



San Francisco  
Estuary & Watershed Science:  
Case Study

## The Future of Suisun Marsh: Balancing Policy with Change

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The San Francisco Estuary, from the Sacramento–San Joaquin Delta to South Bay, is a mosaic of highly altered habitats, often dominated by alien plants and animals. It is also a center of native biodiversity, supporting endemic and charismatic species, from rare plants to vast flocks of waterfowl. Many of these species are in severe decline as result of conflicts between their ecological requirements and the human uses of the estuary and its watershed. At the same time, major forces of change are operating on the estuarine landscape, among them climate change, urbanization, and increased human demand for water. These conflicts in an ever-changing environment present major challenges to policy makers: how do you balance human and ecosystem demands, especially during periods of extreme conditions, such as droughts and floods?

A good place to explore these conflicts, with an eye towards resolving them before they become too severe, is Suisun Marsh. The marsh is already a focus of mitigation habitat creation because it is centrally located in the estuary and is conspicuously large, open, and filled with wetlands and meandering channels. Of particular interest is the future of Suisun Marsh as habitat for native biota (Moyle et al. in press). Here we discuss the marsh as novel ecosystem, emphasizing how policy decisions made today will influence its future and how predicted changes to the marsh should affect these policy decisions.

### The Importance of Suisun Marsh

Suisun Marsh is important as habitat because of its size, position, history, and native biota (Moyle et al. in press). Taken together, these intrinsic characteristics merge to create a vital wetland ecosystem.

### Size and Location

Suisun Marsh is the largest expanse of marsh in the San Francisco Estuary. It covers about 470 km<sup>2</sup> and is located roughly in the middle, adjacent to Suisun Bay. This position means it is strongly influenced both by the tides that surge through the Golden Gate and by freshwater flows from upstream. The marsh is proximate to Fairfield and Suisun City, and so receives urban as well as regional run-off. It also serves as open space for recreation. In addition, it is connected to nearby natural areas, including the Potrero Hills and the vernal-pool prairies adjacent to the North Delta and Yolo Bypass. It is a major stopping place for migratory birds on the Pacific Flyway, and for migrating fishes such as Sacramento splittail and Chinook salmon.

### History

Suisun Marsh is about 6,000 years old; therefore, it has never been without a human presence. While agriculture briefly thrived in the marsh from the late 1800s through the mid-1900s, since the late 19th century marsh management has focused on attracting waterfowl. Hunters, largely from the Bay Area, purchased marshlands to create duck hunting clubs, and vigorously defended the marsh against development and activities that threatened wetland habitat. The State of California also acquired large areas as wildlife reserves and public hunting grounds. Marshlands were diked off from tidal excursions and then managed as freshwater habitat for ducks and their favored food plants. At present, 158 duck clubs manage 75% of the marsh for waterfowl. In short, during the past 150 years, Suisun Marsh has been transformed from a tidal marsh that supported native peoples and wildlife, to farmland and pasture, and to a collection of waterfowl hunting areas with over 300 km of gated dikes that separate marshlands from intervening sloughs.

### Native Biota

Despite its history, Suisun Marsh supports 200+ plant, 180+ bird, 45 mammal, 50+ fish, and 60 butterfly species. Some species are endemic to the marsh, e.g., Suisun song sparrow and Suisun thistle. Many species, however, are not native; a constant problem for managers is keeping alien invaders from dominating habitats crucial for native species. On the other hand, the marsh still supports populations of charismatic species such as tule elk, river otter, white pelicans, and numerous waterfowl. The marsh is also important as a research site because of its accessibility and biotic diversity. It is thus an excellent example of how our growing understanding of an ecosystem can be the basis for management.

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## Suisun Marsh as a Site for Tidal Habitat Restoration

There is widespread agreement that tidal habitats, from salt marshes to mud flats, are important for native species, especially birds and plants (e.g., Palaima 2012). However, there is less agreement on the idea that tidal habitats export nutrients and food organisms that fuel food webs in channels where fish feed, especially native pelagic species. Nevertheless, restoration of tidal habitat is a driving force in planning in the marsh. For example, the *Suisun Marsh Protection Plan* establishes a goal of restoration of 5,000 to 7,000 acres of tidal habitat, in unspecified locations, within the marsh. Likewise the draft *Bay Delta Conservation Plan* recommends restoring thousands of acres of tidal habitat in the Delta and Suisun Marsh as mitigation for the effects of water export facilities. Planners gravitate toward Suisun Marsh because it seems to have an abundance of available places to breach levees, allowing the water flow in and out with the tides (Lund et al. 2010). It is already marsh, so this logic goes, such that all it needs is different management regime. Indeed, small-scale habitat restoration sites that target imperiled species already exist—for instance, Blacklock Island, Peytonia Slough Ecological Preserve, Hill Slough, Rush Ranch—although their restoration success is not well documented. This restoration view ignores the fact that while duck clubs are primarily managed for waterfowl, they also support a diversity of fish and wildlife including species such as river otters that do especially well in the managed wetlands.

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## Sea Level Rise and Other Stressors of Suisun Marsh

Suisun Marsh is constantly changing, despite considerable efforts by waterfowl managers to maintain the freshwater (or nearly freshwater) system for the ducks that hunters prefer. These efforts have included the installation of large salinity control gates at the head of Montezuma Slough in 1988 to keep fresh water in the marsh, as partial mitigation for the diversion of water upstream by the State Water Project. But other changes have made waterfowl management more challenging. For example, flocks of migratory ducks and geese are now attracted to flooded rice fields and wildlife areas in the Sacramento Valley, rather than to the marsh. The listing of endangered species from plants to mice to fish has constrained management options. Thus, dredging of sloughs to maintain levees is restricted, as is release of anoxic water from duck ponds into sloughs, where it can kill fish.

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**Sea level rise** will, conservatively, reach 1 to 2 m by 2100. Sea level has been rising for several decades and the rate of rise is accelerating. As sea level rises, overtopping and erosion of levees will become more frequent, especially during extreme high tides and major flood events. Floods also are expected to occur more often as the result of climate change.

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**Subsidence** of land inside dikes is the result of the way most duck clubs are managed today. Already, about half of all land in the marsh is below sea level. Subsidence increases the likelihood of large-scale dike failures and marshland flooding. The best way to reverse subsidence is to build up organic matter by encouraging dense growth of native marsh vegetation, which may not be favorable to waterfowl in the short term.

**Reduced sediment supply** from upstream sources makes it more difficult to reverse subsidence through sediment deposition. Unfortunately, the whole estuary is now a sediment-starved system, in part because sediment is retained behind dams upstream.

**Reduced tidal energy** occurs as the tidal water is spread over larger areas as the result of submergence of Delta islands, tidal restoration projects, and similar actions. Reduced tidal energy results in less ability for the tides to transport sediment and nutrients to places where they are needed. Essentially, tidal energy in the estuary exists as a fixed quantity, so the larger the total area inundated by tides, the more this energy is dissipated. As a result, tidal currents will be greatly reduced in many channels.

What all this means is that much of Suisun Marsh will become increasingly intertidal and saline, unless enormous sums are spent maintaining ever-sinking dikes. Much of it will become tidal marsh and open water no matter what we do; it is more a matter of 'when' than 'if' this will occur. Our basic understanding of these processes means policymakers can either actively guide the future of the marsh or, by ignoring our collective knowledge, continue to respond to crises as they emerge (Moyle et al. in press).

### **The Future of Suisun Marsh**

Ultimately, given the inevitable changes outlined above, most of the marsh cannot be maintained as diked and managed wetlands (Moyle et al. in press). The marsh will become increasingly tidal with limited space for upslope marsh expansion into new areas. If it continues to be managed as fragmented, diked wetlands until the dikes can no longer be sustained, the end result will probably be large expanses of open, salty water, pushed around by the winds, with low tidal energy to move organisms, nutrients, and sediment in and out of the system. Alternatively, controlled tidal flooding could be allowed in large areas of diked wetlands in the near future. This choice would keep many areas indefinitely as marsh—albeit as brackish marsh less favored by ducks—by allowing marsh plants to deposit organic matter in sufficient quantities to keep soil levels up with sea level rise.

Policies made today about how Suisun Marsh is managed will determine which plants and animals are abundant there in the future. The mixture of native and alien species from all over the world living together in highly altered habitats makes Suisun Marsh a novel ecosystem, unlike any other that exists. This novel ecosystem will continue to change in the future, providing opportunities for creative management.

Because a mixture of policies and changing natural processes will determine what species inhabit the marsh and what the marsh will look like, policies that work with inevitable, predicted environmental change, rather than against it, offer the best opportunity to conserve the high ecological and aesthetic values of this special place. Most policy decisions will allow Suisun Marsh to continue to function as a mixture of tidal and non-tidal habitat, as open space, and as protection for urban areas against sea level rise and flooding. These functions can also be very compatible with management options that favor native species, from plants to fish to birds. Such management, however, may necessitate new forms of science-policy collaboration, political compromise, and some consternation. But a deliberative approach to management, with clear goals for both the near and distant future, is the best way to proceed. Actions we take today will determine the marsh ecosystem of tomorrow—and the diversity of life it will support.

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