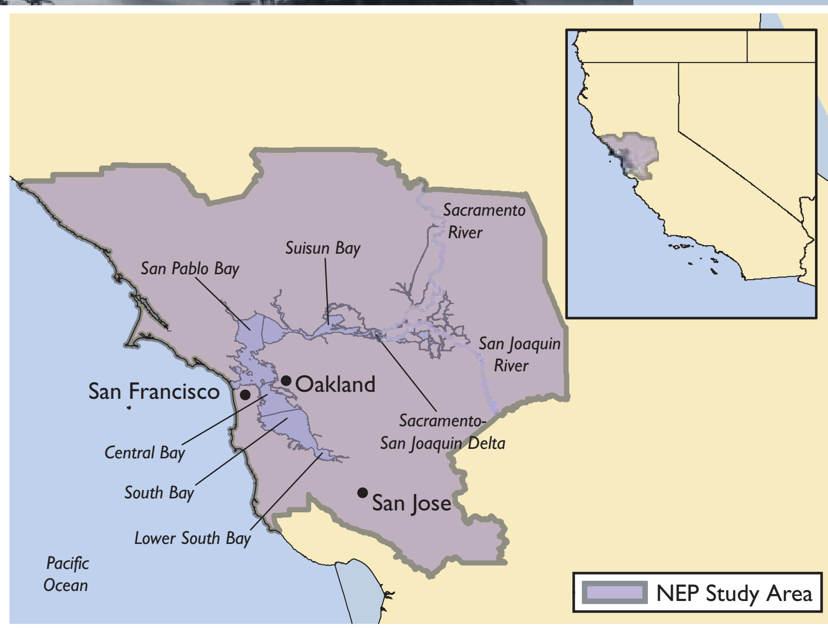
This document contains overall and specific condition of the San Francisco Estuaries Project from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from ***http://www.epa.gov/owow/oceans/nepccr/index.html***

National Estuary Program Coastal Condition Report

Chapter 6: West Coast National Estuary Program Coastal Condition, San Francisco Estuaries Project

June 2007

San Francisco Estuary Project



San Francisco Estuary Project

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Background

The San Francisco Estuary is one of the largest estuaries on the West Coast, encompassing about 460 mi^2 of open water. The Estuary is shallow, and approximately one-third of the total water area has a depth of less than six feet. The Sacramento and San Joaquin rivers supply approximately 90% of the Estuary's freshwater input and drain about 40% of California's land area. These rivers enter the Estuary through the Sacramento-San Joaquin River Delta, a large area of diked and drained swampland in the northern portion of the Estuary (SFEP, 1999). Major embayments within the San Francisco Estuary include the Suisun, San Pablo, Central, South, and Lower South bays.

The San Francisco Estuary and its associated tributaries encompass roughly 1,600 mi^2, provide drinking water to 23 million Californians (two-thirds of the state's population), and irrigate 4.5 million acres of farmland. The Estuary also enables the residents of the nation's fifth-largest metropolitan region to pursue diverse activities, including shipping, fishing, recreation, and commerce. Finally, the Estuary hosts a rich diversity of flora and fauna, with nearly half of the birds that migrate along the Pacific Flyway and about two-thirds of the state's salmon passing through the Estuary (SFEP, 2004).

Environmental Concerns

Freshwater management is an environmental concern in the San Francisco Estuary region. Each day, millions of people, industries, and municipalities around the Estuary use river water for an array of activities, then collect, recycle, treat, and discharge their wastewater into the Estuary. In rural areas, farmers irrigate crops and water their livestock. Maintaining river flows under the pressure of exporting water to southern California is a major environmental concern in the Estuary, and during droughts and heavy rain years, this pressure makes managing the system even trickier. Add to these needs other issues, such as pesticides and other pollutants that get washed into the creeks, rivers, and bays, and water quality management for the Estuary becomes even more challenging.

Population Pressures

The population of the 12 NOAA-designated coastal counties coincident with the San Francisco Estuary Project (SFEP) study area increased by 96.1% during a 40-year period, from 4.5 million people in 1960 to 8.7 million people in 2000 (Figure 6-32) (U.S. Census Bureau 1991; 2001). This rate of population growth for the SFEP study area was slightly lower than the population growth rate of 100.3% for the collective NEP-coincident coastal counties of the West Coast region. However, the coastal counties surrounding the SFEP had the highest population density (844 persons/mi^2) of any of the West Coast NEP study areas (U.S. Census Bureau, 2001). The San Francisco Estuary is surrounded by major metropolitan areas that serve as large centers for international commerce and industrial and recreational activities.

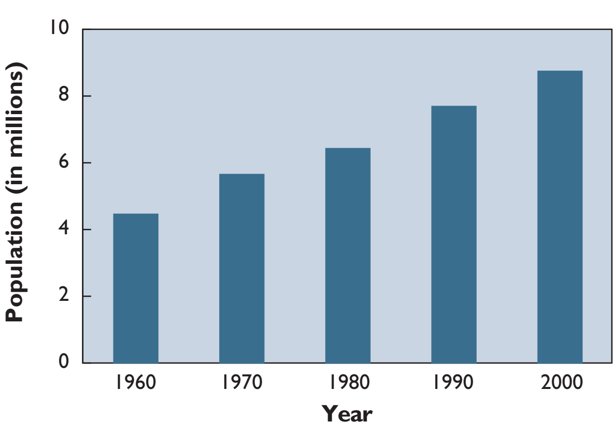


Figure 6-32. Population of NOAA-designated coastal counties of the SFEP study area, 1960–2000 (U.S. Census Bureau, 1991; 2001).

NCA Indices of Estuarine Condition—San Francisco Estuary

The overall condition of the San Francisco Estuary is rated fair based on the four indices of estuarine condition used by the NCA (Figure 6-33). The water quality index is rated fair to poor, the sediment quality index is rated fair, the benthic index is rated good, and the fish tissue contaminants index is rated poor. Figure 6-34 provides a summary of the percentage of estuarine area rated good, fair, poor, or missing for each parameter considered. This assessment is based on data collected by the NS&T Program and Moss Landing Marine Laboratories, under contract to the Southern California Water Resources Research Project (SCWRRP), from 50 stations sampled in the San Francisco Estuary in 2000. Please refer to Tables 1-24, 1-25, and 1-26 (Chapter 1) for a summary of the criteria used to develop the rating for each index and component indicator.

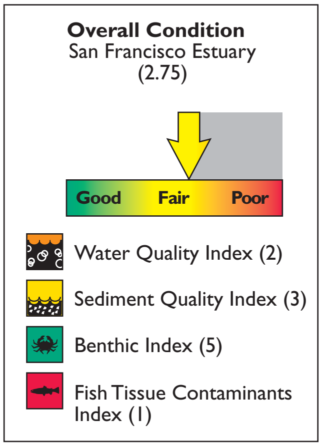


Figure 6-33. The overall condition of the SFEP estuarine area is fair (U.S. EPA/NCA).

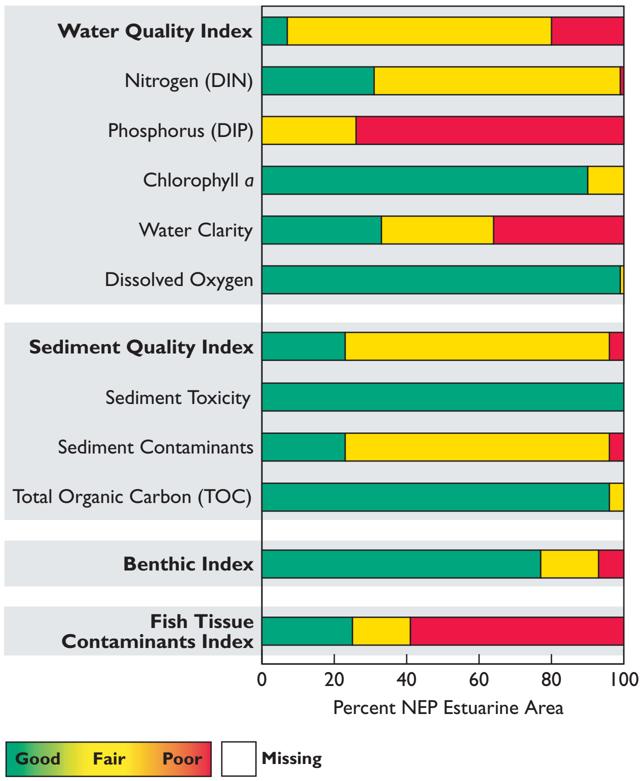
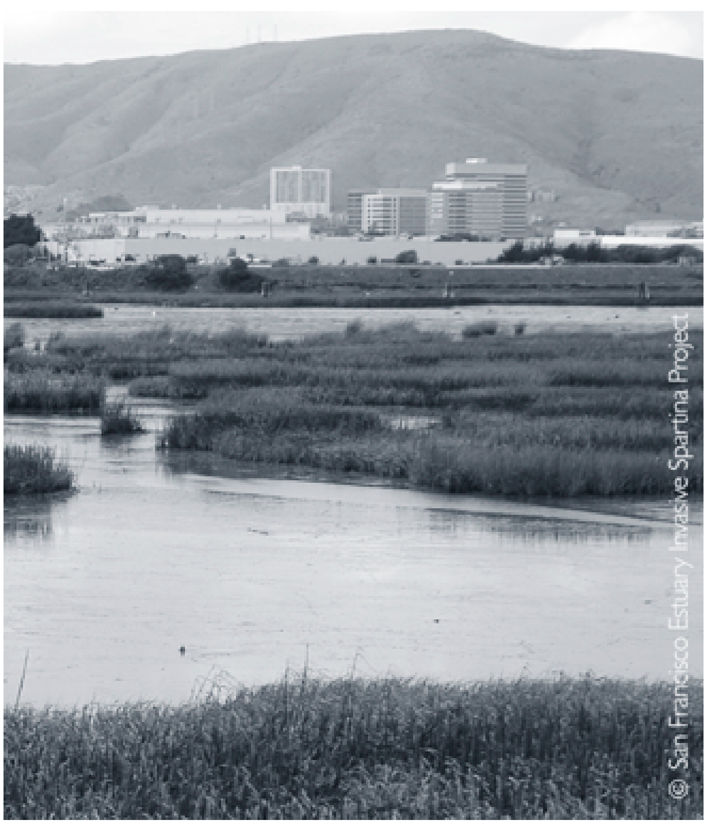


Figure 6-34. Percentage of NEP estuarine area achieving each ranking for all indices and component indicators — San Francisco Estuary (U.S. EPA/NCA).



Water Quality Index

Based on NCA survey results, the water quality index for the San Francisco Estuary is rated fair to poor (Figure 6-35). This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. Some 20% of the estuarine area was rated poor for water quality, and 73% of the area was rated fair. Diminished water quality in the Estuary was primarily due to limited water clarity and to elevated levels of DIN and DIP.

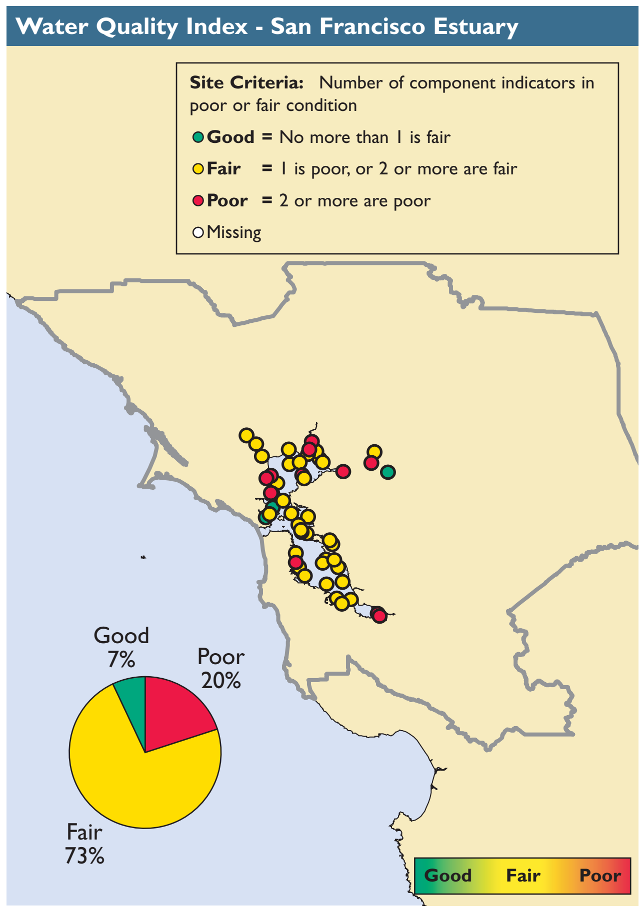


Figure 6-35. Water quality index data for the San Francisco Estuary, 2000 (U.S. EPA/NCA).

The dominant marsh vegetation in this area of the San Bruno Marsh is an invasive, non-native *Spartina*, which is a hybrid of an introduced and a native species (San Francisco Estuary Invasive Spartina Project).

Dissolved Nitrogen and Phosphorus | The San Francisco Estuary is rated fair for DIN concentrations and poor for DIP concentrations. Concentrations of DIN were rated fair in 68% of the estuarine area, and DIP concentrations were rated poor in 74% of the area. In addition to natural inputs of nutrients from offshore coastal upwelling, high levels of urban and agricultural runoff into the Sacramento River may also be major contributors to the elevated nutrient levels found in the San Francisco Estuary.

Chlorophyll a | Chlorophyll *a* concentrations in the San Francisco Estuary are rated good. Ten percent of the estuarine area was rated fair for this component indicator, and the remaining 90% was rated good.

Water Clarity | Water clarity in the San Francisco Estuary is rated poor. Approximately 36% of the estuarine area was rated poor for this component indicator, and 31% of the area was rated fair.

Dissolved Oxygen | Dissolved oxygen conditions in the San Francisco Estuary are rated good, with 99% of the estuarine area rated good for this component indicator. Although conditions in the San Francisco Estuary appear to be generally good for dissolved oxygen, measured values reflect daytime conditions, and some areas of the Estuary may still experience hypoxic conditions at night.

Sediment Quality Index

The sediment quality index for the San Francisco Estuary is rated fair (Figure 6-36). This index was developed using NCA data on three component indicators: sediment toxicity, sediment contaminants, and sediment TOC. Four percent of the estuarine area was rated poor for sediment quality, exceeding thresholds for at least one of these component indicators, and 73% of the area was rated fair, primarily as a result of sediment contaminant levels.

Sediment Toxicity | Sediment toxicity in the San Francisco Estuary is rated good, with 100% of the estuarine area rated good for this component indicator.

Sediment Contamination | The San Francisco Estuary is rated good for sediment contaminant concentrations, with 4% of the estuarine area rated poor for this component indicator and 73% of the area rated fair.

Total Organic Carbon | The San Francisco Estuary is rated good for sediment TOC. TOC concentrations were rated good in 96% of the estuarine area and fair for the remaining 4% of the area.

Sediment Quality Index - San Francisco Estuary

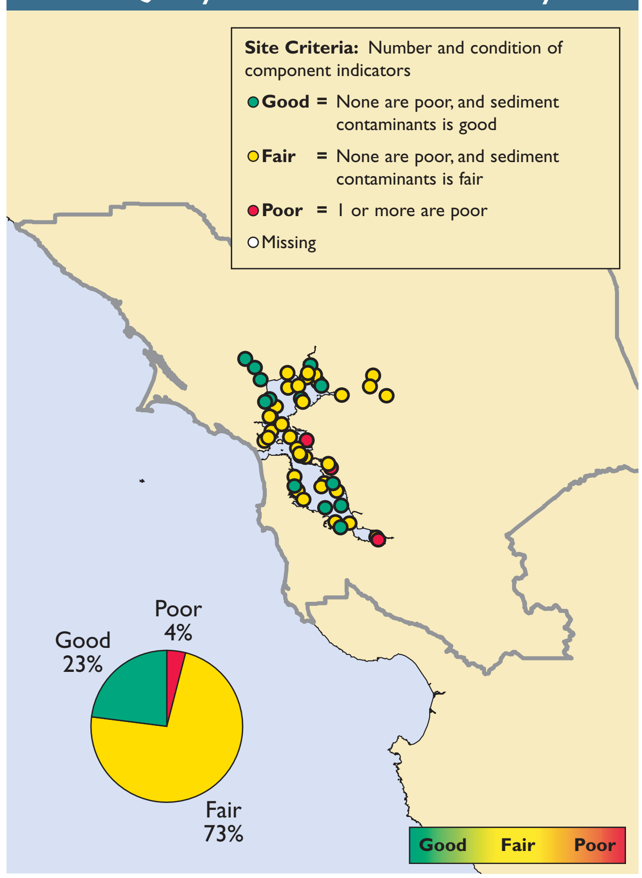


Figure 6-36. Sediment quality index data for the San Francisco Estuary, 2000 (U.S. EPA/NCA).

Benthic Index

The condition of the benthic invertebrate communities in the San Francisco Estuary is considered good based on deviations from the expected species richness (Figure 6-37). A significant linear regression between log species richness and salinity that was moderately strong ($r^2 = 0.54$, $p < 0.01$) was found in the Estuary. Six percent of the estuarine area was rated poor based on a lower-than-predicted species richness, and 16% of the area was rated fair. The remaining 78% of the estuarine area was rated good for benthic condition. It is possible that sediment contamination contributed to the lower species richness in several of the areas rated poor and fair because 6 ERLs were exceeded at 6 of the 11 sampling sites in these areas. However, the reduced species richness is not simply related to sediment contamination because 21 of the 39 sites rated good for the benthic index had an equivalent or greater number of contaminants exceeding their ERLs.

Fish Tissue Contaminants Index

The fish tissue contaminants index for the San Francisco Estuary is rated poor. Fifty-eight percent of all stations sampled where fish were caught exceeded EPA Advisory Guidance values using whole-fish contaminant concentrations (Figure 6-38). These risk calculations are appropriate for populations that consume whole fish. The contaminants found in the fish tissues sampled included total PCBs and, occasionally, mercury.

Sediment Contaminant Criteria (Long et al., 1995)

ERM (Effects Range Median)—Determined for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.

ERL (Effects Range Low)—Determined for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

Benthic Index - San Francisco Estuary

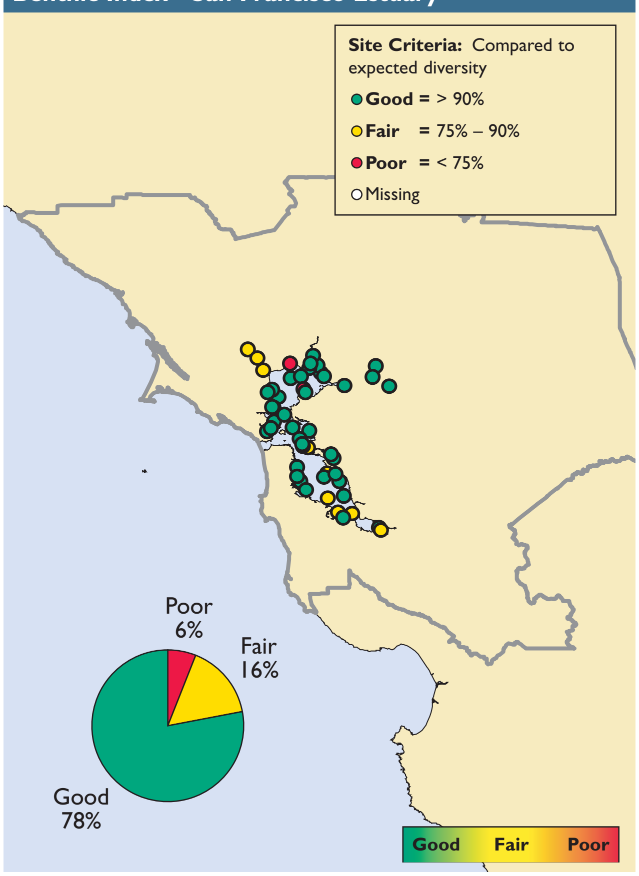


Figure 6-37. Benthic index data for the San Francisco Estuary, 2000 (U.S. EPA/NCA).

Fish Tissue Contaminants Index - San Francisco Estuary

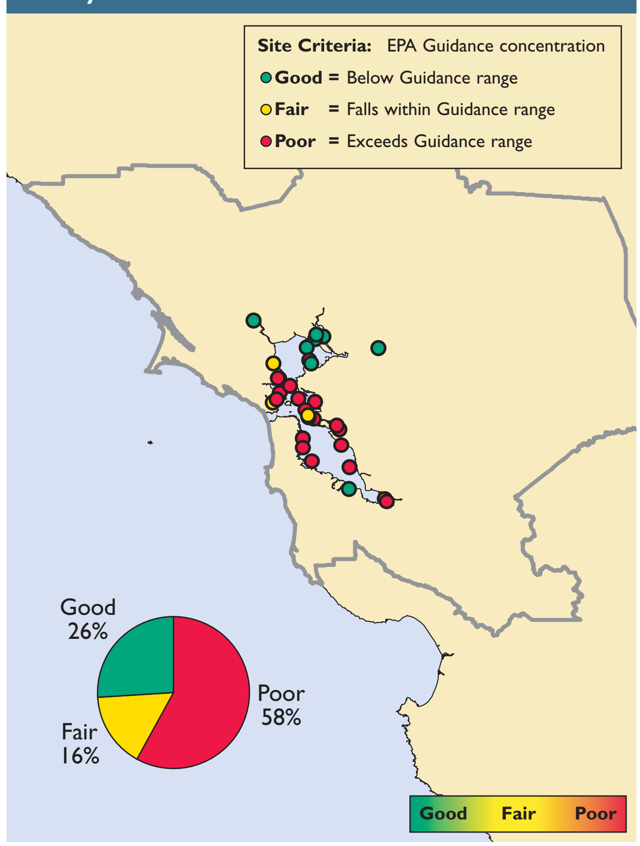


Figure 6-38. Fish tissue contaminants index data for the San Francisco Estuary, 2000 (U.S. EPA/NCA).

San Francisco Estuary Project

Ecosystem Indicators for the San Francisco Estuary

The San Francisco Estuary is considered one of the best-studied ecosystems in the world; however, the myriad of disparate data-collection efforts for the Estuary has not resulted in a coherent performance-measurement system. Currently, no single, objective, and comprehensive assessment of the health of the San Francisco Estuary and its watersheds is widely recognized as valid by ecosystem managers and policy makers. Such an assessment would identify problems early, direct agency efforts towards real priorities, and measure the impacts that collective actions are having on the system's health so that the SFEP can continue to adapt and improve its management strategies. The assessment would be conducted using a variety of environmental indicators, which are the vital signs derived from the chemical, biological, and physical measurements that mark the improvement or deterioration of the ecosystem. A recently released U.S. Government Accountability Office (GAO) report (U.S. GAO, 2004) recommends that leadership at the highest levels of government mesh the disparate efforts of multiple agencies and organizations into a coherent, science-based environmental management system for the Estuary.

Although no program in the San Francisco Estuary area is currently charged with integrating measurements and indicators into an assessment of ecosystem condition, identifying attributes that define ecosystem condition, or pinpointing gaps in that knowledge, progress is being made towards these goals. In 2004, The Bay Institute (TBI) and its partners made the first attempt to assess the ecological condition of the Estuary and reported the results using language accessible to the general public in its Ecological Scorecard (TBI, 2003). Additional partnerships between organizations studying the Estuary have been created to develop a consensus set of indicators for use by all stakeholders. These partnerships recently completed a report (Thompson and Gunther, 2004) documenting 47 separate recommended environmental indicators and have organized indicator workshops. These efforts build on previous indicator identification efforts and existing Bay-region monitoring programs, including the Interagency Monitoring Program and the USGS Regional Monitoring Program.

The Ecological Scorecard was a collaborative project between the San Francisco Estuary Institute (SFEI), the Center for Ecosystem Management, and TBI. Assisted by a grant from the SFEP, this project evolved over a three-year period, with input from a wide-range of local scientists and a panel of nationally recognized experts. The Scorecard's Bay Index uses science-based indicators to grade the condition of the San Francisco Bay region, the first of a series of four major ecological regions of the Estuary (i.e., San Francisco Bay, San Francisco Delta, San Joaquin River, and Sacramento River) to be assessed. The Scorecard's indicators are combined into eight indices that track the Estuary's environment (e.g., habitat, freshwater inflow, water quality); its fish and wildlife (e.g., food web, shellfish, fish); and the management of its resources (e.g., fishable, swimmable, drinkable). The grading system compares current conditions in the Bay and its watershed to historical conditions, environmental and public health standards, and restoration goals. Grades in the 2005 Scorecard (see figure) range from B to F, reflecting the long-term decline in the Bay's ecological health; however, there are some small but noticeable short-term improvements in the area's habitat and shellfish populations (TBI, 2003; 2005).

Another effort to develop environmental indicators is being led by the SFEP and its partner, SFEI. These agencies have formed a Bay Area Indicator Consortium to provide direction in strategizing the development of ecosystem indicators for the San Francisco Estuary. The Consortium recommends that the same indicators developed for the Ecological Scorecard be expanded and used as the starting point for the ecosystem indicators. In May 2004, the SFEP partnered with the SFEI and the Consortium to produce the report *Development of Environmental Indicators of the Condition of San Francisco Estuary: A Report to the San Francisco Estuary Project*, which was submitted to EPA Headquarters in September 2004 (Thompson and Gunther, 2004).

With support from EPA, the Consortium organized an Indicators Workshop in January 2005. Workshop participants explored new state and federal initiatives highlighting the need for "performance-based environmental management," as well as recent successes by the SFEP to develop a meaningful environmental indicator system. The workshop's purpose was to build consensus on the importance of and the need for scientifically valid, leading environmental indicators; to develop a framework for interagency cooperation and collaboration on the development, refinement, and use of environmental indicators; and to attract commitments of ongoing financial and programmatic support. Workshop attendees included approximately 40 participants representing the agencies developing and entities using the data (SFEP, 2006).

AREA	GRADE	SUMMARY	LONG-TERM	SHORT-TERM
	D+ Score = 31	**Habitat** Bay habitat loss is slowly being reversed, but pace of restoration unchanged since 2003 – at current rate, more than 150 years to reach tidal marsh restoration goal.	▼	▲
	C+ Score = 58	**Freshwater Inflow** Reduced inflows still degrade the Bay ecosystem – inflow improved in 2004, but overall conditions since 2000 are worse than two previous decades.	▼	◀▶
	B- Score = 65	**Water Quality** Open waters are cleaner than in 2003, but not all standards are met in parts of the Bay. Toxic sediments, stormwater runoff are major problems. South and San Pablo Bays are most polluted.	▲	▲
	F Score = 10	**Food Web** Plankton levels in Suisun Bay are still critically low, reducing food resources for fish and birds. Phytoplankton levels in all other parts of the Bay are improving.	▼	◀▶
	B Score = 73	**Shellfish** Crab and shrimp numbers rise in Central and South Bays, but not in the upper Bay. Estuarine species lose ground to marine shellfish.	▼	▲
	C- Score = 45	**Fish** Recent upward trend reverses, fish populations return to critically low levels. Estuarine species of the upper Bay are hardest hit.	▼	◀▶
	C- Score = 38	**Fishable-Swimmable-Drinkable** More fish were caught but most are still unsafe to eat. Beach closures continue to rise, drinking water violations hold steady.	▼	◀▶
	C- Score = 46	**Stewardship** Little progress towards conserving more water, reducing pesticide use, and restoring freshwater inflows, but some efforts to issue pollution limits move forward.	▼	◀▶

Grades are for the 2002-2005 period

A = Excellent
B = Good
C = Fair
D = Poor
F = Critical

Short-term = trend over last 5 years
Long-term = trend over last 25 years or more

▲ = improving
▼ = declining
◀▶ = stable

San Francisco Bay Index 2005 Scorecard (TBI, 2005).

San Francisco Estuary Project Indicators of Estuarine Condition

The San Francisco Estuary has had the benefit of several long-term monitoring programs, including the Regional Monitoring Program for Trace Substances (RMP), sampling and analysis by USGS, and the Interagency Ecological Project (IEP). The RMP has investigated chemical contamination in the water, sediments, and biota of the Estuary since 1993 and provides data on spatial patterns and long-term trends for use in management of the Estuary (SFEI, 2003). The USGS has more than 35 years of water quality data on various parameters, such as chlorophyll, nutrients (phosphorus and nitrogen), suspended sediments, salinity, and dissolved oxygen. The USGS data provide a record of biological and chemical changes in the Estuary. These data have been used to show improvements in dissolved oxygen concentrations in the South Bay and changes in phytoplankton production in Suisun Bay (USGS, 2006b). The IEP has monitored fisheries and the effects of freshwater diversions on the biota of the San Francisco Bay proper and the Sacramento-San Joaquin Delta since 1971 (IEP, 2006). Recent IEP data have shown drastic declines in important delta fish species, such as striped bass, delta smelt, and longfin smelt (Hieb et al., 2005). Other local, state, and national programs, such as the Bay Protection and Toxic Cleanup Program, Coastal Intensive Sites Network (CISNet), EMAP, and NOAA's NS&T Program, have also provided data on the water, sediments, and biota of the San Francisco Estuary. It is beyond the scope of this writeup to comprehensively discuss all of these indicators; however, several indicators of particular interest are discussed in the following sections. Additional information about the San Francisco Estuary is available from http://sfep.abag.ca.gov or http://www.sfei.org.

Water and Sediment Quality

Current and historical activities in California have contributed PCBs, pesticides, and mercury and other heavy metals (e.g., silver and copper) to the sediments of the San Francisco Estuary. Urban runoff in area watersheds is a significant, contemporary source of various contaminants, including mercury and PCBs, which are currently the topic of TMDLs proposing large reductions in urban runoff (CRWQCB, 2004). Although many of these contaminants have been banned, they are persistent in the environment, biomagnify through the food web, and bioaccumulate in fish and wildlife. The issue of sediment contamination in the Estuary is exacerbated by the waterbody's current levels of turbidity. Hydraulic gold mining in the Sierra Nevada foothills during the Gold Rush washed hundreds of millions of metric tons of sediment into the Estuary (Wright and Schoellhamer, 2004), which was enough sediment to decrease water depths by as much as five to ten feet (CRWQCB, 2004). Sediments within the shallow Estuary continue to be resuspended by daily tidal actions and winds. Resuspension of contaminated sediments introduces biologically available contaminants into the water column. The turbidity that is caused by this resuspension also controls the depth to which natural light can penetrate in the water column, limiting photosynthesis and affecting the food web.

The highest concentrations of contaminants in the sediments are most often found at the urbanized edges of the Estuary, and the distribution of these contaminants is primarily driven by two factors: inputs from industrial and military sources near San Jose, southern San Francisco, and Oakland, as well as the East Bay shoreline; and the distribution of the fine particles to which these contaminants are sorbed. Many of the areas with high concentrations of PCBs, DDT, and/or chlordane in sediment correspond to the areas of the Estuary (e.g., South San Francisco Bay, San Pablo Bay, and along the East Bay shoreline) with high percentages of fine sediments (Connor et al., 2004).

PCB contamination remains one of the greatest water quality concerns in the Estuary, and PCB cleanup is a primary focus of the San Francisco Regional Water Quality Control Board (SFRWQCB). PCB contamination is greatest in the South Bay; all samples from the South Bay exceeded the PCB water quality objective, with maximum concentrations measured at the southern end of the South Bay. The few samples that did not exceed the objective were from the northern portion of the San Francisco Estuary (CRWQCB, 2004). In another study, the California Toxic Rule (CTR) water quality criteria for PCBs were exceeded in 90% of RMP water samples collected from the Estuary from 1993 to 2003, and regression analyses have shown exponential declines in PCB concentrations in mussels at most transplant locations from 1980 to 2003 (Davis et al., in prep).

Although concentrations of legacy pesticides (i.e., pesticides that have been banned, including DDTs, chlordane, and dieldrin) in the Estuary continue to be an issue, there are some indications that water quality has improved over time. Legacy pesticide concentrations exceeded CTR water quality criteria in 5% to 20% of water samples collected during 1993–2001 (Connor et al., 2004); however, declining concentrations of legacy pesticides have been observed in transplanted mussels from the Estuary (Davis et al., in prep).

Mercury contamination in the Estuary dates back to 19th-century mining practices, and sediment cores from the South Bay reflect the historic changes in concentrations over time (SFEI, 2004). Pre-mining concentrations were about four to five times lower than today's concentrations (Conaway et al., 2003). The legacy of mercury mining in the South Bay has created a reservoir of high mercury concentrations within the Bay's water and sediments (Figure 6-39). Old mines are also a continuing source of mercury, which can be mobilized from land and transported to the Estuary during rainfall events. In 2002, the concentration of total mercury exceeded the water quality objective in 32% of samples and was above the sediment target concentration in 84% of the samples (SEFI, 2004).

Other contaminants, such as copper, have demonstrated declines in the San Francisco Estuary. Copper concentrations in water, clams, and sediments collected from the South Bay declined from 1979 to 2003. RMP water data show statistically significant declines in copper concentrations at all historical South Bay stations, and USGS data show corresponding declines in copper concentrations measured in the clam *Macoma balthica* and in sediments from the South Bay. Declines of copper in *Macoma* have been correlated with declines in copper in effluents from the Palo Alto WWTP, located in the South Bay (SFEI, 2004).

Primary production of phytoplankton in the San Francisco Estuary has historically been light-limited because of the waterbody's turbidity (SFEI, 2004). In recent years, chlorophyll levels in the Estuary have

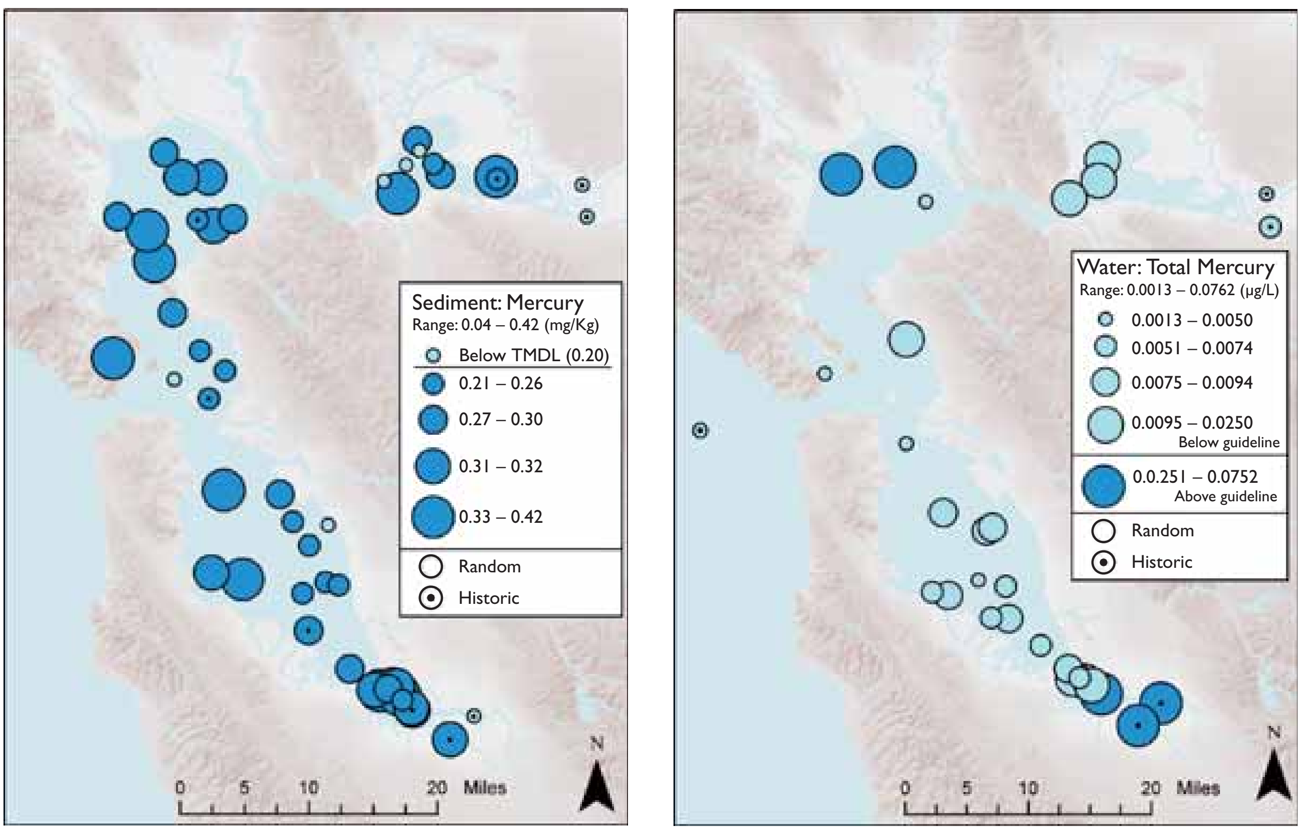


Figure 6-39. Maps of mercury concentrations in water and sediment of the San Francisco Estuary (SEFI, 2004).

increased, while turbidity in the Bay has declined (SFEI, 2006). A South Bay suspended-sediment model, developed by USGS, predicts that increases in wetland area (as proposed under the South Bay Salt Pond Project) could result in increased sediment deposition onto wetlands and a subsequent decrease in suspended sediments in the water column (Shellenbarger et al., 2004). The resulting increase in light penetration could cause higher phytoplankton productivity. In the northern reaches of the Estuary, chlorophyll concentrations have dramatically decreased in Suisun Bay sites since the invasion of the freshwater clam *Potamocorbula* in 1986. The high abundance of this filter-feeding clam has resulted in declines in chlorophyll in this Bay, from an average of 9.8 mg/L (pre-invasion) to 2.1 mg/L (post-invasion) (SFEI, 2003).

Habitat Quality

Wetlands serve several important functions in the San Francisco Estuary, including acting as natural filters, trapping sediment, and providing habitat for a variety of fish, shellfish, waterfowl, and other wildlife. It is estimated that the Estuary has lost more than 500,000 acres of tidal wetlands since 1850 (SFEP, 1999). The acquisition and restoration of the region's wetlands is a top implementation priority of the SFEP's *Comprehensive Conservation and Management Plan* (SFEP, 1993), and the SFEP has focused on tracking this issue as an indicator of the health of the Estuary. Since 2001, 15,000 acres of Cargill salt ponds and related lands have been acquired in the South Bay, and 1,400 acres have been acquired in the North Bay (SFEP, 2004).

Habitat in the Estuary has been affected by the introduction of invasive species. For example, giant reed (*Arundo donax*) was originally introduced into California by the Spanish in the late 1800s for erosion control along drainage canals. Since then, this species has become a significant problem along riparian areas around the Estuary because it spreads easily, requires large amounts of water, can smother native riparian vegetation, and is highly flammable. The reed has been found from Sacramento River tributaries to small urban streams throughout the Estuary. Eradication and education programs for this invasive species are currently underway in areas of the Estuary (SFEP, 2000).

Living Resources

Public attention has focused on invasive species in the Estuary since the 1990s, when the first comprehensive study was pursued (Cohen and Carlton, 1998). Some of the many invasive species present in the San Francisco Estuary include the green crab, shimofuri goby, *Spartina alterniflora* and its hybrids, Asiatic clams, and Asiatic zooplankton. For example, the green crab (*Carcinus maenas*), native to the Atlantic coast of Europe, was first found in the southern portion of the San Francisco Estuary in the early 1990s and has spread north at least as far as the Carquinez Strait. Researchers have found that, in contrast to their slow growth rates in Europe, green crabs grow rapidly and reach sexual maturity during their first year in the Estuary. During the course of a 9-year study, the green crab significantly reduced the abundance of 20 invertebrate species, and within just 3 years of being introduced, reduced densities of native clams and native shore crabs by 5% to 10% (SFEP, 2000). Studies are still underway to determine the full impacts of these recent invaders on the estuarine ecosystem.

Chemical contaminant levels in fish and wildlife are a concern in the San Francisco Estuary. For example, 25 years after the ban on the use of PCBs in California, concentrations in some Estuary sport fish remain 10 times higher than human health consumption guidelines (Davis et al., in prep). An interim human health consumption advisory issued by the California Office of Environmental Health Hazard Assessment (OEHHA), in response to elevated levels of mercury, PCBs, and other contaminants, has been in place since 1994 (SFEI, 2005). Between 1994 and 2003, 93% of all fish sampled by the RMP exceeded the California OEHHA screening value for PCBs; roughly 50% exceeded the screening value for mercury; and 3.5% exceeded the screening value for DDT. In addition, all leopard shark samples and almost all striped bass samples exceeded the mercury screening value (Greenfield et al., 2005). The SFRWQCB has calculated that a 40% reduction in mercury levels in striped bass would be necessary to meet the TMDL target of 0.2 ppm (Looker and Johnson, 2004). Over the long term, concentrations of lipid-normalized DDTs in leopard shark, shiner, and white croaker suggest statistically significant declines in concentrations from 1994 to 2003. Decreases in chlordane concentrations in leopard sharks, striped bass, and white croaker were also observed (Connor et al., 2004). No long-term trends have been detected in lipid-normalized PCB data. PCB levels in leopard shark, white croaker, and striped bass were higher in 1994 compared to other years, but the interannual variation since 1994 has fluctuated without a clear decline. Mercury concentrations in striped bass have shown no decline during the period from 1970 to 2003 (Greenfield et al., 2005).

Similarly, mercury levels in bird eggs remain a concern for Estuary managers. Concentrations of mercury in eggs from area terns and endangered California clapper rails have been close to the wet-weight threshold-effects level target of 0.5 ppm proposed in the draft TMDL for mercury (Schwarzbach and Adelsbach, 2003). Recent RMP data show median wet-weight concentrations of mercury in least tern eggs to be 0.6 ppm (SFEI, 2006). A more conservative threshold may be established to protect more sensitive species, such as the endangered least tern.

Scientists from the RMP and the Southern California Coastal Water Research Project (SCCWRP) have developed a multi-metric approach for measuring the effects of contaminants on benthic communities. Benthic communities were assessed based on taxa diversity, abundance of organisms per sample, number of contaminant-tolerant organisms, and the proportion of contaminant-sensitive benthic amphipods to sensitive mollusks. Highly impacted sites were concentrated in the lower-central and southern portions of the Estuary, and the most severely impacted benthic sites were located in sub-embayments, coves, and channels along the margins of the Estuary (Figure 6-40). In particular, all samples from San Leandro Bay were classified as severely impacted, and samples from the deeper areas of the Estuary indicated minimal impact. Combining this method with other measures of contamination, such as sediment toxicity and sediment chemistry, can help support the link between contamination and benthic impact (SWRCB, 2004).

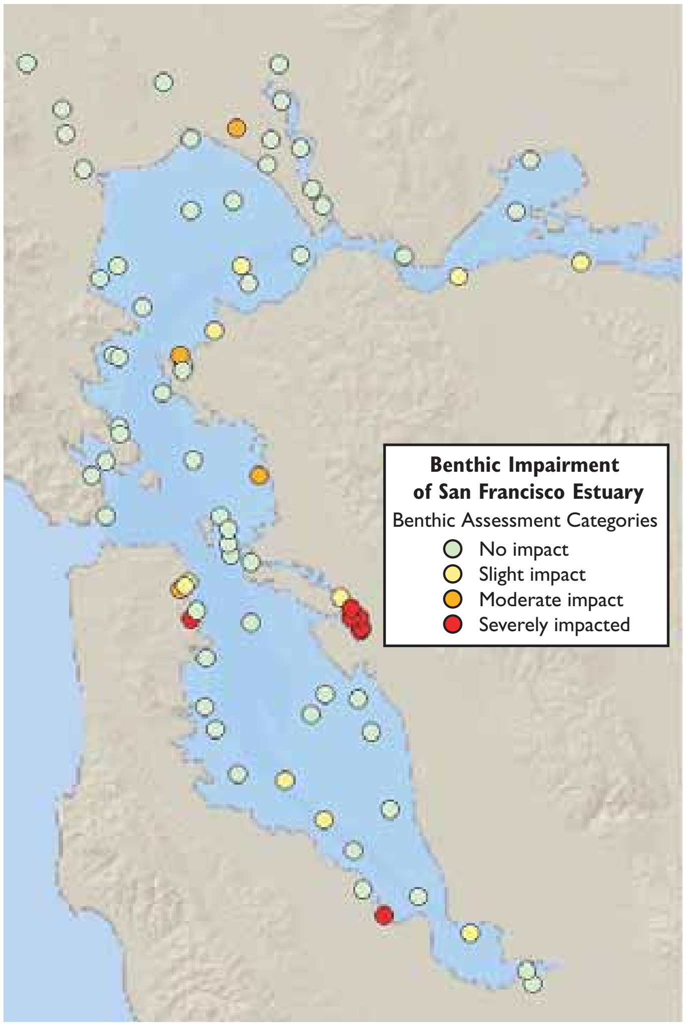
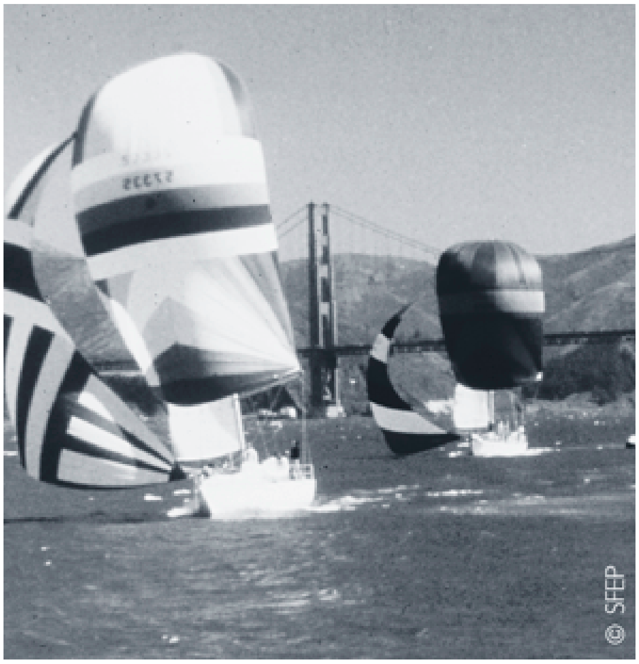


Figure 6-40. Map of benthic impact based on assessment of benthic assemblage. Data from from NOAA-EMAP, RMP, Bay Protection and Toxic Cleanup Program, and CISNet (SFEI).



Racing on the San Francisco Estuary (SFEP).

Current Activities, Accomplishments, and Future Goals

Probably the biggest, most visible accomplishment of the SFEP is the large number of environmental education and outreach efforts taking place around the San Francisco Estuary, as well as an incredible number of watershed management planning activities. Almost every city or town now has a "friends of" creek or river group that has adopted the waterway running through its midst, and parks, ponds, and marshes have likewise been taken under someone's wing. Interest and a sense of ownership in the Estuary—in part encouraged by the improved public access offered by the San Francisco Bay Trail—is on the rise. As the state's population increases and open space and wildlife habitat continue to be lost to housing and development, the Estuary becomes yet an even more important resource to Bay-area residents. This grassroots energy in turn feeds regulatory efforts to protect and enhance the Estuary.

Water supply reliability and adequate inflows to protect aquatic resources are priorities of the SFEP's CCMP (SFEP, 1993). Cutoff of California's surplus water supplies from the Colorado River by the U.S. Department of Interior (DOI) provided the impetus for a historic shift from an era of centralized state and federal water planning to a more regionally and market-driven approach. Working together several years ago, water and environmental interests helped pass Proposition 50, the largest water bond in California history.

Data from the RMP and other programs have been integral in the development of TMDL reports by the SFRWQCB. TMDLs are action plans that set targets for acceptable levels of the contaminants that threaten the beneficial uses of the Estuary, such as sport fishing, wildlife habitat, and the preservation of rare and endangered species. The SFRWQCB plans to issue TMDLs for mercury and PCBs within the next year; these contaminants have exceeded thresholds of concern by factors of almost 4 to 10 (SFEI, 2005). TMDLs for other contaminants are also planned. Except for diazinon, which is driven by aquatic toxicity, these TMDLs are mostly driven by the impacts of the contaminants on human and wildlife consumers of contaminated fish (Figure 6-41) (SFEI, 2005). Since many contaminants partition to the sediments, the SFRWQCB is proposing sediment targets as a means of reducing contaminant levels in fish and wildlife to safe levels. Fish targets are also likely to be included.

Stronger planning, improved regulations, and increased acquisition and restoration are the main thrust of 12 wetland management actions called for in the SFEP's CCMP. One element, the setting of goals for the types, locations, and quantities of wetlands desired to maintain the ecosystem's health, will provide the biological foundation for the regional wetlands management plan.

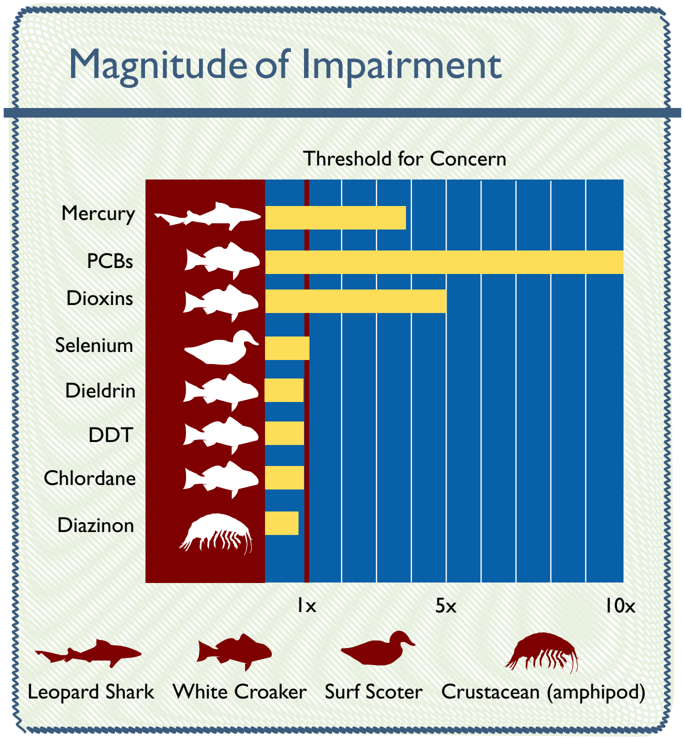


Figure 6-41. Summary of degree of Estuary impairment by high-priority pollutants in various species (SFEI, 2005).

Public support for wetlands and creek restoration has been tremendous, as indicated by the large numbers of volunteers who have adopted creeks and participated in restoration activities. One SFEP Implementation Committee member reported that, in his organization alone, more than 12,000 people logged 36,000 volunteer hours. Planned restoration projects include about 19,000 acres in the North Bay (13,000 acres of tidal marsh and 6,000 acres of non-tidal or mixed hydrology) and 18,000 acres in the South Bay (SFEP, 2004).

Conclusion

The task confronting those working on assessing and managing the San Francisco Estuary and its watershed is complex because of the diversity and scale of the human demands on the Estuary. Many potentially competing needs must be carefully balanced by many different agencies and stakeholder groups. Within this context, there are a variety of monitoring and assessment initiatives and concerns. Based on data from the NCA, the overall condition of the San Francisco Estuary is rated fair; however, data from the SFEP and other sources indicate that chemical contaminants are affecting the beneficial uses of the Estuary. Water quality guidelines continue to be exceeded for PCBs and legacy pesticides; chemical contaminant levels in many popular sport fish continue to exceed human health screening values; and evidence exists that benthic communities are affected by high levels of contamination. The aquatic food web of the San Francisco Estuary is continually exposed to multiple contaminants, and these contaminant levels pose a threat to the fish and wildlife in the Estuary, as well as to sport fish consumers. Estuary managers, through the TMDL process, are establishing target values for protection of the Estuary's beneficial uses. Long-term monitoring is crucial in illuminating changes in contaminant levels in the waters, sediments, and wildlife of the Estuary. Integrating this information into policy allows for a scientifically sound basis for the management of the San Francisco Estuary.

Alcatraz Island is located in the San Francisco Estuary (Jennifer Lloyd Blough).