Brief Overview of Historical Suisun Tidal Marsh Form and Ecological Function with Notes on Restoration Science

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Tidal Marsh Form

The following table shows the types of fully tidal marshland commonly recognized by the regional community of wetlands scientists. There are historical as well as modern examples of these types.

	high	low	young	old	fresh	brackish	Saline
fringe marsh	**X**	**X**	**X**	**X**	**X**	**X**	**X**
broad marsh	**X**	**X**	**X**	**X**	**X**	**X**	**X**
high marsh			**X**	**X**	**X**	**X**	**X**
low marsh				**X**	**X**	**X**	**X**
young marsh					**X**	**X**	**X**
old marsh					**X**	**X**	**X**

It is essential to remember that tidal marshland consists of a variety of major landscape features that are regularly distributed through space and over time relative to tidal datums (e.g., mean High Water) and each other. These features are regionally known as the vegetated marsh plain, the tidal marsh channels of first- through sixth-order, and the tidal marsh pannes or ponds. These features are, in turn, recognized as compositions of smaller features. For example, the interior plains away from channels and marginal areas near channels supported different plants communities. In Suisun, the areas near channels tend to have supported tall emergent monocot species including tules and bullrushes, whereas the interior areas away from channels supported "snipe marsh," a community of low-growing dicots including salt grass and pickleweed. The higher-order channels had meanders, straight reaches, natural levees, overhangs, seepage faces, slump blocks, deeps and shallows, and intertidal flats. Each of these minor features is the preferred habitat for one or more protected species of plants or wildlife during one or more life stages.

The historical picture provides the clearest indications of the distribution and abundance of tidal marshlands and their component features. In general, channel density, meaning the amount of channel edge per unit area of marsh surface, decreases up-estuary, with decreasing aqueous salinity. This is because the number and length of smaller-order channels decreases. And this is because the smaller channels are captured by brackish vegetation that grows lower in the intertidal zone than saline vegetation. The number of ponds also decreases, but their average size greatly increases. Based upon the available record, the most complex and longest drainage networks and the smallest ponds were associated with the salt marshes of the South Bay. The simplest and shortest drainage networks and the largest ponds were associated with the fresh-brackish marshlands of Suisun. An historical picture of tidal marshland in the Delta remains to be constructed.

Within the major subregions of the Delta, Suisun, Carquinez Strait, San Pablo Bay, Central Bay, and South Bay, the historical distribution and abundance of tidal marshland was mainly controlled by topography. The relatively steep shoreline terrain of Carquinez Strait, northern Contra Costa, Pinole, South-Central Marin, and East Central Bay involved

less tidal marsh than the gentle terrain and broader valleys of the Delta, Suisun, North San Pablo Bay, and South Bay.

The tidal marshlands of the South Bay, Central Bay, San Pablo Bay, and probably western Suisun Bay have evolved during the last 2-3 thousand years. During this time, tidal marsh vertical accretion has been able to keep pace with a slow rate of sea level rise. But the marshlands of central and Eastern Suisun are older. They are essentially western extensions of the riverine Delta. These marshlands intercepted the estuary in its eastward transgression, as the rates of sea level rise and estuarine transgression slowed. The central portion of Suisun marsh shows evidence of being partly drowned. It looks as if the rate of sea level rise slowed through Carquinez Strait, such that only the western portion of the Suisun marshlands began to be drowned, before the rate of sea level rise slowed to the pace of marshland accretion.

It should be remembered that Suisun marsh is not only a composite of tidal marsh and diked marsh, of old marsh and young marsh, of high marsh and low marsh, or of marshlands of varying salinity. It is also a composite of tidal marshlands with estuarine and riverine origins. Suisun marsh was, and is, naturally the most complex subregion of the San Francisco Bay-Delta system.

Tidal Marsh Function

The historical tidal marshlands of Suisun had abiotic and biotic functions. The major abiotic functions relate to the influence of tidal marshland on estuarine sediment supply and tidal prism.

Tidal marshlands are sediment sinks, meaning that they tend to retain whatever sediments they receive from the tides. Empirical calculations of sediment filtration by the historical marshlands of Suisun are now possible, but have not been made. It is safe to say that the marshlands played an important seasonal role in the regulation of sediment supplies downstream through Carquinez Strait. There is also evidence that the bayshore of Suisun is very sensitive to changes in sediment supply coming through the Delta. During times of decreased sediment supply, some parts of the shoreline tend to erode, and during times of increased sediment supply, the same areas of shoreline tend to advance bayward.

Due to the ability of brackish plants to colonize the lower limits of the intertidal zone, there was scant amounts of intertidal flat in Suisun, relative to the more saline subregions downstream.

The total tidal prism of the historical marshlands has not been estimated, although an empirical estimate is possible. However, a simple comparison of navigational charts for times before and after hydraulic mining and marshland reclamation shows that the historical tidal prism of the marshlands helped maintain more deep bay and deep channels than exist now. For example, it is apparent that the tidal prism of the marshlands along Suisun Slough maintained its depth adequate for deep draft boats, without any need for dredging.

The biotic functions of the historical marshland can be classified among the major component features, the vegetated plain, the ponds, and the channels.

The marsh plain is a source of dissolved and particulate organic matter and detritus that nurtures the estuarine food web. This may be especially important in the Bay-Delta food web because it seems to be based on detritus. The marsh plain is also the habitat for numerous species of small mammals and birds that are hunted by larger predators. The vast areas of "snipe marsh" of low-growing vegetation away from tidal channels was historically favored by hunters for ground-nesting birds, elk, rabbits, and other small game.

The tidal marsh ponds were celebrated centers of activity for waterfowl and shorebirds. Many of the modern and historical duck clubs are named for tidal marsh ponds that were exploited for waterfowl hunting. The intensive, historical market hunting was focused on the tidal marsh ponds of western Suisun. There are numerous popular accounts of the dense congregations of waterfowl associated with many of the larger, natural ponds west of Suisun Slough, although some of the most celebrated ponds were further East, in the western part of Grizzly Island.

It is recorded that the diking of Suisun marsh was related much more to agriculture, including cattle grazing, than hunting. Following the reclamation of the marshland for agriculture, and as the agriculture failed on the diked baylands, there evolved a practice of water management on diked baylands for waterfowl hunting. But the diking of the lands did not originate as a hunting practice. The natural ponds were long celebrated for their hunting opportunities.

This does not mean that the duck clubs and diked baylands are not as good or better than the natural ponds for waterfowl production and conservation. But it does suggest that the natural tidal marsh ponds were historically important waterfowl habitats.

The intensive waterfowl use of the tidal marsh ponds probably relates to their structure as habitat and to their abundant food resources. The ponds were mostly larger than an acre in size, were less than two feet deep, with fine grain sediment of silt and diatoms, devoid of vegetation except for sago pondweed and widgeon grass, and surrounded by low-growing vegetation that permitted a long view of predators. Based upon weekly records for 1980-81 in similar ponds in the brackish part of Petaluma Marsh, the salinity of the ponds in Suisun probably ranged from about 0.0 ppt in the February of very wet years to about 160 ppt in October of very dry years. Seasonal averages were probably about 10 ppt, 25 ppt, 60 ppt and 80 ppt for winter, spring, summer, and fall, respectively. Other records from Petaluma marsh indicate a very high concentration of macroinvertebrates in such ponds, with fall densities of certain insects exceeding 1,ooo individuals per quarter meter square. It is unlikely that these ponds ever dried out, and a large invertebrate food resource was probably available for most of the year.

The ecological functions of the tidal marsh channels are less clearly documented. They can be surmised within reason, however. In considering the ecological functions of the channels, it may be instructive to think of the tidal marsh as living tissue, and to think of the network of channels large and small as the vascular system, including the capillaries. The moon (heart) drives the tidal flow (blood). Materials are delivered to, and taken from the marsh plain (tissue) through the smallest channels (capillaries). Materials are conveyed to and from the marsh and the rest of the estuarine system via the larger channels (vessels). Given the importance of the channels in material exchange, it might be expected that ecological functions would be concentrated along the smaller channels. And this is generally observed. For example, the highest concentrations of native fishes in Suisun

occurs in the relatively undisturbed First Mallard Branch of Montezuma Slough. The greatest species richness for plants and insects and amphibian and mammals and birds occurs along the lower-order natural tidal marsh channels of mature tidal marshland. It has been assumed by many estuarine ecologists in the region that the historical tidal marshlands of Suisun were important nurseries for anadromous and other estuarine fishes, based upon the occurrence of these functions in other marshlands on the northern West Coast. But this assumption remains to be tested.

Notes on Restoration Science

Tidal marshes are fairly well understood as natural landscapes. For example, the relationship between channel form and tidal prism is probably well enough known to design stable channels of different sizes, at least for saline conditions. The relationships between salinity regime and the number and size of ponds on the marsh surface and the amount of channels large or small have also been described. But additional field work is needed to verify channel designs for fresh to brackish conditions.

Furthermore, there is appreciable evidence of the historical and existing support functions of tidal marsh ponds and channels as habitats for birds and fishes, although these ecological functions of the habitats are not as well understood as the habitat themselves.

In short, a number of consultants and researchers in the region are probably able to design tidal marshlands that will provide the desired types and levels of ecological functions, in self-sustaining ways, given adequate access to the tides and an adequate supply of suspended sediment. How regional or local sediment supplies might constrain the amount of tidal marsh restoration remains unknown.

It should also be remembered that the community of wetlands scientists is not advocating conversion of all diked baylands to tidal marshlands. Indeed, at this time, there is no consensus recommendation of any kind. Rather, there is a growing recommendation in concept to restore tidal marshlands along gradients of tidal elevation, aqueous salinity, and distance from the main axis of the estuary, within each of 4 to 10 subregions of the estuary.

There seems to be general agreement that the conservation of waterfowl in the region will require intensive management of some amount of diked baylands in some if not all subregions.

The emerging, broad, conceptual, regional picture of wetlands health has tidal marsh restoration adjoining intertidal flats along the shorelines of the open bays and straits from the South Bay through Suisun; along the major local creeks and sloughs such as Coyote, Alameda, Novato, San Antonio, Petaluma, Sonoma, Napa, Suisun, Hill, and Nurse; and including zones of transition into low-gradient uplands. This conceptual template leaves intact large portions of diked baylands between the bayshore, the major local creeks and sloughs, and the uplands within each subregion.

However, no one seems so sure of these concepts and facts as to promise rapid success for large-scale tidal marsh restoration. What would probably be most prudent is a number of significant pilot projects to test the most recent ideas and to refine the design concepts. It is generally agreed that large-scale tidal marsh restoration should proceed slowly, in order to improve upon the science of restoration without threatening existing resources.

End.