

San Francisco Bay Fishable-Swimmable-Drinkable Index

INDICATOR ANALYSIS AND EVALUATION

A. Background

San Francisco Bay is an important and heavily used resource for the Bay Area's human population. Many Bay fish and crab species are caught by recreational and subsistence anglers. Bay beaches and nearshore waters attract swimmers, kayakers, and board sailors. Surface runoff and groundwater from the Bay's many watersheds – near and far – provide drinking water to Bay Area residents.

Human uses of the Bay and its watersheds are affected by many factors, most dramatically by contamination of Bay waters and fishery resources by toxic chemicals entering the Bay as sewage, industrial discharges, and agricultural and urban runoff. Water pollution affects people directly, rendering Bay waters unsafe for recreation or contaminating drinking waters supplied by Bay watersheds. A number of toxic chemicals are also concentrated in the Bay's food web – contaminants absorbed by plankton are magnified in fish and birds farther up the food chain and ultimately transferred to human consumers.

Federal and state law protects some of these human uses of the Bay. The federal Clean Water Act requires that water bodies like the Bay meet water quality objectives that protect specific "beneficial uses", including protection of aquatic life, water supply, recreation, and fish consumption. While the effects of water quality on aquatic life are assessed in the Water Quality Index, the Fishable-Swimmable-Drinkable Index evaluates the effects of water quality on the other beneficial uses identified by the law. In addition, this Index evaluates the value of the Bay to recreational fishers.

B. Indicators

The Fishable-Swimmable-Drinkable Index used four indicators to assess the value and utility of the Bay as a resource for people.

- 1. Fishable (catchable)** – fishing success of recreational anglers
- 2. Fishable (edible)** – tissue concentrations of selected contaminants in recreational fish species
- 3. Swimmable** – frequency of beach postings and closures
- 4. Drinkable** – quality of local drinking water source supplies

Each indicator was calculated using different data sources and different methods; therefore the methods and results for each indicator are described in separate sections below.

C. Grading and Evaluation

For each indicator, upper and/or lower reference conditions, corresponding to "excellent" and "very poor" ecological conditions, were established. Reference conditions were based on historical conditions or earliest available data, public health requirements (e.g., U.S. Environmental Protection Agency screening levels for fish tissue contaminant levels, maximum contaminant limits for drinking water source supplies), and best professional judgment. The range of the indicator results from the upper and lower reference conditions was subdivided into five categories, corresponding to letter grades A through F. Each letter grade also corresponded to a "grade point", ranging from 0 (for F) to 4 (for A). The Index was calculated as the "grade point average" of the component indicators, and is reported as a **Grade** (i.e., A-F) and a **Score** (i.e., the grade point average expanded to a 100-point scale using a multiplication factor of 25).

D. Methods and Indicator Evaluation

Indicator 1. Fishable (catchable)

The Bay once supported vibrant commercial and recreational fisheries for many species. Today, other than a small commercial fishery for Pacific herring, only recreational and subsistence fisheries remain, supported by a handful of Bay fish and shellfish species. The Fishable (catchable) indicator measures recreational fishing success for several dozen fish and shellfish species caught in the Bay from commercial passenger fishing vessels ("partyboats").

Data source: The Fishable (catchable) indicator measures recreational fish success using data from the California Department of Fish and Game (CDFG) Commercial Passenger Fishing Vessel database (CPFV) (Hill and Schneider, 1999). This database contains information on "partyboat" fishing from nearly 200 geographic locations, called "blocks", along the California coast, in San Francisco Bay and along the Sacramento River. The indicator was calculated using data from four "blocks" in San Francisco Bay: CDFG block areas 488 (Central Bay), 489 (South Bay), 301 (San Pablo Bay), 302 (Suisun Bay), and 308 (Carquinez Straits). For these blocks, catch data for most species were available from the early 1960s to 2001.

Calculations: Fishing success was measured for each year as the number of fish (and shellfish) caught per angler per day, and was calculated using all fish and shellfish species reported to the California Department of Fish and Game by the boat operators in their logbooks.

Grading and Evaluation: Recreational fishing success in San Francisco Bay and nearby coastal waters declined prior to the 1960s, when the earliest data from continuous

datasets on the recreational fishery are available. Skinner (1962) reported that anglers regularly landed 20 striped bass per day in the 1930s but that catch fell to less than ten fish per day by the 1950s. However, for grading the Fishable (catchable) indicator the upper reference conditions was set at >2 fish per angler per day, slightly lower than the average catch measured for the first five years for which CDFG CPFV data are available for the Bay of 2.2 fish per angler per day (Table 1). The break point between a C and D grade was set at 1 fish per angler per day, a level at which, on average, every fisherperson catches a fish). The lower reference condition was set at 0.5 fish per angler per day, the level at which, on average, half of all anglers do not catch a fish during a day of fishing.

Table 1. Evaluation and grading for the Fishable (catchable) indicator.

Fishable (catchable) Indicator					
Reference condition	Fishing success (#fish/angler*day)	Rationale for reference conditions	Ecological condition	Grade point	Grade
Upper	>2	Upper reference condition was set at 2 fish/ angler*day, less than the average measured from 1960-1964. Lower reference condition was set at 0.5 fish/angler*day. Intermediate grade interval based on a linear scale.	Excellent	4	A
	>1.5-2		Good	3	B
	>1-1.5		Fair	2	C
	≥0.5-1		Poor	1	D
Lower	<0.5		Very poor	0	F

Results:

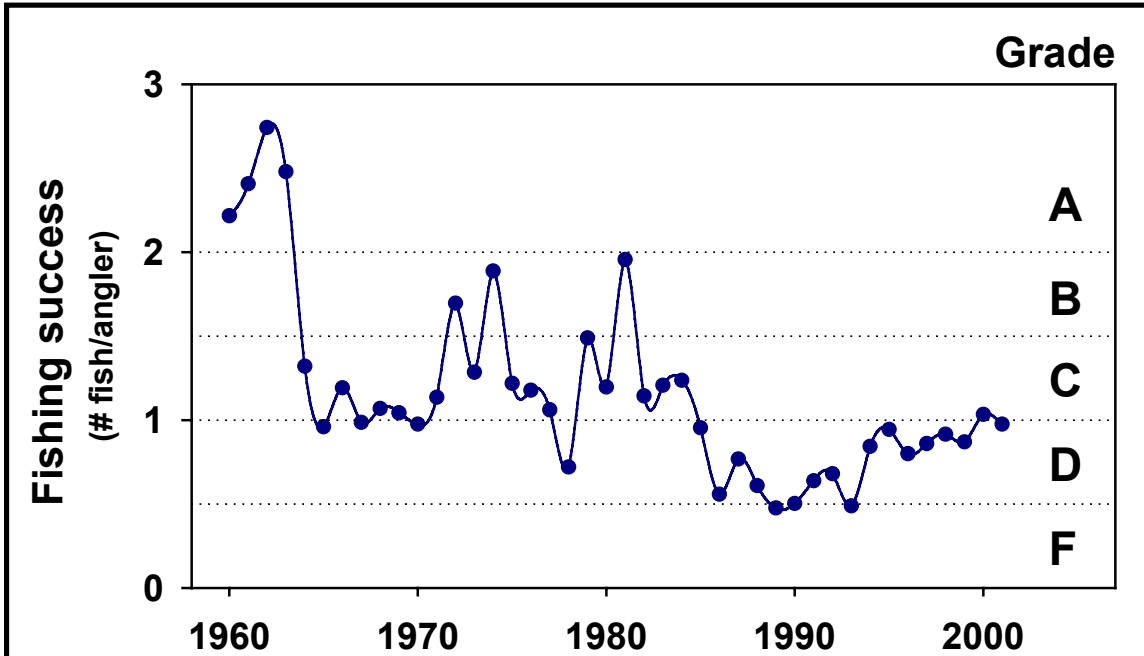


Figure 1. Changes in the Fishable (catchable) indicator from 1960 to 2001. The indicator measures fishing success for recreational anglers fishing from partyboats in San Francisco Bay.

Fishable (catchable)	Grade	Trends	
		Long-term (1960-2001)	Short-term (5-year)
In 2001, anglers caught less than one fish per day, a 60% decline from 1960s fishing success	D	↓ (declining)	↔ (stable)

Recreational fishing success declined by more than 60% over the past 40 years.

Recreational fishing success declined by 80% from the early 1960s, when anglers usually caught more than two fish per day, to 1990 when half of all anglers did not catch any fish (regression, $p < 0.001$) (Figure 1). Since then, fishing success has improved slightly – in 2001, sport fisherman caught, on average, almost one fish per day. During the most recent five-year period (1997-2001), fishing success did not significantly improve (regression, $p > 0.1$).

The greatest decline was for striped bass.

Landings of striped bass, the most frequently caught species, declined significantly (regression, $p < 0.01$), by more than 90%, falling from more than 2 fish per angler per day in the early 1960s to just 0.15 fish per angler per day in the 1990s. The decline in striped bass landings coincided with declines in the abundance of juvenile striped bass measured by the CDFG Fall Midwater Trawl survey (Figure 2).

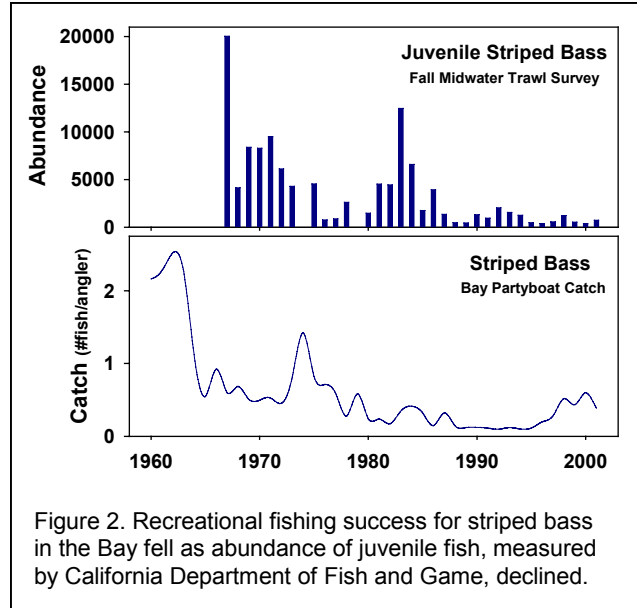


Figure 2. Recreational fishing success for striped bass in the Bay fell as abundance of juvenile fish, measured by California Department of Fish and Game, declined.

Fishing success for other species varied (Figure 3).

Sturgeon landings declined significantly (regression, $p < 0.05$), dropping by more than 50% during the past 40 years. Catch of other commonly caught species, including salmon, rockfish, halibut and croaker, varied from year to year.

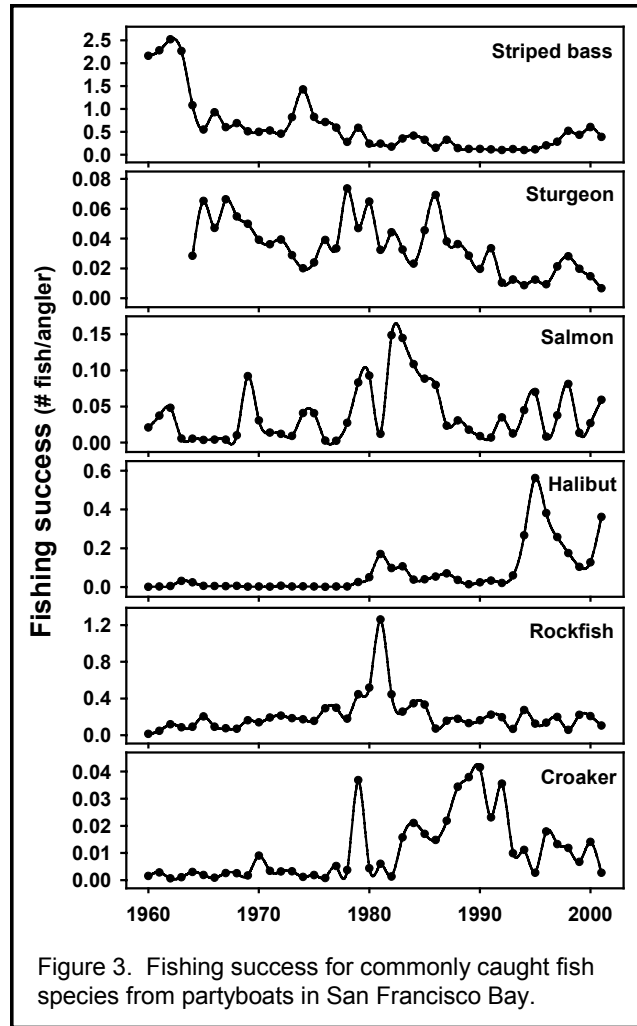


Figure 3. Fishing success for commonly caught fish species from partyboats in San Francisco Bay.

Fishing effort fluctuated between 1960 and 2001 but was not correlated with overall fishing success (figure 4).

The overall decline in fishing success was not correlated with fishing effort (correlation analysis, $p > 0.4$).

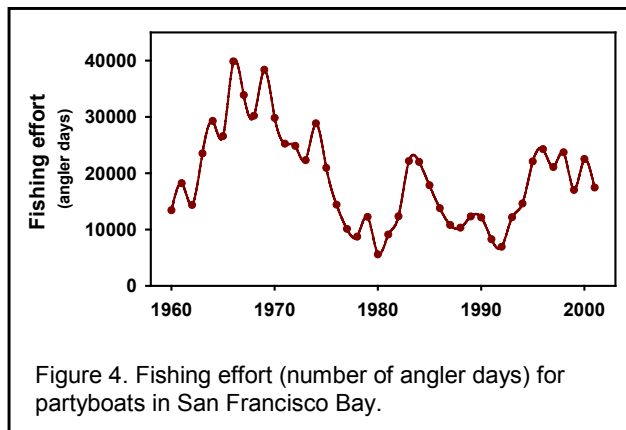


Figure 4. Fishing effort (number of angler days) for partyboats in San Francisco Bay.

Indicator 2. Fishable (edible)

The Bay was once an important source of seafood for local markets as well as export. Today, because many fish species caught in the Bay are contaminated with the toxic chemicals that pollute Bay waters and sediments, the public is advised against consuming most of the fish species that reside in the Bay.¹ The Fishable (edible) indicator evaluates contaminant levels of several sport fish species that are commonly caught in the Bay, measuring the percentage of fish with tissue contaminant concentrations that are below the U.S. Environmental Protection Agency screening levels for PCBs, mercury, DDTs, or chlordane pesticides.

Data source: The Fishable (edible) indicator is calculated using data from the San Francisco Bay Regional Monitoring Program for Trace Substances.² Data on tissue contaminant levels in a variety of fish species collected at several locations in the Bay are available for three years, 1994, 1997, and 2000. Additional information was found in Greenfield et al. (2003).

Calculations: The Fishable (edible) indicator was measured as the percentage of fish collected each year with tissue contaminant levels below screening levels established by the U.S. Environmental Protection Agency (USEPA) for any of four toxic compounds (mercury, PCBs, DDT, and chlordane pesticides) (Table 2). These "legacy" contaminants are no longer used but they are resistant to natural breakdown and persist in the Bay environment, particularly in sediments. For the indicator, results from six fish species (striped bass, white croaker, shiner perch, jacksmelt, leopard shark, and white sturgeon) were pooled. Screening levels adopted by the USEPA for each of the four contaminants were based on research by Brodberg and Pollock (1999) and, when exceeded, are used as an indication that intensive site-specific monitoring and evaluation of human health risk should be conducted. Subsequently developed fish consumption advisories are

¹ Information on fish consumption advisories for San Francisco Bay is available at www.oehha.ca.gov/fish/general/sfbaydelta.html.

² More information on the RMP can be obtained at www.sfei.org and at www.sfei.org/rmp/index/html. RMP fish tissue contaminant data can be downloaded at www.sfei.org/rmp/data/rmpfishtissue.htm.

developed based on measured fish tissue contaminant concentrations and predicted effects of consumed contaminants on human health.

- **Mercury** occurs naturally in Coast Range mountains north and south of the Bay. Contamination of Bay waters (see Water Quality Index, Trace Elements indicator) and sediments resulted from historic mercury and gold mining activities resulted in Bay watersheds. The organic form of mercury, methylmercury, is highly toxic and is readily bioaccumulated by animals and transferred up the food chain. Mercury tends to be most concentrated in long-lived predatory species such as striped bass and some Bay-resident sharks (e.g., leopard shark). Methylmercury attacks the nervous system and is particularly hazardous to developing fetuses and young children.³
- **Polychlorinated biphenyls (PCBs)** are a group of dozens of related chemical that were used extensively in a variety of industrial applications. Their manufacture was banned in 1978 but they continue to leak into the environment from contaminated stream sediments and urban storm drain runoff. In Bay waters, PCB concentrations exceed water quality standards in nearly every region of the Bay (see Water Quality Index). PCBs are highly toxic, resistant to degradation, and they have strong tendency to accumulate in animal tissues. Exposure to PCBs can cause developmental abnormalities, impaired immune and endocrine function, and cancer. PCBs bioaccumulate in food chain, becoming more concentrated in animals like predatory fishes that are higher up in the food chain.⁴
- **DDT** is an organochlorine insecticide that was used very extensively in homes and agriculture from the 1940s to 1972, when it was banned. DDT, and its several breakdown products, are present in Bay waters (see Water Quality Index) and sediments and continue to enter the Bay as runoff from contaminated soils and sediments. This chemical is very persistent in environment, resistant to metabolism, and it bioaccumulates in aquatic food webs. DDT affects the nervous system and is also classified by USEPA as a probable carcinogen.
- **Chlordanes**, another group of organochlorine insecticide, were used extensively in home and agriculture. Although their use has been restricted for decades, they also persist in the Bay environment. Chlordanes are neurotoxins and probable carcinogens, resistant to metabolic breakdown and they also bioaccumulate in the food web.
- The RMP also tested for dieldrin, another organochlorine insecticide, and dioxin, a highly toxic industrial chemical. However, these two contaminants were not included in the Fishable (edible) indicator. For dieldrin, the detection limit for the

³ For more information on mercury contamination in fish and effects on human consumers, see www.oehha.ca.gov/fish/hg/index.html.

⁴ For more information on PCB contamination in fish and effects on human consumers, see www.oehha.ca.gov/fish/pcb/index.html.

chemical is the same as the screening level; therefore the level of precision for evaluating results in some samples was low. Dioxin contamination was evaluated using different analyses for each of the three years of RMP sampling, making direct comparison of tissue contamination levels among samples from different years difficult (Greenfield, 2003). Inclusion of results for these chemicals would not have changed the grade for the indicator.

Table 2. Screening level concentrations for each of the four contaminants assessed in the Fishable (edible) indicator.

Contaminant	Screening level	Type and source	Health effects
Mercury	0.3 ug/g wet weight	Heavy metal. Naturally occurring, mining, Bay sediments and contaminated stream sediment runoff.	Neurotoxicant, can cause developmental abnormalities, and impair coordination and mental function, bioaccumulates in tissues
PCBs	20 ng/g wet weight	Industrial chemical. Bay sediments, stream and urban storm drain runoff.	Developmental abnormalities, impaired endocrine and immune function, cancer, bioaccumulates in tissues
DDT	100 ng/g wet weight	Pesticide. Bay sediments, contaminated stream sediments and runoff.	Neurotoxicant, probably carcinogen, bioaccumulates in tissues
Chlordanes	30 ng/g wet weight	Pesticide. Bay sediments, contaminated stream sediments and runoff.	Neurotoxicant, probably carcinogen, bioaccumulates in tissues

Grading and Evaluation: San Francisco Bay waters and sediments are contaminated with a number of "legacy" contaminants, including mercury, PCBs, and DDT (see Water Quality Index). These chemicals and compounds are no longer used but, because they are resistant to natural breakdown, they persist in the environment, particularly in Bay sediments. During high flow and tidal events, as well as dredging, which disturb Bay sediments, the contaminants can be resuspended in Bay waters. In addition, these contaminants are still discharged into the Bay as runoff from contaminated streams and urban storm drains. For Water Quality Index indicators, the upper reference condition used was set a level somewhat below that at which all contaminant concentrations are below water quality standards. Therefore, for the Fishable (edible) indicator, the upper reference was not set at 100%, a level at which all fish caught in the Bay have tissue contaminant levels below the screening level, but rather at 80% (Table 3). The lower reference conditions was set at 20% and intermediate grades assigned using a linear scale.

Table 3. Evaluation and grading for the Fishable (edible) indicator.

Fishable (edible) Indicator					
Reference condition	Fishing success (% of fish with tissue concentration below screening level)	Rationale for reference conditions	Ecological condition	Grade point	Grade
Upper	>80%	Upper reference condition was set at >80%, indicating the majority of fish are safe to eat. Lower reference condition was set at ≤20%. Intermediate grade interval based on a linear scale.	Excellent	4	A
	>60-80%		Good	3	B
	>40-60%		Fair	2	C
	>20-40%		Poor	1	D
Lower	≤20%		Very poor	0	F

Results:

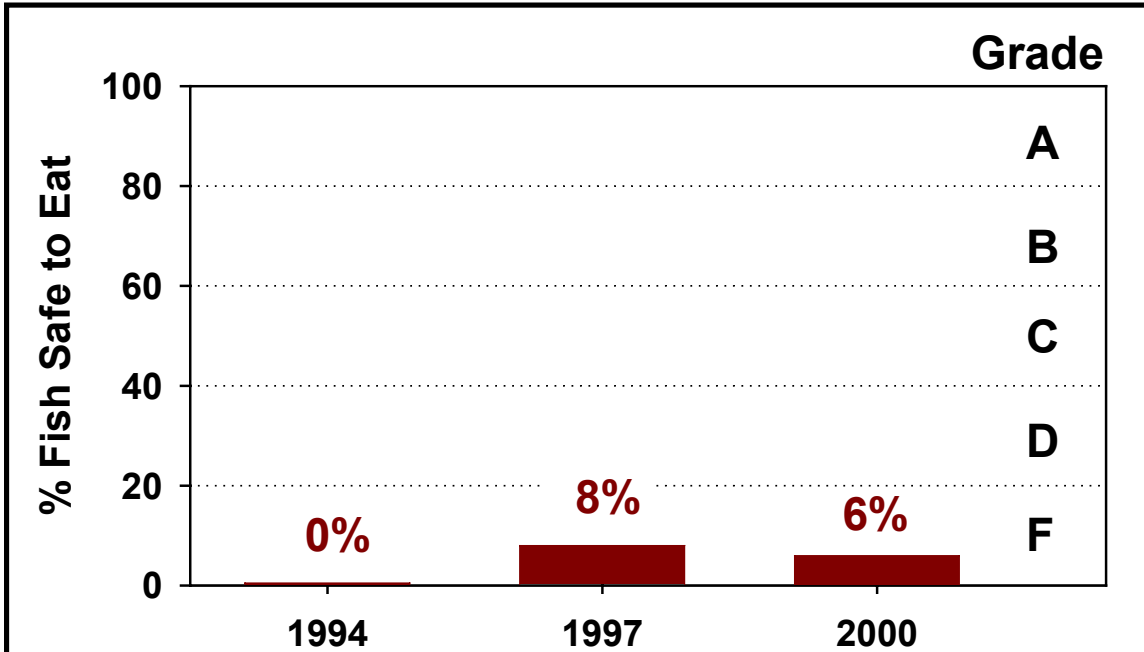


Figure 5. Changes in the Fishable (edible) indicator from 1994 to 2000. The indicator measures the percentage of fish caught in the Bay with tissue contaminant concentrations that are below the U.S. Environmental Protection Agency screening levels.

Fishable (edible)	Grade	Trends	
		Long-term	Short-term (6-year)
In 2000, 94% of fish exceeded safe consumption levels for toxics	F	no data	↔ (stable)

Bay fish species are contaminated with PCBs, mercury, DDTs, and chlordanes. In 2000, 94% of all fish sampled had a tissue concentration for at least one of these contaminants that was higher than screening levels for human consumption (Figure 5).

PCB contamination of Bay fishes is extremely severe.

Nearly all fish caught in the Bay have tissue PCB concentrations higher than the screening level (Figure 6). In 2000, 89% of all fish had tissue PCB levels higher than the screening level. More than 40% of all fish sampled had excessive mercury concentrations in their tissues.

Contamination levels of Bay fishes did not change between 1994 and 2000 (Figure 6).

From 1994 to 2000 the percentage of fish with tissue concentrations in excess of screening levels did not significantly change (regression, $p > 0.1$, all contaminants). Long-term results for selected species for each of the four contaminants reported by Greenfield et al. (2003) also show no changes in tissue contamination levels.

Different fish species are contaminated with different toxics (Figure 7).

White croaker and shiner perch are most severely contaminated with PCBs, with 100% of sampled fish exceeding the screening level. Mercury contamination was most severe in leopard shark (98% exceeded screening levels), striped bass (55% exceeded screening levels), and white sturgeon (35% exceeded screening levels). Less than 5% of fish had excessive tissue concentrations of pesticides.

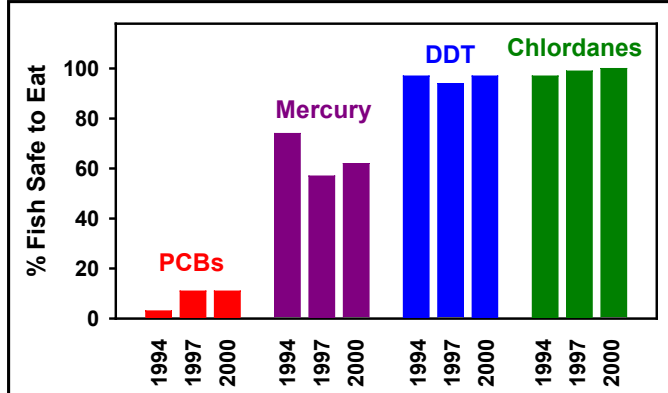


Figure 6. Percentage of fishes with tissue contaminant concentrations below USEPA screening levels for each of the four contaminants measured in the indicator.

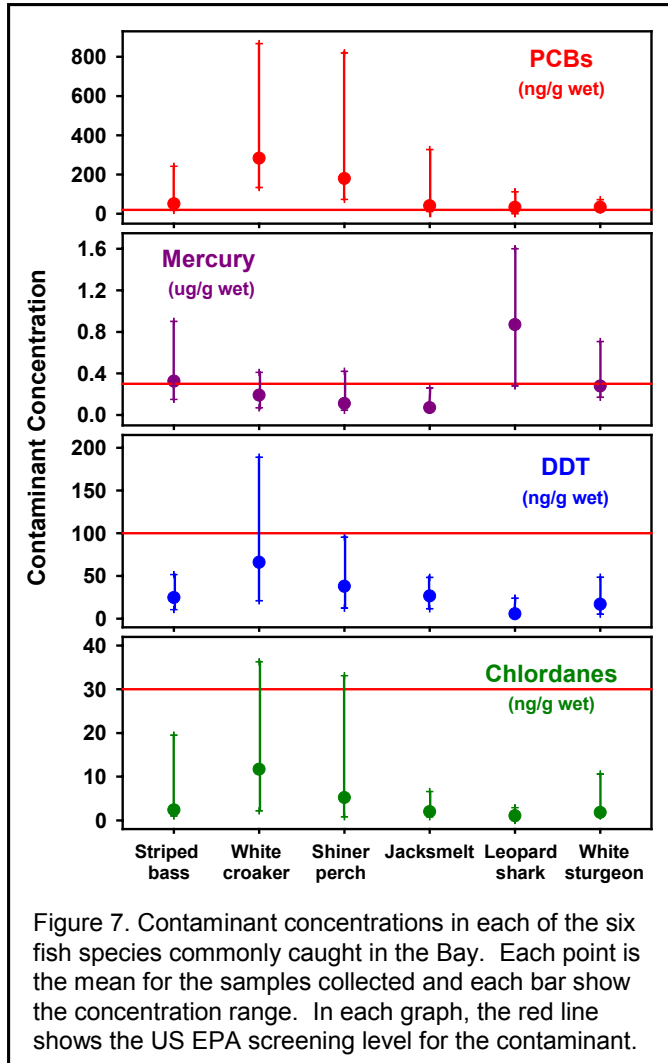


Figure 7. Contaminant concentrations in each of the six fish species commonly caught in the Bay. Each point is the mean for the samples collected and each bar show the concentration range. In each graph, the red line shows the US EPA screening level for the contaminant.

Indicator 3. Swimmable

Aquatic sports are very popular in the Bay Area. San Francisco Bay has some of the finest windsurfing beaches in the country and every year long-distance swimmers brave the waters between San Francisco and Alcatraz Island. All the counties surrounding the Bay have public parks along the shoreline, many with beaches for water play and swimming. The Bay shoreline (especially in San Mateo County) also has numerous lagoons with beaches and public access. Public use of the Bay waters is increasing as new parks, such as Eastshore State Park, are developed.

Exposure to waters contaminated by sewage or urban runoff can cause a variety of human illness, including gastroenteritis, respiratory illness, ear, nose, and throat problems, and skin rashes. The Swimmable indicator measures the number of days per year that public beaches on the Bay's shores were posted with warnings against swimming or closed because of water quality concerns. The indicator is calculated based only on the public beaches that are monitored and reported to the State and is not a complete inventory of the beaches that are monitored or have advisories and postings.

Data Source: California Assembly Bill 1946 requires the State Water Resources Control Board (SWRCB) to post monthly beach data coastal counties throughout the state listing beach warnings, closures and rain advisories resulting from bacterial contamination.⁵ However, for the Bay beaches located in five Bay Area counties (Table 4), reporting has been inconsistent and incomplete, at least in part because the SWRCB has not issued clear reporting guidelines to the Bay side counties. For example Bay and lagoon beaches in San Mateo County with advisories and closings are not reported to the SWRCB. Therefore the indicator was calculated for just 2001 and 2002 using only beach posting and closure information reported to the SWRCB for Alameda, Contra Costa, and San Francisco counties. For earlier years, some monitoring information is available for four of the five counties but, for some counties, individual beaches and posting or closure dates are not consistently identified.

Calculations: The Swimmable indicator measured the total number of days per year in which any of the public beaches that are monitored and reported to the SWRCB were posted or closed. The indicator is not a complete inventory of the beaches that are monitored or have advisories and postings. Beach postings and closures tend to be seasonal and occur most frequently during and following rainstorms. However for calculation of the indicator, days in which multiple Bay beaches were posted or closed were only counted once.

⁵ For more information on SWRCB beach surveys see www.swrcb.ca.gov/beach/index/html.

Table 4. San Francisco Bay Area beaches.

Beach	County	Comments
Crown Memorial State Beach	Alameda	
Keller Beach	Contra Costa	
McNears Beach China Camp Paradise Cove Schoonmaker Beach Fort Baker, Horseshoe Cover NW	Marin	Marin County began regularly monitoring beaches in 2003 and reports posting on the www.earth911.org website
Aquatic Park Crissy Field Candlestick Park Recreation Area	San Francisco	San Francisco County has reported beach posting to the State Water Resources Control Board since 1999.
Aquatic Park (lagoon) Coyote Point Lakeshore 1 and Lakeshore 2 (lagoon)	San Mateo	San Mateo County monitors Bay shore beaches and posts reports on the www.earth911.org website but is not required to report postings to the State Water Resources Control Board. The county does report closures and posting of its coastal beaches to the SWRCB.

Grading and Evaluation: The upper reference conditions was set at <1day of beach closures or postings (Table 4). The lower reference condition was set at 73 days, indicating that Bay beaches were posted or closed for 20% of the year. Intermediate grade levels were set at 5 days (<2% of the year) for the B-C break point and 36 days (10% of the year) for the C-D break point.

Table 4. Evaluation and grading for the Swimmable indicator.

Swimmable Indicator					
Reference condition	Beach posting/closres (days)	Rationale for reference conditions	Ecological condition	Grade point	Grade
Upper	<1	Upper reference condition was set at <1 day per year (effectively 0 postings or closures). The lower reference condition was set at 73 days, or 20% of the year. The C-D break point was set at 36 days (10% of the year) and the C-B break point at 5 days (<2% of the year).	Excellent	4	A
	≥1-5		Good	3	B
	>5-36		Fair	2	C
	>36-73		Poor	1	D
Lower	>73		Very poor	0	F

Results:

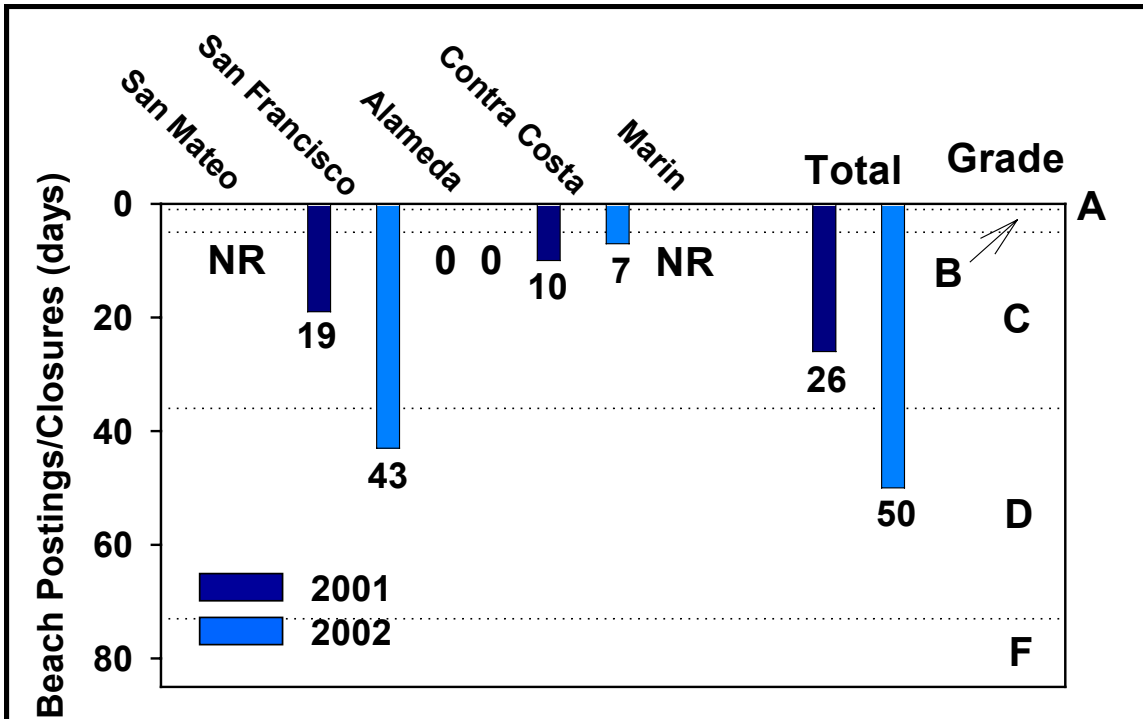


Figure 8. Results of the Swimmable indicator for 2001 and 2002. The indicator measures the total number of days per year that Bay beaches were posted or closed due to poor water quality. The number of days for each of the counties and the indicator total are shown below the bars. NR=not reported.

Swimmable	Grade (2002)	Trends	
		Long-term	Short-term (2-4 year)
In 2002, Bay beaches were closed for 50 days, 14% of the year	D	no data	↔ (declining)

San Francisco Bay beaches were frequently closed or posted because of poor water quality.

In 2001, Bay beaches were posted or closed for a total of 26 days, nearly 7% of the year. The following year (2002), Bay beaches were posted or closed for 50 days, or nearly 14% of the year.

The frequency of beach closures has increased.

The number of days that Bay beaches were posted or closed in 2002 was nearly double the number of days reported in 2001. For San Francisco County, which reported to the SWRCB since 1999, the frequency of beach closures has increased steadily since 1999 (Figure 9). Some of this increase may reflect increased monitoring efforts.

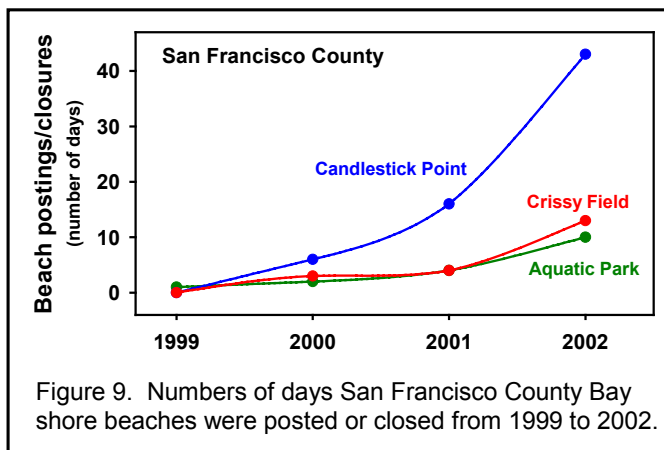


Figure 9. Numbers of days San Francisco County Bay shore beaches were posted or closed from 1999 to 2002.

Beach closures were caused by urban storm drain and uncontrolled sewage discharges, which usually occurred during and following winter rainstorms.

Beach postings or closures in San Francisco County were prompted by releases of poorly treated water from the combined stormwater and sewage collection system, which during rainstorms exceeds the capacity of the wastewater treatment system. Beach closures in Contra Costa County (Keller Beach) were the result of a malfunctioning sewage-lift station. Beach closings in San Mateo County (not included in calculation of the indicator) can be traced to contaminated water in urban storm drains.

Many Bay Area beaches were not regularly monitored and/or posting or closures were not reported to the SWRCB.

In 2001 and 2002, only three of five Bay Area counties with public Bay shore water access (Alameda, Contra Costa, and San Francisco), regularly reported monitoring or closure data to the SWRCB.

The San Francisco Regional Water Quality Control Board lists the San Francisco Bay to be "fully supporting" for the swimmable beneficial use over nearly all of its surface area.

Beach closings and advisories are relatively infrequent. Only the toxic "hot spots" in the shipping harbors are not fully supporting the swimmable beneficial use.

Indicator 4. Drinkable

Bay Area residents receive their drinking water from a variety of sources, ranging from local runoff to water imported from distant parts of the Bay's Central Valley watershed. The quality of that water reflects the health and management of the source watershed. Many agricultural, industrial and land use activities introduce sediments, pesticides, hydrocarbons, and toxic trace elements into the watershed. When, as a result, standards for human health are exceeded, water treatment costs can increase, service may be disrupted and/or water supplies may be reduced. The Drinkable indicator measures

the percentage of drinking water suppliers that reported exceedences of drinking water quality standards (maximum contaminant limits, MCLs) in their source water supplies for one of five classes of contaminants: nitrogen compounds, heavy metals, pesticides, hydrocarbons, and industrial chemicals (Table 5).

Chemical	Category
Nitrate (as NO ₃) Nitrate + nitrite (as N) Nitrate nitrogen (NO ₃ -N) Nitrite (as N)	Nitrogen compound
Mercury Selenium	Metal
1,2-dichloropropane Atrazine Bentazon Chlordane Dibromochloropropane (DBCP) Simazine Toxaphene	Pesticide
Benzo(a)pyrene	Hydrocarbon
Ethylene dibromide (EDB) Tetrachloroethylene Trichloroethylene	Industrial chemical

Data source: For the San Francisco Bay Area, 41 drinking water suppliers (Table 6) were identified. Only suppliers that served more than 20,000 people were included in the analysis. Combined, these suppliers serve nearly 5.7 million people. Eighteen of the suppliers, serving more than 2.2 million people, use groundwater (i.e., wells) for some or all of their supply but the percentage of total source supply derived from groundwater sources was not determined. Data on exceedences of maximum contaminant limits (MCLs) in their source water supplies for each of five classes of contaminants (nitrogen compounds, heavy metals, pesticides, hydrocarbons, and industrial chemicals) were obtained from the California Department of Health Service Drinking Water Quality Monitoring database.

Calculations: For each of the five contaminant categories, the percentage of suppliers that reported an exceedence of an MCL in at least one of their sources water supplies was calculated and graded according to the grading scale shown in Table 7. The indicator was calculated as the grade point average of the grade results for each of the five contaminant categories. Data for the number of drinking water sources that exceeded an MCL were also evaluated but were not included in calculation of the indicator.

Table 6. Bay Area drinking water suppliers included in the Drinkable indicator.
S=surface water source, G=groundwater source,

Supplier	County	Population	Water sources
Alameda County WD	Alameda	280000	S, G
California Water Service, Livermore		50670	S, G
East Bay MUD		1200000	S
City of Hayward		121000	S
City of Pleasanton		55000	S, G
San Ramon SD (Dublin)		22500	S, G
Contra Costa WD	Contra Costa	225000	S
City of Martinez		30000	S
Marin Municipal WD	Marin	177961	S
North Marin WD		50000	S
City of Napa	Napa	70000	S
San Francisco PUC	San Francisco	751732	S
Mid-Peninsula WD	San Mateo	27500	S
City of Burlingame		27831	S
California Water Service, Bear Gulch		64790	S
California Water Service, San Carlos		28260	S
California Water Service, San Mateo		90460	S
California Water Service, South SF		51460	S, G
City of Daly City		104000	S, G
City of Millbrae		21236	S
Estero Municipal Improvement District		32583	S
City of Redwood City		80703	S
East Palo Alto Water Works District		29506	S, G
City of Milpitas	Santa Clara	58000	S, G
City of Morgan Hill		34785	S, G
City of Mountain View		71000	S, G
City of Palo Alto		58000	S
San Jose Water Company		921000	S, G
City of Santa Clara		97134	S, G
City of Sunnyvale		125000	S, G
City of San Jose, Evergreen/Edenvale		68000	S, G
Great Oaks WC, Inc.		64873	S, G
City of Benicia	Solano	26000	S
City of Fairfield		75000	S, G
Suisun City		25000	S
City of Vallejo		130000	S
City of Vacaville		82528	S, G
City of Petaluma	Sonoma	43500	S
City of Santa Rosa		140000	S
City of Rohnert Park		39259	S, G
Town of Windsor WD		23718	S, G
TOTAL		5674989	

Grading and Evaluation: For each contaminant category, the upper reference condition was set at <1 % of systems reporting exceedences of an MCL for a chemical in the contaminant category (Table 7). The lower reference condition was set at >18% of systems reported an exceedence. Intermediate grades were set based on a linear scale. The grade increment, 6%, corresponded to 2.5 of the total 41 drinking water systems and was nearly twice the variability (standard deviation) in percentage of systems reported an MCL exceedence for any of five contaminant categories from 1994-2003.

Table 7. Evaluation and grading for the Drinkable indicator.

Drinkable Indicator					
Reference condition	% of systems reporting exceedence of MCL (each contaminant category)*	Rationale for reference conditions	Ecological condition	Grade point	Grade
Upper	<1	Upper reference condition was set <1% of systems reporting a MCL exceedence. Lower reference condition set at ≥18% of systems reporting an exceedence. Intermediate grade interval based on a linear scale.	Excellent	4	A
	1-<6		Good	3	B
	6-<12		Fair	2	C
	12-<18		Poor	1	D
Lower	≥18		Very poor	0	F
* Indicator was calculated as grade point average of grades from each of five contaminant categories.					

Results:

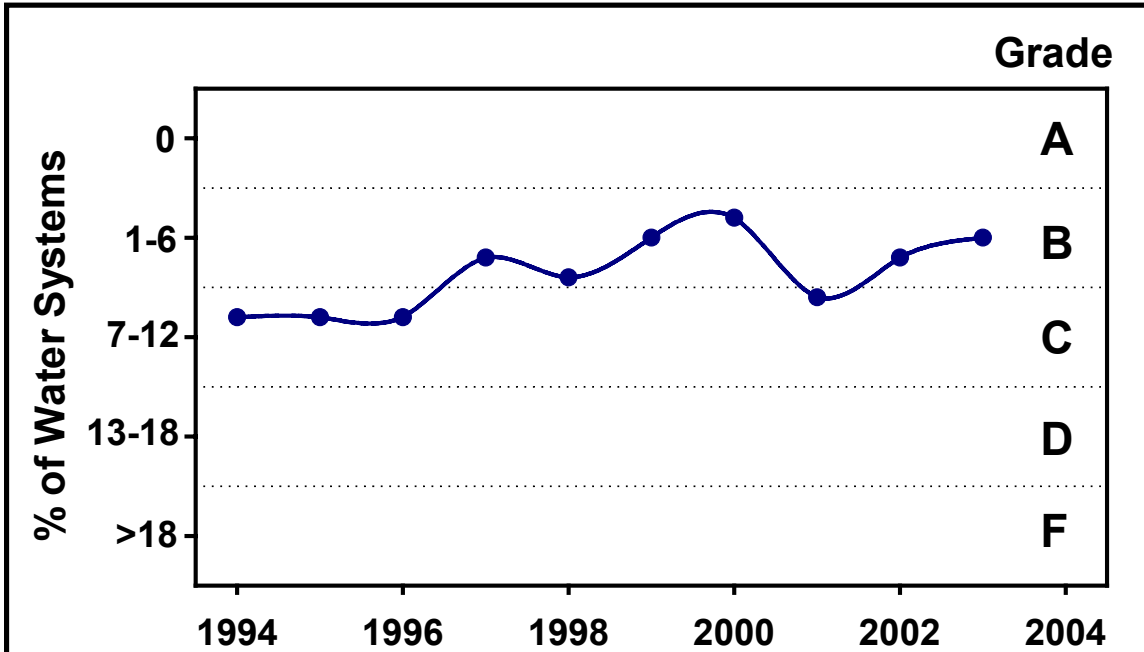


Figure 10. Changes in the Drinkable indicator from 1994 to 2003. The indicator was calculated as the grade point average of the results from each of five contaminant categories. For each contaminant category, the percentage of water systems that reported an exceedence of maximum contaminant limits was measured and graded.

Drinkable	Grade (2003)	Trends	
		Long-term	Short-term (2-4 year)
In 2003, 10% of drinking water suppliers reported MCL exceedences for at least one contaminant category (nitrogen compounds) in their source water supplies.	B	no data	↔ (declining)

Most Bay Area drinking water suppliers do not exceed maximum contaminant limits for most contaminants in their source waters supplies.

However, since 1994, some Bay Area drinking water providers reported exceeding allowable contaminant limits for one or more of the five classes of contaminants in at least one of their source water supplies. In 2003, 10% of drinking water suppliers reported exceedences for nitrogen compounds, 7% for heavy metals, and 6% for industrial chemicals (Figure 11). Maximum contaminant limits for pesticides and hydrocarbons have not been exceeded for the past six years.

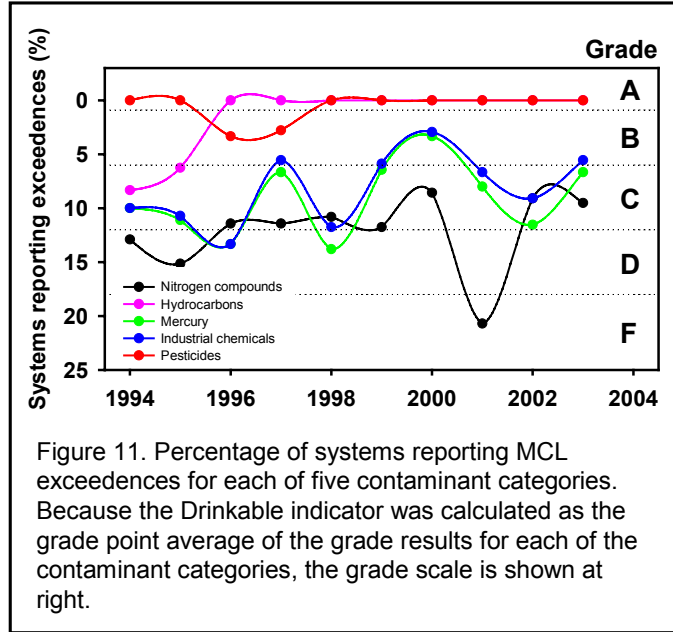


Figure 11. Percentage of systems reporting MCL exceedences for each of five contaminant categories. Because the Drinkable indicator was calculated as the grade point average of the grade results for each of the contaminant categories, the grade scale is shown at right.

Most drinking water sources do not exceed MCLs for most contaminants.

Since 1994, an average of 2% of waters sources used by Bay Area providers reported exceedences of one or more of the contaminants (Figure 12).

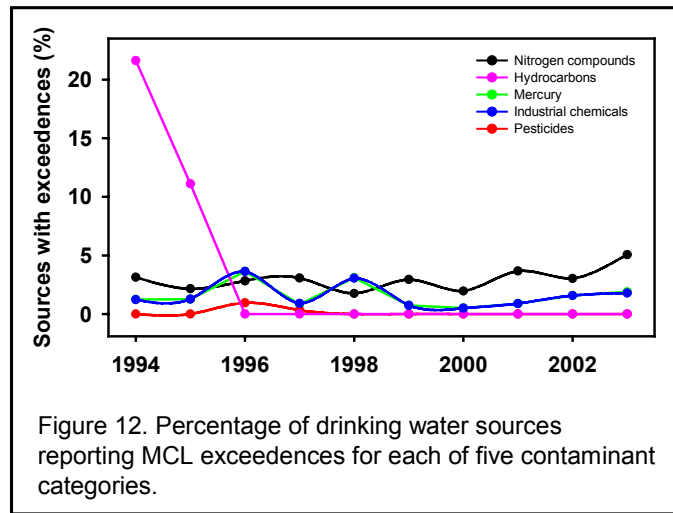


Figure 12. Percentage of drinking water sources reporting MCL exceedences for each of five contaminant categories.

Most exceedences were measured in groundwater source supplies.

More than 85% of all exceedences reported from 1994-2003 were for groundwater sources. Problem contaminants in Bay Area surface water supplies were nitrogen compounds, hydrocarbons and pesticides. Even though a major portion of Bay Area drinking water comes directly from Central Valley surface water sources, via the Tuolumne and Mokelumne Rivers or the Delta, a substantial amount of Bay Area drinking water comes from groundwater that is recharged with local runoff and imported water.

Quality of Bay Area drinking water source supplies appears to be improving.

Based on the percentage of systems reporting exceedences, the quality of source waters used by Bay Area suppliers improved between 1994 and 2003. However, this improvement may reflect discontinued use of contaminated sources rather than clean up of the contaminated water source (although, with the exception of hydrocarbon

contamination, such a trend is not apparent in the percentage of drinking water sources that reported MCL exceedences from 1994 to 2003, Figure 12).

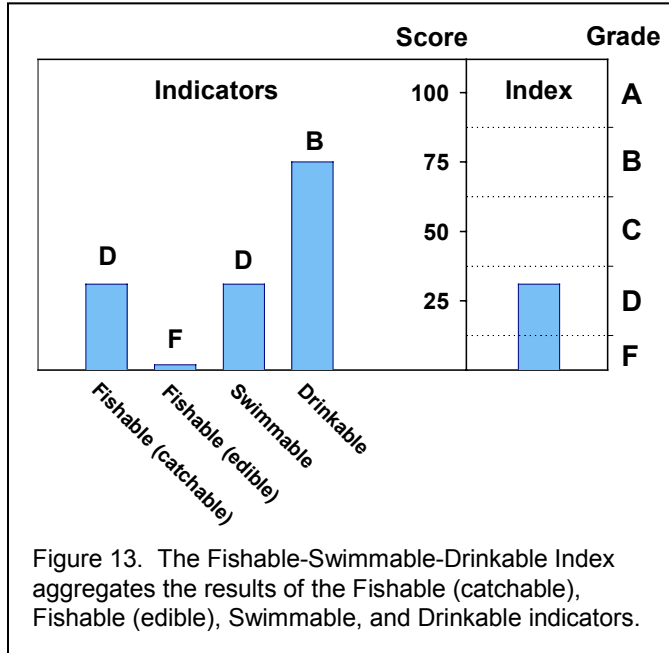
E. Fishable-Swimmable-Drinkable Index

The San Francisco Bay Fishable-Swimmable-Drinkable Index aggregates the results of the Fishable (catchable), Fishable (edible), Swimmable, and Drinkable indicators (Figure 13).

The time periods for which data were available for each of the indicators varied, therefore the Index was calculated using the most recent results of each indicator. For most indicators information on long-term trends (and even short-term trends) was not available as data but, for some, it can be inferred.

Many human uses of the Bay are impaired as a result of the Bay's poor water (and sediment) quality. The low grade (D+) and score (31 out of 100) for the Index reflected low grades for three of the four indicators. Recreational fishing success was at near historic lows, a decline correlated with declines in

population abundance of several popular sport fish species. Nearly all fish caught in the Bay were too contaminated with either mercury or PCBs to be safe to eat. Bay beaches were posted or closed for 14% of the year, nearly double the number a days just a year earlier. The quality of drinking water sources from the Bay's watersheds and groundwater basins (which are rigorously monitored) was good, although a few groundwater sources contained levels of some contaminants in excess of allowable concentrations.



F. References

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