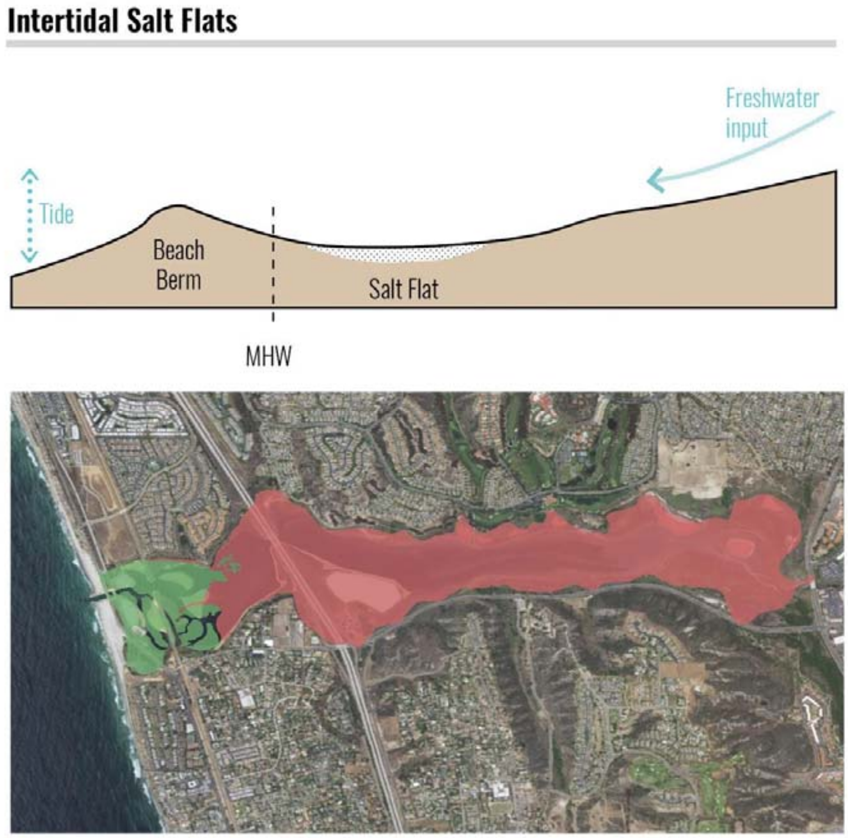

Figure 2. The top panel shows a cross section for historical intertidal salt flats. Historical salt flats (pink) in estuaries such as Batiquitos Lagoon in northern San Diego County were generally intertidal in nature (historical habitat types, modern aerial).

While some salt flats clearly fall into one of these typologies, distinguishing many others without ancillary information on elevation, inundation regime, and formative processes is challenging to impossible, illustrating the wide variety of context in which salt flats were found. More research is needed to differentiate between features and refine the typology.

Contemporary Salt Flat Distribution and Characteristics

Like other intertidal habitat types, salt flats have experienced dramatic changes since the 19th century, with losses of approximately 80% of total area (Stein et al. 2014). However, there are still a few salt flats in the California Bight region, for example in Devereux Slough, San Elijo and Tijuana estuaries. Remaining salt flats include a mixture of salt flats that likely function similar to historical analogs (e.g., salt flats at San Elijo Lagoon; Figure 3) and unvegetated features resulting from legacies of human use or anthropogenic disturbance such as soil compaction, grading, fill, or sediment deposition (e.g., salt flats at the Tijuana River estuary in places with a history of military activity; Figure 3).

Somewhat surprisingly, however, historical salt flat extent is more robustly documented than the current extent of salt flats. While contemporary coastal wetland mapping for the Southern California

Bight is available both from the National Wetlands Inventory (NWI) and Center for Geographical Studies (CGS) at California State University, Northridge, they employ standardized classification schemes that do not distinguish between different types of unvegetated intertidal habitats (e.g., salt flats and mud flats; Cowardin et al. 1979). Salt flats and mud flats are therefore indistinguishable in these products; as a result, the regional distribution of salt flats in the contemporary landscape remains poorly documented and regional assessments of estuarine habitat change (e.g., Stein et al. 2014) have not been able to differentiate change over time between these two unvegetated wetland types.

Local assessments of change over time in salt flat extent and distribution (e.g., Beller et al. 2014, Safran et al. 2016) have used coarse differentiations between salt flats and mudflats based on the presence or absence of a connection to subtidal open water, paired with input from local experts. However, these maps represent only an approximation of salt flat habitat, and have not been validated in the field or systematically evaluated by regional advisors. As a result, detailed mapping of current salt flat distribution, vetted through local knowledge and field validation, remains a regional need (see Goal 4).

Figure 3. Images of contemporary natural salt flats in San Elijo Lagoon (top) and Tijuana estuary (bottom).

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