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Water Quality Improvements are Critical to Waterfront Development: Lessons from Boston, San Francisco and Kitakyushu

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WATER QUALITY IMPROVEMENTS ARE CRITICAL TO WATERFRONT DEVELOPMENT: LESSONS FROM BOSTON, SAN FRANCISCO AND KITAKYUSHU

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ABSTRACT

In the course of about 10-30 years, three cities (Boston, San Francisco, and Kitakyushu) have transformed their urban waterfronts. In each case, the waterfront evolved from a polluted, industrial, or decaying state to one of the most attractive parts of the city. In each case, the costs associated with these new waterfront policies were expensive, costing several billion dollars. But these water quality improvements spurred much larger real estate re-investment and made these waterfront locations important hubs for residents and visitors.

This workshop celebrates Kitakyushu's success in restoring its water quality. This paper supplements that story by summarizing restoration efforts in Boston Harbor and San Francisco Bay to evaluate what kinds of water quality improvements are key to future waterfront development. I classify water quality changes into the following categories:

- Aesthetics – both visual and olfactory;
- Oxygen – besides anoxia, also includes chlorophyll and nutrients impacts;
- Pathogens – influencing uses such as swimming, wading, and boating;
- Toxic Contaminants – impacts to marine organisms and human harvesters;
- Signature Species - including fish, birds, or marine mammals;
- Habitat Restoration– including wetlands or benthic habitat; and
- Ecosystem Services—end-products of nature yielding human well-being.

Historically, most water quality improvements have focused on the first three categories. In Boston Harbor and San Francisco Bay, aesthetics, dissolved oxygen, and pathogen levels improved within a few years of pollution control efforts in the urban areas. In both estuaries, recreational fishing has been slow to improve because of the long-term persistence of toxic contamination. The experience with signature species has been mixed with some successes, particularly seals and right whales in Boston Harbor and sea lions in San Francisco Bay. Future efforts, particularly in San Francisco Bay, are emphasizing habitat restoration. Assigning value to habitat restoration has often depended on characterizing the economic value of the natural ecosystem services provided by a healthy ecosystem.

KEY WORDS

Water quality, urban, waterfront, estuary, bay, harbor, restoration

INTRODUCTION

The rapid industrial development of many of our world's great cities has been accompanied by the degradation of their rivers, harbors, and bays. Changing economic patterns have made much of this waterfront area available for re-development For this celebration of Kitakyushu's revitalization, this paper explores two case studies in the US, Boston and San Francisco, where public outrage led to extensive public programs to improve water quality. These water quality improvements were, in turn, followed by extensive urban waterfront re-development.

Like Kitakyushu, where Dokai Bay was known as "The Sea of Death", the demise of Boston Harbor and San Francisco Bay was so great that they were mocked in popular culture. The refrain of a popular rock song about Boston's Charles River was "I love that dirty water." Newspaper headlines proclaimed Boston water quality to be the "Harbor of Shame," and a presidential campaign commercial used the harbor's pollution to deride the capability of its governor, Michael Dukakis. San Francisco newspapers featured the Bay as a giant garbage dump for trash disposal.

Despite this public ridicule, the decline in these cities' waters was ignored by the regional politicians and bureaucrats who were charged with preventing their degradation. As in Kitakyushu, where the degradation of the city's environment was reversed thanks to the activities of a citizens' group of women concerned about the health of their families, citizen activists were key in reversing the course of degradation. In Boston, a citizens' law suit was brought by the Conservation Law Foundation to form a new agency responsible for constructing and operating metropolitan Boston's water and wastewater infrastructure. In Berkeley, CA three women formed a citizens' organization, Save the Bay, that brought about state legislation for the formation of a new agency responsible for coastal zone management, the Bay Conservation and Development Commission (BCDC).

Ironically, while environmental protection took a back seat in these cities to economic development, the subsequent improvement in water quality has been accompanied by a spurt of economic development and prosperity. The waterfronts of Boston Harbor and San Francisco Bay are now prime real estate and keystones of their local tourist attractions. The clean-up of Boston Harbor has been accompanied by $5.8 billion in waterfront development with future plans for another $5.8 billion. (www.savetheharbor.org) Boston's waterfront attracts 23 million visitors each year. About $15 billion has been spent on waterfront development since the formation of BCDC, and San Francisco's waterfront attracts 35 million visitors per year (www.sfcvb.org). Wood and Handley (1999) argue that these examples are not unique—indeed that water quality improvements are a necessary precursor to waterfront revitalization worldwide.

CHARACTERIZING WATER QUALITY IMPROVEMENTS

If water quality improvements are necessary for waterfront revitalization, is it possible to determine what kind of improvements are the most valuable? A complex mixture of specific outcomes comprise water quality improvements. Using the examples of Boston and San Francisco, Table 1 classifies the kinds of water quality changes that resulted and their relationship to further waterfront development. These water quality benefits are grouped into seven categories and discussed individually.

Table 1. Water quality improvements in Boston Harbor and San Francisco Bay.

	Boston	**San Francisco**
Aesthetics	Black water and sulfide odors disappear when sludge dumping and SSO discharges end. Harbor water clarity improves.	Solid waste disposal ended on coast. Landfills closed and converted to park land.
Oxygen	SSO and CSO controls reduce Inner Harbor anoxia	Nitrification of effluent discharges associated with DO rebound.
Pathogens	SSO and CSO controls reduce beach and shellfish closures significantly	SSO and CSO controls reduce pathogen presence.
Toxics	Secondary treatment and pre-treatment reduce toxics inputs more than 10-fold, but fish advisories remain.	Secondary treatment and pre-treatment reduce toxics inputs, but legacy deposits of Hg and PCBs cause fish advisories.
Signature Species	Winter flounder tumors eliminated, and North Atlantic Right Whales sighted in harbor.	Migratory birds rebound and sea lions take over boat moorings
Habitat restoration	Marsh and beach restoration efforts (tens of acres).	Goal of restoring 100,000 acres of tidal wetlands will take several decades to implement.
Ecosystem Services	The harbor's ability to provide natural waste assimilation slowed public concern for its quality	Wetlands restoration is helped by the importance of wetlands to flood attenuation

Aesthetics—Look, Feel, and Smell

The vast majority of waterfront users will never actually experience the water directly, but simply determine that it looks clean and smells healthy. Waters that look or smell bad discourage any other recreational uses that might be made of them. Aesthetic improvements probably have the most measurable economic benefit as reflected in real estate values. Studies have shown that ocean views increase the market price of a house by 8-60% depending on the quality of the view (Benson et. al, 1998). Few studies have been attempted to quantify the relationship of water quality and real estate values, though water clarity was positively associated with housing prices neighboring Maine lakes (Poor et al., 2001).

Despite its possible pre-eminent importance in the economics of urban waterfront recovery, aesthetic quality has eluded most performance measurement—beauty, as they say is in the eye of the beholder. Recently, though, many cities have used specialized boats to clear their waters of trash, and tonnage of trash removed has become an important metric of citizen beach clean-up efforts or stormwater treatment efficiency.

Boston Harbor for many years was fouled by human waste floatables, oily slicks, and decaying pier pilings. Sludge turned the outgoing tide black, and the bottom of the harbor was characterized as "black mayonnaise." Ending sludge dumping and reducing most Sanitary and Combined Sewer Overflows (SSOs and CSOs) allowed a rapid recovery to the harbor water quality which keyed a renaissance in real estate development.

San Francisco Bay has been very muddy with low clarity for many years, and limited access minimized the population's view of the Bay. But the use of the lowlands fringing the Bay for the deposition of solid waste had widespread impact on the aesthetics of the Bay. Images of trucks dumping trash into the Bay were sufficient to mobilized extensive public outrage. While development of the San Francisco waterfront was mostly independent of water quality changes, re-development is now expanding into areas previously dominated by heavy industry and military uses. The formation of BCDC has provided strict standards for the aesthetics of all waterfront development along the Bay as well as the creation of a Bay Trail to enable public access along the shoreline.

Oxygen

Because oxygen is so basic to life, it has been the pre-eminent water quality indicator historically. Historically, most US estuarine waters have had dissolved oxygen (DO) standards of 5 ppm, but further analysis has found that concentrations below 5 ppm can be sufficiently protective in different types of estuarine waters, particularly deeper channels (Maryland, 2005).

Both Boston and San Francisco (Figure 1) found that the concentrations of carbonaceous and ammonia wastes in primary-treated sewage effluent and untreated sewage wastes in SSOs and CSOs exceeded the natural cleansing capacity of the waters. As SSOs and CSOs were reduced and secondary treatment was accomplished for these areas, dissolved oxygen improved significantly (Fitzpatrick et al., 1996; Cloern et al., 2003).

Pathogens

Boating and swimming are most threatened by pathogens which generally enter urban waters from SSOs and CSOs. The resumption of swimming at Boston Harbor beaches proved to be a powerful symbol of harbor recovery. Improved operations made the initial impact on pathogen levels, followed by strategic reduction of Combined Sewer Overflows nearest swimming beaches (Rex et al., 2002). CSO and SSO treatment has also improved pathogen levels in San Francisco Bay , but its year-round cold water temperatures have minimized public interest in the impact of pathogens. Both San Francisco and Boston have lost the ability to harvest shellfish.

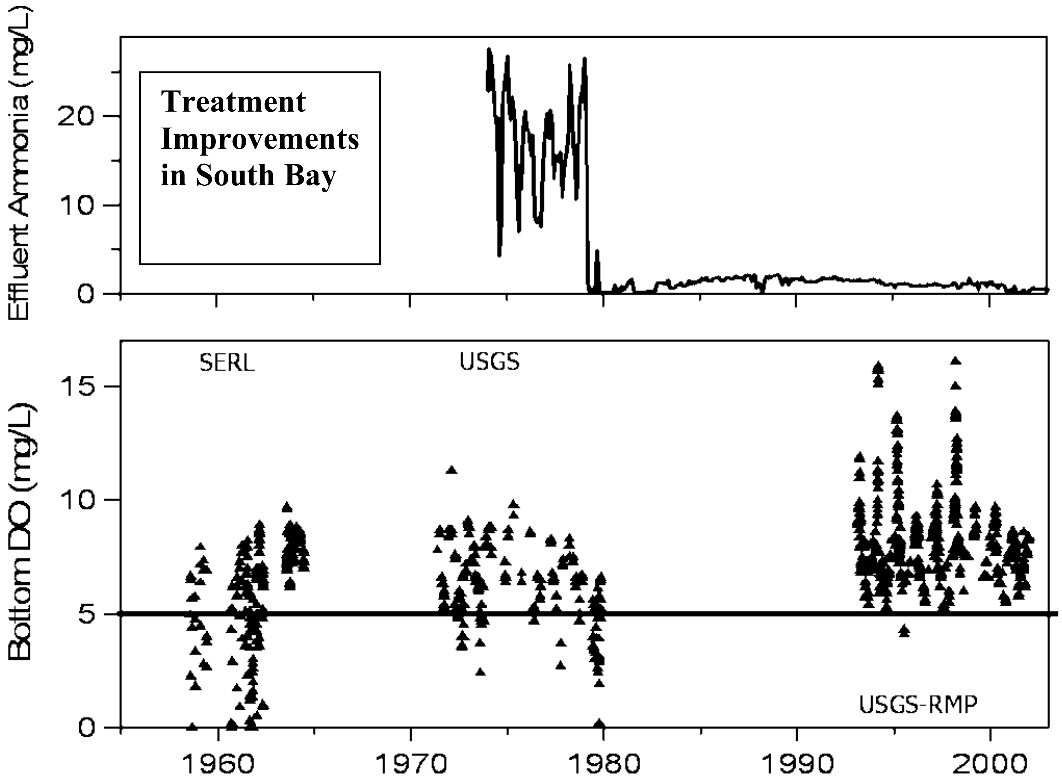

Figure 1. Oxygen conditions in South San Francisco Bay improved due to wastewater treatment improvements (After Cloern et al., 2003).

Toxic Contaminants

Most urban harbor restorations are associated with waterfront uses that have a legacy of toxic pollution. As a result, nearshore sediments can often have high enough levels of contaminants that either directly affect the health of the organisms living nearby or cause those organisms to be sufficiently contaminated to pose a risk to humans or top food chain predators that can cause biological impacts. Decontamination of these nearshore sediments is generally expensive with costs that can approach $100 per cubic meter of sediment.

The dilemma facing most waterfront developers is how to balance the spatial extent of expensive treatment with appropriate environmental contamination goals. In the United States, this determination is generally made on a case-by-case risk assessment. Given the widespread nature of the legacy contaminants, most US regulators eliminate or minimize the discharge of new contaminants and remediate historic contamination to the extent that is economically feasible. Despite these efforts, recovery has been slow in many US waterfront cities, and health advisories are often in place that limit the consumption of fish caught from these waters. The incidence of tumors in winter flounder declined dramatically in Boston Harbor fish (Rex et al., 2002). However, despite improvements in water quality, fish advisories remain in both Boston and San Francisco (Figures 2 and 3), and it is expected that these problems will persist for many years (Rex et al., 2002: Hunt et al., in preparation).

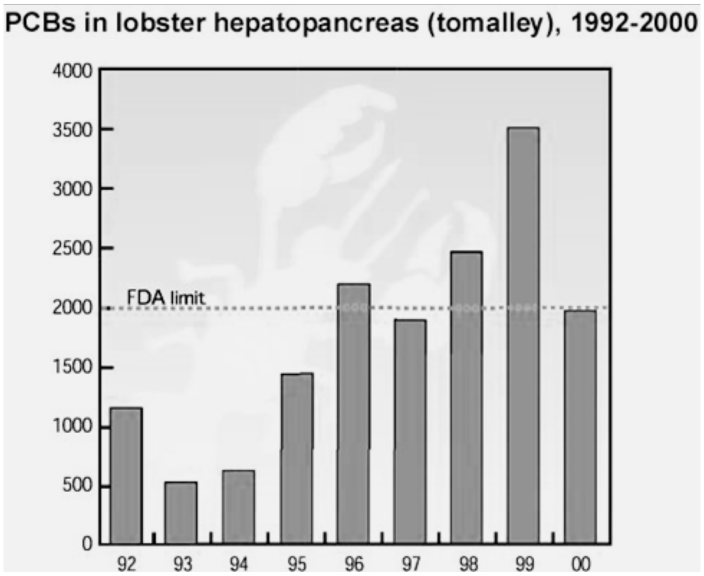

Figure 2. Boston Harbor lobster tomally continue to exceed regulatory limits despite large improvements in waste discharges (from Rex et al., 2002).

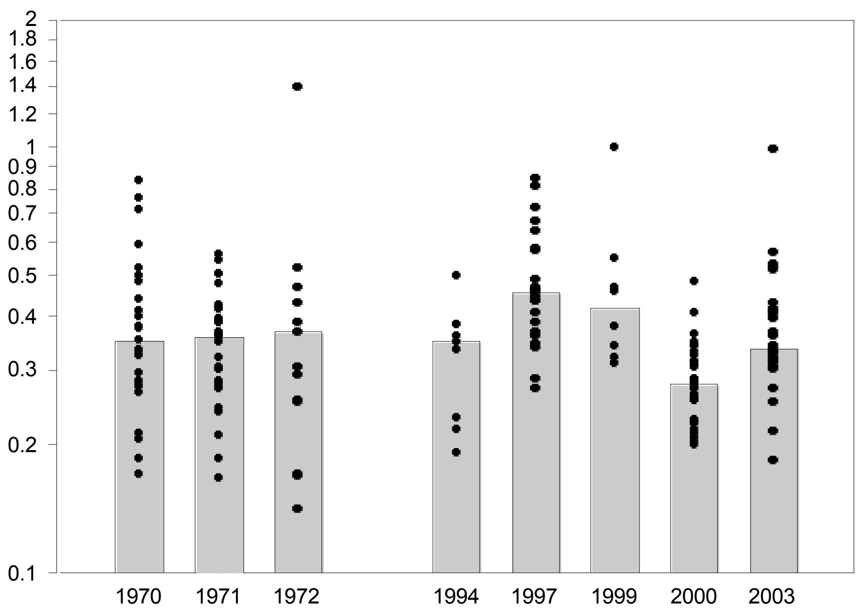

Figure 3. Mercury concentrations in San Francisco Bay fish remain above the 0.3 ppm threshold despite large reductions in waste discharges (from Hunt, in prep.).

Regionally Significant Species

Many bays develop the reputation for a specific component of their flora and fauna. Examples usually include a popular food item from the region—blue crabs in the Chesapeake Bay, lobster in Boston Harbor, or bakugi clams in Tokyo Bay (Edomae). In other instances, this animal could include a marine mammal—Orca whales in Vancouver, Canada. It is often difficult to capture the public's attention with water quality improvements, but the presence of a popular seafood or marine mammals provide an easily understandable documentation of the impact of restoration efforts.

Early Boston polling showed that the public did not think the large capital expenditures to improve Boston's infrastructure would make a significant difference in the Harbor, but news reports of harbor seals and even the endangered North Atlantic Right Whale provided dramatic evidence that the harbor was cleaner and spurred an increase in harbor boat tours. In San Francisco Bay, the downtown marina Pier 39 has become the home for a colony of several hundred sea lions, who are so popular that their photos can be found on tourist web blogs.

Habitat Restoration

Given the importance of regionally significant species to invigorate the public's support for water quality improvements, habitat restoration of critical spawning, nursery, or feeding habitat is gaining prominence in US estuaries. Examples include the restoration of tidal wetlands, sea grass beds, oyster reefs, or tributary stream rehabilitation for anadramous fish. While both Boston Harbor and San Francisco Bay have a number of restoration projects sponsored by the government and non-profit volunteer groups, the restoration of San Francisco Bay's wetlands is one of the most ambitious such projects in the US, with its goal to restore 100,000 acres (45,000 hectares) of tidal wetlands. This effort was initiated by the development of goals for the amounts and kinds of wetland habitats necessary for a the bird, fish, and mammal populations dependent on the Bay and its wetlands (Figure 4). Public support for the restoration of Bay salt ponds has been further rallied by the reappearance of tens of thousands of migratory birds in one of the first wetland areas to be restored.

Ecosystem Services

Naturally functioning ecosystems provide many societal benefits that can include flood prevention, waste assimilation, nursery areas for fisheries, and habitat for migratory marine mammals and birds. Healthy wetlands provide a fringing buffer that filters contaminants or maximizes their degradation. This area is still being conceptualized by scientists and hasn't fully translated into public policy. However, the most recent strategy for ocean management includes Ecosystem-Based Management. Japanese engineers have developed coastal designs that provide ecosystem services provided by beaches, and some coastal parks include water feature designs that provide re-aeration water quality benefits.

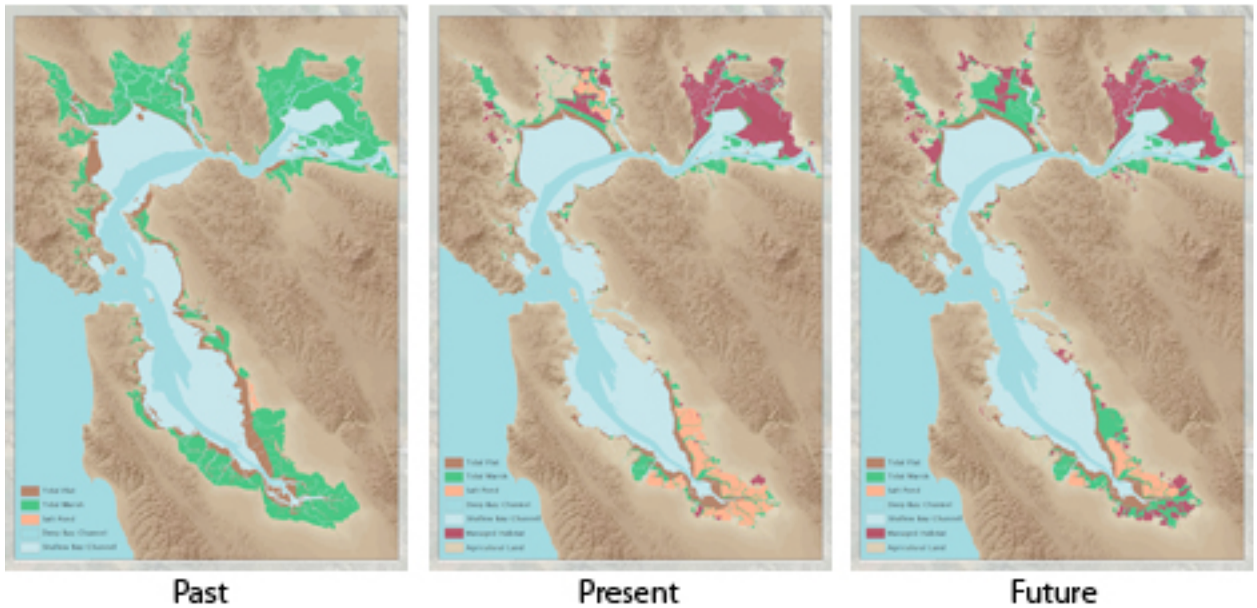

Figure 4. The development of wetlands habitat goals for San Francisco Bay based on historical habitats provided a template for 50 years of habitat acquisition and restoration around the Bay (adapted from Goals Project, 1999).

DISCUSSION AND CONCLUSIONS

Levy and Connor (1992) have argued that basic improvements in sewage transport systems, rudimentary sewage treatment, and sludge handling and treatment were the most cost-effective elements of the Boston Harbor Project. This conclusion is consistent with the San Francisco Bay example, where recovery and restoration efforts began with controlling basic sources of pollution or ending the direct discharges of hundreds of tons of solid waste to coastal wetlands. Upgrades of the sewage transport system to eliminate discharge of raw sewage wastes in dry weather and minimize wet weather CSOs also were responsible for early recovery efforts. In both cases, the impact of these early efforts created public support for further recovery, including further waste treatment and habitat restoration projects.

Water quality improvements were not fully realized before waterfront development plans were initiated. The existence of clean-up plans, evidence of their implementation, the ability of the public to access the waterfront to see improvements, citizen water quality monitoring programs, and the pressure of environmental activists create a positive feedback loop for ongoing improvements that raise the attractiveness of urban waterfronts, make them the centerpiece of a revitalized city, and stimulate further re-development. Both the existing technical literature and these two case studies indicate that water quality improvements are the key to urban waterfront development, and that the associated economic development can easily pay back the initial water quality investments. The case studies suggest that the process of embarking on water quality improvements may be more important than the specific elements of the plan, as long as the public is involved in vetting the process and monitoring long-term improvements.

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