SAN FRANCISCO ESTUARY — 1800s AND TODAY

Since the 1800s, there has been substantial human activity that has severely affected the San Francisco Bay coastal ecosystem, including its natural biota, sedimentation patterns, hydrology, and water and sediment chemistry. Private and public individuals and agencies are working hard and cooperatively to study the area's environmental issues and develop management strategies based on peer-reviewed scientific research. The future isn't bleak, but it requires our dedicated attention. Studied issues include:

WATER DIVERSION

Today, about 40 percent of the freshwater discharge of the Sacramento and San Joaquin watersheds is diverted for local consumption. An additional 24 percent is exported by aqueducts to southern California. Most of this diverted water is used to irrigate farmland, and the demand for additional water is expected to increase because of the profitability of agricultural production. Reduced discharge of freshwater into the estuary hinders spawning of certain fish species, modifies water and sediment transport, and makes it more difficult to dilute and flush out contaminants. Meanwhile, higher salinity values mean a reduction in habitat for marine organisms that are highly sensitive to water salinity.

THE INTRODUCTION OF EXOTICS

The introduction of exotic species has had devastating effects on the natural populations by displacing or outcompeting them for space and resources. More than 130 species of plants, invertebrates, and fish that are not indigenous to the region have been released into the bay waters since the mid-19th century, some inadvertently (foreign vessels expelling bilge water with its exotic plankton into the bay), some on purpose. Today, just about all of the common large invertebrates that dwell in shallow water are exotic species; of the 42 species of fish that inhabit the upper bay, 20 have been introduced by humans.

Golden Gate Bridge—viewed from Crissy Field, looking North towards Marin Headlands. Header image: Intertidal wetlands. Photos by Katryn Wiese ©

WETLAND LOSS

Since 1950, over 95 percent of the estuary's wetlands have been lost to development, levee construction, pollution, erosion, and rising sea level. Sediment infilling of a bay and its wetlands is a natural process, but it has been greatly accelerated by human activity, such as when, during the 19th century, gold mining washed huge quantities of sediment into the bay. Wetlands are critical habitats for many fish and wildlife. Their destruction has caused an extreme decline in fish diversity. Various groups are striving to re-establish wetlands and migratory-bird sites where parts of the bay were diked to create farmland and salt evaporation ponds. The largest such project on the West Coast is currently under way in South San Francisco Bay, restoring 16,000 acres of salt evaporation ponds to tidal marsh and other natural habitats.

WATER QUALITY

Bay waters receive a great variety of toxic contaminants from agricultural, industrial, and urban activities. Many of these substances, such as pesticides, PCBs, petroleum hydrocarbons, and trace metals, have long-range consequences for the health and future of all estuarine organisms. The high concentrations of cadmium, silver, mercury, and lead that have been measured at certain localities in bay muds are known to interfere with the growth and reproduction of fish, mammals, and birds. Furthermore, toxins ingested at the bottom of the food web magnify upwards, so there is concern for the health of humans who consume them. The urbanization and agricultural practices of the San Francisco Bay area and the San Joaquin valley have substantially increased the levels of ammonia, nitrate, and phosphate in the waters of the bay (primarily from fertilizers, detergents, and sewage). This influx of nutrients can trigger algal blooms that can choke enclosed waterways and lead to depleted oxygen in the water. Over the last three decades, consistent improvements in state-of-the-art wastewater treatment, particularly in South San Francisco Bay, have helped reduce the influx of nutrients and other toxins. More such measures and technology are scheduled to be in place in the near future.

Goldfield legacy

Hydraulic mining in the foothills of the Sierra Nevada. Photo from Sutter's Mill Museum.

The development of mercury-mining operations in the hills of the San Francisco Bay Area just in time for the Gold Rush was an incredibly fortuitous event in the development of the U.S. economy. Unfortunately, it also carried long-lived negative environmental consequences. Tailings from the region's mercury mines leached into the watershed and eventually into San Francisco Bay. Much of the mined mercury was transported to the Sierra Nevada foothills, where miners used it by the wagonload to extract gold flecks from sediment. Approximately 10,000 tons of this mercury later re-entered San Francisco's North Bay embedded in 12 billion m^3 of mercury-laced hydraulic-mining debris—sediment transported and dumped by the Sacramento River. While these old mercury and gold mines have been largely cleaned up and no longer pose a threat to the environment, the mercury they released is still cycling through the sediment carried by the Sacramento and San Joaquin rivers and dumped in San Francisco Bay. Once added to the bay, it takes as long as 50 years for the estuary to remove it. As the Sacramento River continues to tap into these old mercury-laced sediments, we continue to resupply the bay with mercury. Certain unanticipated "gifts" of the Gold Rush keep on giving!

The mercury employed in gold mining in the Sierra Nevada was refined liquid quicksilver or elemental mercury. When this inorganic mercury is microbially processed in sediments rich in organic substances (such as decomposition products of grasses and other plants in wetands), it can be transformed into methylmercury, a potent neurotoxin that is harmful to developing fetuses and young children. This methylmercury is transported and biomagnified through the food chain, leading to elevated concentrations in some commercial and sport fish. Human consumption of fish caught in the bay is already restricted because of this contamination. As we plan restoration projects for marshes that were once sinks for mining debris and as we dredge regions of ancient sediments, we must consider human-health and environmental consequences of mercury that may be released in various chemical forms from the sediments of the bay.