Geography of Wetlands in the San Francisco Estuary

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Abstract

Much scientific work has been initiated in recent years to understand the nature of wetlands in the San Francisco Bay Area. An improved understanding of wetlands as habitats has changed the way they are defined. There have been large advances in the technology of mapping, and this has increased the ways that wetlands can be measured and viewed. There has been a large increase in the interest in historical ecology, and this has revealed ecological changes in wetlands that were previously unrecognized. And there is more thinking about the relationships among wetlands, bays, and watersheds, which will hopefully lead to more integrative research.

This presentation highlights some of the more important recent advances in basic scientific understanding about the form and ecological functions of wetlands in the Bay Area. The following three basic ideas are illustrated with examples from the past and present, drawing upon the work of many people: (1) wetland habitats are hierarchical; (2) the natural diversity of our wetlands is primarily due to variations in topography and climate; and (3) the past and present arrays of wetlands can be explained by combinations of natural habitat controls and human land uses.

Introduction

SLIDE 1: AERIAL VIEW OF THE S.F. BAY AREA INCLUDING THE DELTA.

Ecological planning means understanding habitat change. Knowing change involves comparing past and present conditions. When change is understood, the past reveals the probable future.

In an effort to support regional wetlands planning, we are conducting a general study of wetlands change. This is a short presentation of some of the basic findings of our study, and some of the bigger questions that the findings have raised.

SLIDE 2: THREE MAIN POINTS.

We wish to address three basic ideas: (1) wetlands are hierarchical; (2) physical processes control the *natural* diversity of wetlands; and (3) the regional mosaic of wetlands is a product of these physical processes *plus* human land uses.

SLIDE 3: SOME TYPES ARE PARTS OF OTHER TYPES.

Let's begin with the first point: wetland habitats are naturally arranged in a spatial hierarchy. In other words, some wetland habitats are relatively small, and exist as parts of other wetland habitats.

For example …

SLIDES 4 - 11: SUCCESSIVELY CLOSER LOOKS AT TIDAL MARSH HABITATS.

?? Here we see an infra-red aerial photo of tidal marshland.

?? Upon closer examination we see that the marshland consists of channels large and small, ponds, and a vegetated plain.

?? When on the ground we see the plain has patches of plant colors that reflect variations in elevation and soil chemistry. When we walk to the pond …

?? We see that it sometimes dries and cracks, although it is wet now.

?? Away from the pond lead small channels covered by plants.

?? And these small channel lead to larger channels with natural levees above high tide …

?? And slump blocks and shoals of shellfish beds exposed when the tide is low.

?? These are some of the smaller habitats that comprise the tidal marshland.

SLIDE 12: SOME TYPES LAST LONGER.

The hierarchy is not only spatial. Some wetlands last longer than others. For example, we can contrast the persistent tidal marsh …

SLIDES 13 - 19: MONTHLY VIEWS OF A SEASONAL WETLAND, FEBRUARY THROUGH AUGUST.

… with monthly changes of non-tidal seasonal surface waters, during:

?? February

?? March

?? April

?? May

?? June

?? July

?? and August.

SLIDE 20: PHYSICAL PROCESSES CONTROL NATURAL HABITAT DIVERSITY.

Now let's turn to the second point we wish to make: Physical processes control the *natural* diversity of wetland habitats. We emphasize the term, natural, to make room for the effects of people, which we will address next.

Here we wish to suggest that there are two basic kinds of wetlands in our region - those that are maintained by the tides, and those that are not. The distribution and abundance of tidal wetlands is constrained by the supply of suspended sediment that the tides carry (there is plenty of water - it is called the *Pacific Ocean*!) The distribution and abundance of non-tidal wetlands is constrained by the supply of water on the ground surface above the tides (there is plenty of sediment - it is called *the land*!). Our supplies of sediment and water are controlled by climate, but topography controls where these supplies are stored. In essence, topography and climate control the distribution and abundance of all our wetlands.

Let's look at some examples of topographic controls.

SLIDE 21: HISTORICAL MAP OF MUDFLATS AND TIDAL MARSHES.

Here we see the distribution of estuarine mudflats, in dark brown, and tidal marshlands downstream of the Delta, circa 1800. The blue places are tidal marsh pannes, or ponds. Notice that most of the marshlands existed in the broad, shallow basins of the South Bay, North Bay, and Suisun Bay Areas. We can also see that scant mudflats and marshlands existed opposite the strong fetch of the Golden Gate, along the crescent from Emeryville to Richmond, or along the steep topography of the San Francisco, Southern Marin, and Carquinez bayshores.

SLIDE 22: HISTORICAL MAP OF MUDFLATS, TIDAL MARSHES, AND PALUSTRINE WETLANDS.

We can also examine the historical distribution of the poorly drained, very fine-grain alluvial soils above the tides, where water would naturally puddle during heavy rains. Notice that these kinds of soils are most common along the valley bottoms, especially in Santa Clara Valley, which is the least steep of all the valleys that attend the Estuary.

SLIDE 23: EXAMPLES OF CLIMATIC CONTROLS.

Now lets turn our attention to some examples of climatic controls, which are more obvious among non-tidal wetlands, such as …

SLIDES 24 - 27: VIEWS OF SEASONAL PALUSTRINE AND RIPARIAN WETLANDS.

?? persistent surface waters

?? seasonal surface waters on fine-grain alluvium

?? willow stands (these were historically called sausals)

?? and riparian zones.

SLIDE 28: REGIONAL HISTORICAL MAP OF ALL MAJOR WETLAND HABITATS.

All of these major types of wetland habitats (mudflats, tidal marshes, tidal marsh pannes, sausals, creeks and riparian zones, and various other kinds of seasonal and persistent non-tidal surface waters) are evidenced around the historical estuary.

This is the most complete map ever made of the historical wetlands ecosystem of the Bay Area. Let's look closer.

SLIDE 29: HISTORICAL WETLANDS ECOSYSTEM OF NILES CONE AREA.

Here we see the two main branches of Alameda Creek that delineated a triangular alluvial fan. We can see that the southern branch of the creek has mostly been abandoned. And there is evidence of older creek courses, in the middle of the fan, and leading to the willows. The kind of fine grain sediments left by the old branch are not yet evident at the new branch. The large patch of fine grain sediment to the north of the new branch relates to a different creek. We might note that the Coyote Hills seem to function as a barrier to runoff and ground water flows. We might also note that the tidal marsh pannes are larger near freshwater runoff. In this one area, as elsewhere around the Estuary, we can see how climate and topography interact to control the natural diversity of wetland habitats.

SLIDE 30: THE WETLANDS MOSAIC IS A PRODUCT OF PHYSICAL CONTROLS AND LAND USES.

Now we will attempt to illustrate some ways that people have affected the distribution and abundance of wetlands in the Bay Area.

SLIDE 31: OHLONE MIDDEN SITES AT COYOTE HILLS.

Let's begin by acknowledging that people have inhabited the Estuary for perhaps five thousand of years.

Each of these gray circles represents a large midden of the Ohlone people. Each midden represents many generations of land use planning and practice. We should ask, to what extent did they affect the form and function of their wetland habitats?

SLIDE 32: HISTORICAL VIEW OF CRYSTAL POND.

A little further north was the largest tidal marsh panne in the Estuary. There is strong evidence that this pond was managed by the Ohlone people to harvest salt. Was this the origin of the modern Bay Area salt industry?

SLIDE 33: HISTORICAL VIEW OF TIDAL MARSH PANNES AT IGNACIO.

Much further north, along the western shore of San Pablo Bay near Ignacio, there was an unusual cluster of large tidal marsh pannes where many Miwok people lived. Did they manage these pannes for salt, or for waterfowl, or both?

SLIDE 34: REGIONAL HISTORICAL MAP OF ALL MAJOR WETLAND HABITATS.

We might ask ourselves: what land uses practices were successfully employed by native peoples to manage wetlands in the Bay Area? And which of these methods should be used today?

SLIDE 34: REGIONAL MODERN MAP OF ALL MAJOR WETLAND HABITATS.

Here we see a regional map of the modern wetland ecosystem. Notice that the historical expanse of tidal marshlands has been replaced for diked baylands that are managed for natural resources (shown in teal color), diked baylands that are farmed or grazed (shown in straw color), and diked baylands as salt collectors (shown in dark blue color). The historical fine grain alluvial sediments are shown as part of the modern condition because they still exist, although they may be partially covered or locally disturbed.

SLIDE 35: REGIONAL MODERN MAP OF ALL MAJOR WETLAND HABITATS, WITH IR PHOTO INSERT.

Let's take a closer look at the modern condition, through this infra-red window.

SLIDE 36: IR AERIAL PHOTO WITH MAP OF SEASONAL WETLANDS.

In this Infra-red aerial photograph of farmed baylands along the Petaluma River, we have mapped the average extent of seasonal surface waters, shown in yellow. These wetlands form in low spots where oxidation and hence subsidence of the historical tidal marsh soils is greatest.

SLIDE 37: IR AERIAL PHOTO WITH MAP OF SEASONAL WETLANDS AND MAP OF HISTORICAL TIDAL MARSH PANNES.

Now we see the historical distribution of tidal marsh pannes (shown in dark blue), as well as the existing seasonal surface waters. Note that there is some spatial correspondence between the two types of wetland habitat. This is because the pannes existed on the organic-rich soils of the tidal marsh plain, which have oxidized and subsided more than other parts of the historical tidal marshland.

We might ask: which, if any, ecological functions of the tidal marsh pannes have been transferred to the seasonal surface waters?

SLIDE 38: CLOSE-UP OF BOUNDARY BETWEEN FINE-GRAIN ALLUVIUM AND DIKED BAYLAND.

If we leave the infra-red photograph, we can examine the possible relationships between a patch of fine grain alluvial sediments (shown in gold), with their tendency to puddle during heavy rains, and adjacent patches of farmed diked baylands (shown in straw color) and diked baylands managed for natural resources (shown in teal).

SLIDE 39: CLOSE-UP OF FINE-GRAIN ALLUVIUM, DIKED BAYLAND, AND ROADS.

If we add a map of local highways and residential roads, we can see that much of the fine grain alluvium is probably disturbed. In fact, much of the alluvial plain is covered with urban infrastructure, meaning roads and buildings and parking lots and so forth.

SLIDE 40: CLOSE-UP OF FINE-GRAIN ALLUVIUM, DIKED BAYLAND, ROADS, AND SEASONAL WETLANDS.

Adding a map of seasonal surface waters begs the question: which, if any, of the ecological functions of the alluvial plain have been transferred to the diked baylands?

SLIDE 41: ART BY ELISE BREWSTER.

These kinds of questions are accumulating for the region as a whole. Our improved understanding of ecological change can help us see the possibilities, but how much of which ecological functions do we need to restore? The historical changes of the past two hundred years may not be so extreme as they seem. Comparable changes could occur in the next two centuries. And, to a large degree, people will control the future changes. Therefore, the most basic question is: what do we want the future to be?

End.