Water Quality Indexes: The San Francisco Bay Scorecard and Beyond

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San Francisco Bay

- Important, receives 40% of state's runoff, fish passage, home to over 6.7 million residents
- Long history of anthropogenic disturbance – urban and agricultural development
- Large and complex system, difficult to assess water quality
- Significant investments in water quality remediation
- Public and decision-makers want to know: "How clean is the water"?
- We need simple answers that synthesize complex monitoring information. This is not easy…

Reporting Environmental Progress

A growing number of large-scale estuarine restoration programs have public level "indicator" reports and/or websites which are based on trends:

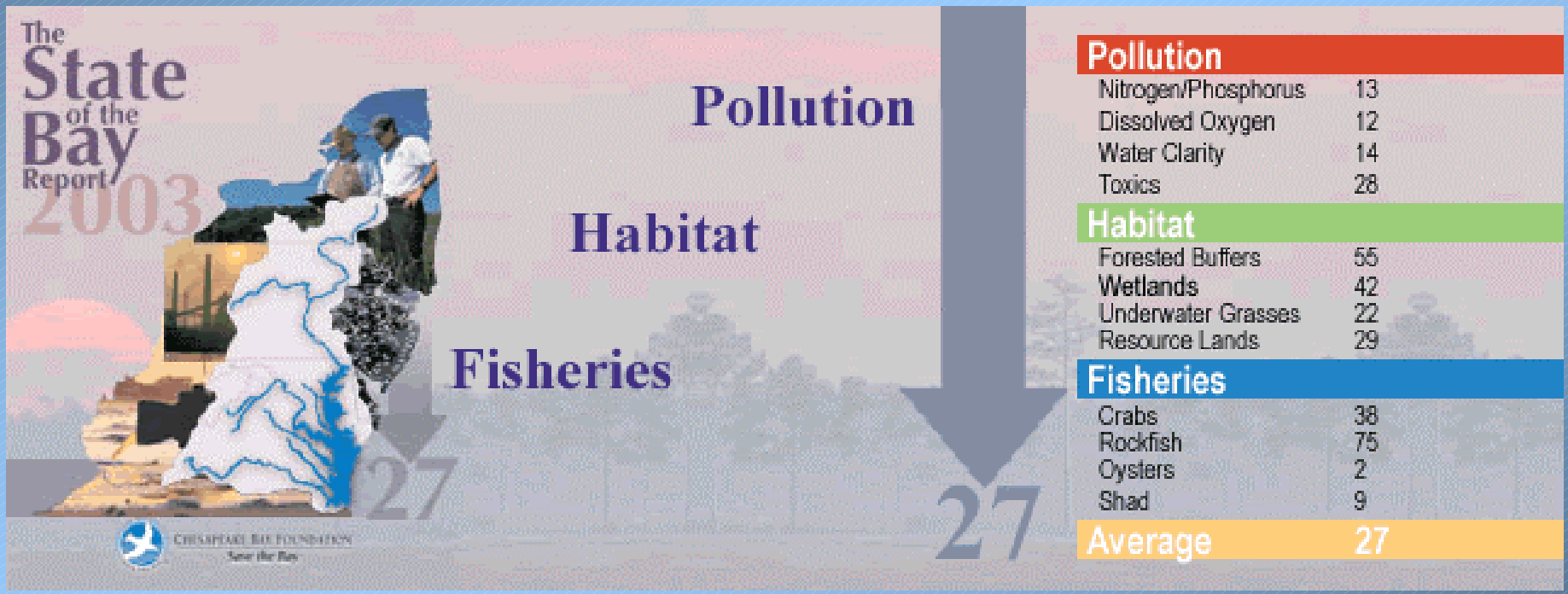
Chesapeake Bay Program
Georgia Basin Puget Sound Indicators report

Some programs actually grade condition or progress:

Chesapeake Bay Foundation
Australia's Moreton Bay Report Card
EPA's Index of Watershed Indicators (IWI)
EPA National Coastal Condition Report

Chesapeake Bay Foundation

The State of the Bay Report



Source: www.cbf.org

Moreton Bay Report Card 2003

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

B+ Moreton Bay – Overall rating

- The health of Moreton Bay improved slightly
- Large areas complying with Water Quality Objectives
- Reduced severity of *Lyngbya* blooms
- 2002 grade: B

C+ Southern Bay

- Reasonable water quality except for high turbidity
- High sewage nitrogen signal in some areas
- Shallow seagrass meadows, lack of recovery where previously lost
- 2002 grade: B-

B- Broadwater

- Moderate water quality
- Stable seagrass meadows, moderately impacted
- Elevated sewage nitrogen signal throughout
- 2002 grade: A- (Southern Broadwater)

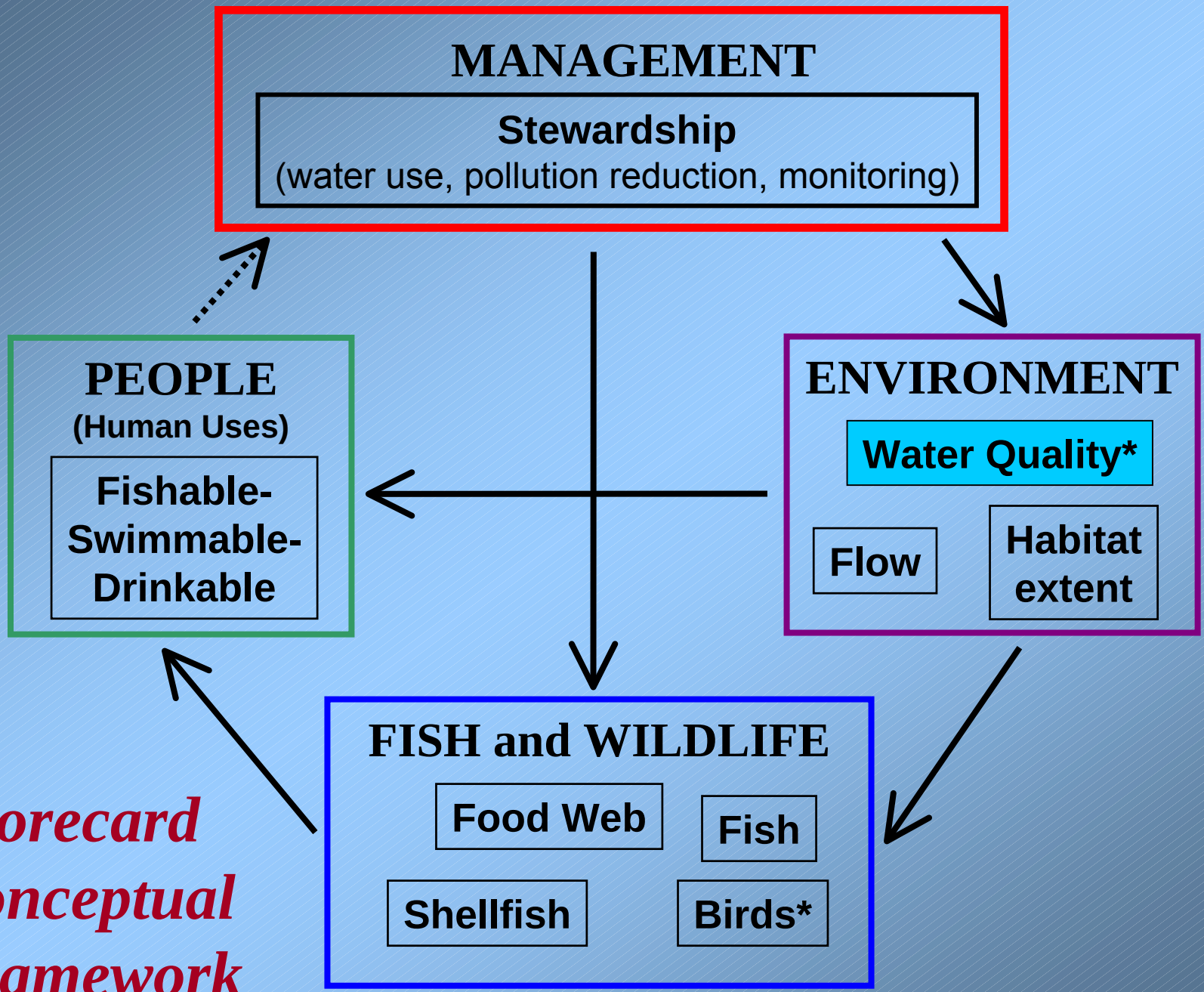
Ecosystem Health Monitoring Program

Excerpt from: www.coastal.crc.org.au

The San Francisco Bay Water Quality Index –

one of eight indexes of the Bay Index (Ecological Scorecard)

	D+ Score = 32	**Habitat** Bay habitat loss is slowly being reversed, but it could take nearly 200 years to reach the tidal marsh restoration goal.	long-term ↓ short-term ↑
	D Score = 29	**Freshwater Inflow** Reduced inflows are still degrading the Bay ecosystem, and recent gains from wetter years and new standards are being eroded	long-term ↓ short-term ↓
	C Score = 55	**Water Quality** Open waters are cleaner, but standards are not met in parts of the Bay. Toxic sediments and storm runoff are a major problem.	long-term ↑ short-term ↔
	F Score = 10	**Food Web** Plankton levels in the upper Bay have crashed, reducing food sources for fish and birds. Alien species are locally dominant.	long-term ↓ short-term ↔
	B- Score = 63	**Shellfish** Crab and shrimp numbers are increasing, but commercial harvest is still down from previous high levels.	long-term ↓ short-term ↑
	C- Score = 39	**Fish** After a long decline, fish populations are stable at low levels, but some species are still endangered.	long-term ↓ short-term ↔
	D+ Score = 31	**Fishable-Swimmable-Drinkable** Fish are harder to catch, and unsafe to eat. Beach closures are up, drinking water violations are down.	long-term ↓ short-term ↔
	C- Score = 43	**Stewardship** Water conservation, pollution limits, monitoring, and restoration efforts are finally underway, but progress is slow.	long-term ↓ short-term ↔

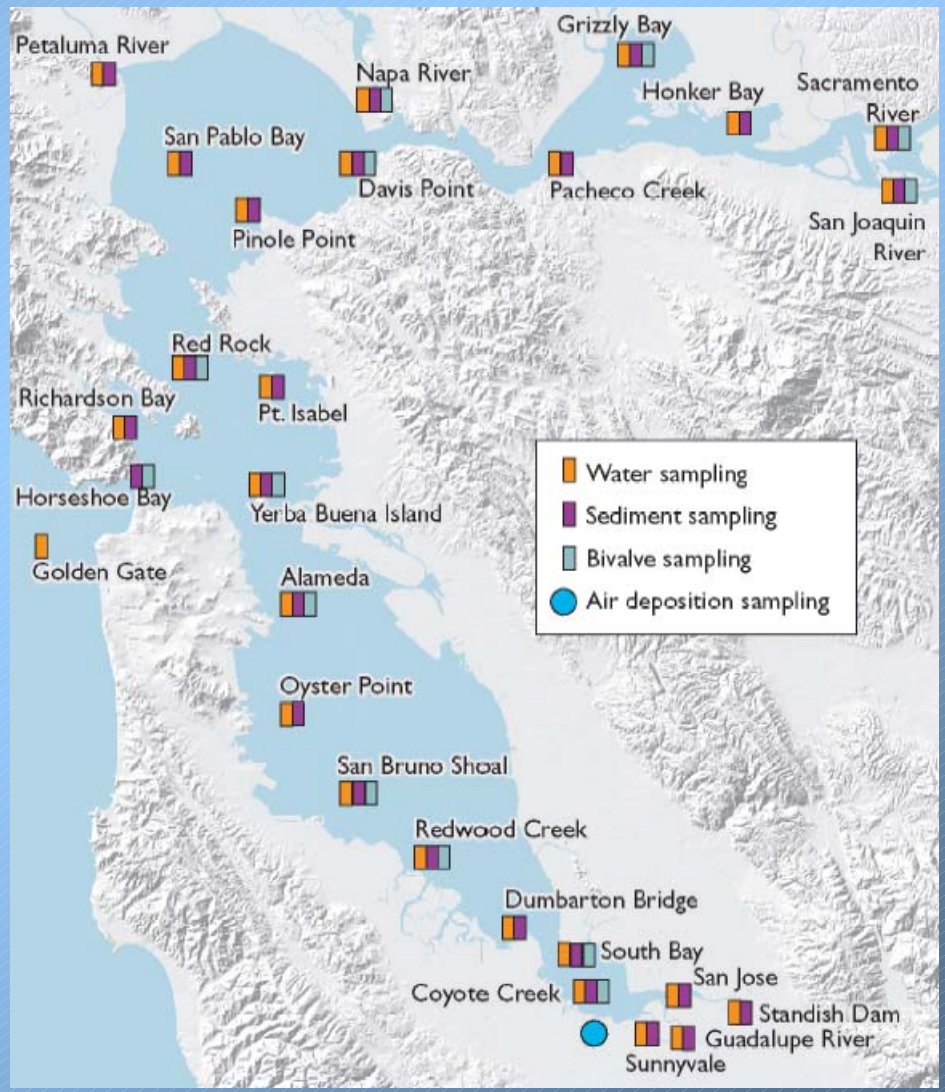


Scorecard Conceptual Framework

Scorecard Water Quality Index developed for San Francisco Bay

four sub-regions:

- Suisun Bay
- San Pablo Bay
- Central Bay
- South Bay



http://www.sfei.org/rmp/pulse/pulse2003.pdf

Water Quality Index Criteria

- Summarize the scope, magnitude, and frequency of the water quality problem
- Summarize the results for key classes of compounds that impair ecosystem health
- Compare water quality using existing standards
- Facilitate comparison with studies in different regions
- Score water quality on a 0-100 scale with 100 being the best and 0 the worst condition consistent with the grading system used for other Scorecard indexes

CCME Water Quality Index 1.0 Method

Method developed by the British Columbia Ministry of the Environment, Lands and Parks and adopted by the Canadian Council of Ministers of the Environment.

- Calculation of each indicator incorporated three different measurements (metrics):

  1. number of variables whose objectives are not met "failed variables" (**Scope**)

  2. frequency with which the objectives are not met "failed tests" (**Frequency**)

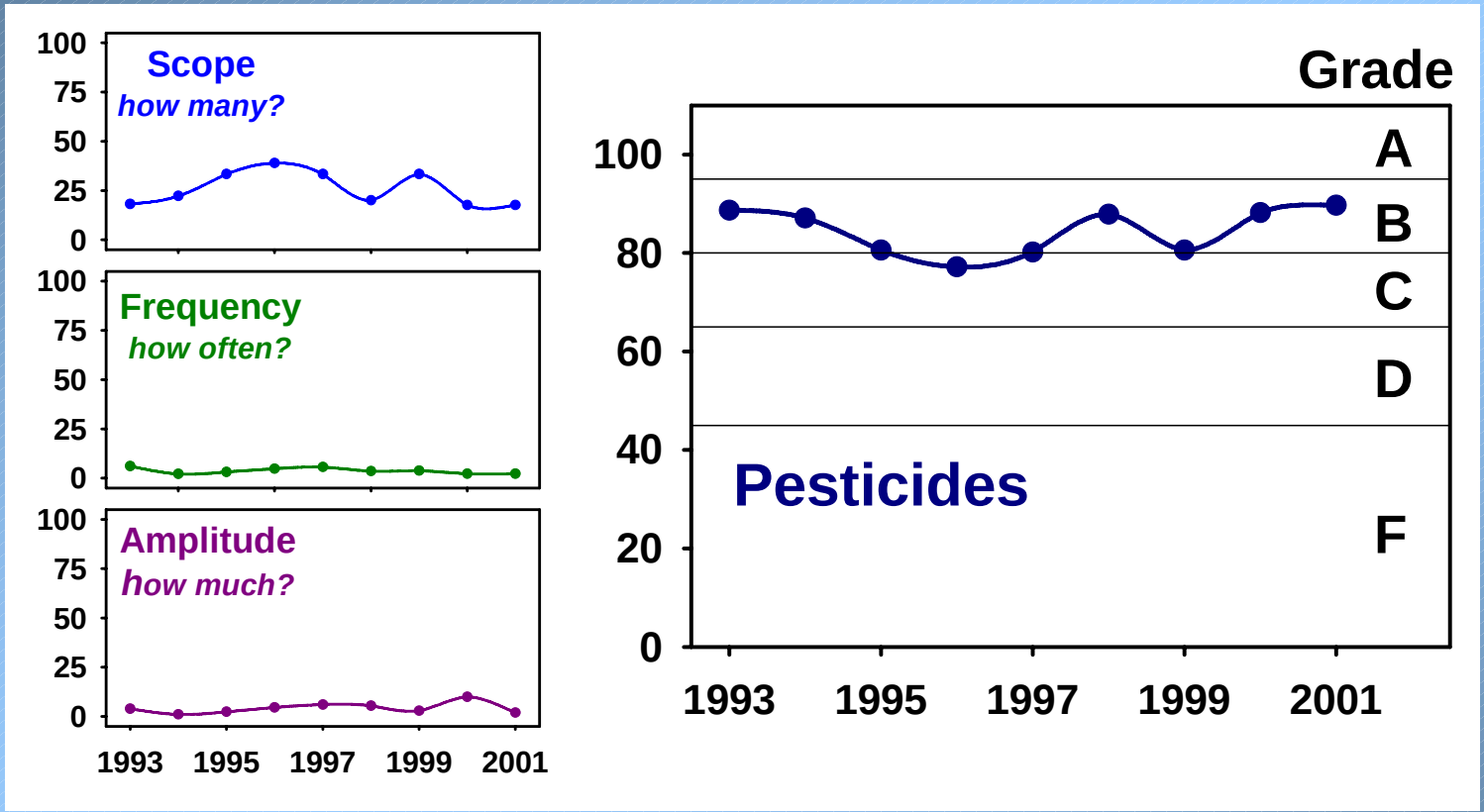
  3. amount by which the objectives are not met (**Amplitude**)

- The Scoring scale (0-100) was consistent with the Scorecard approach.
- Index calculator available

Index aggregates the scores of five Indicators

1. **Trace elements**: (µg/L) silver, arsenic, cadmium, chromium VI, copper, mercury, nickel, lead, selenium, zinc
2. **Pesticides:** (pg/L) α-HCH, β-HCH, Chlorpyrifos, Diazinon, Dieldrin, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, γ-HCH, Heptachlor, Heptachlor oxide, Hexachlorobenzene, Mirex, p,p'-DDD, p,p'-DDE, p,p'-DDT
3. **PAHs:** (ng/L) Acenaphthene, Anthracene, Benz(a)athracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Dibenz(a,h)anthracene, Fluorathene, Fluorene, Indeno(1,2,3-cd)pyrene, Pyrene
4. **PCBs:** (pg/L) Total
5. **Dissolved oxygen:** (mg/L)

Calculation of Indicators

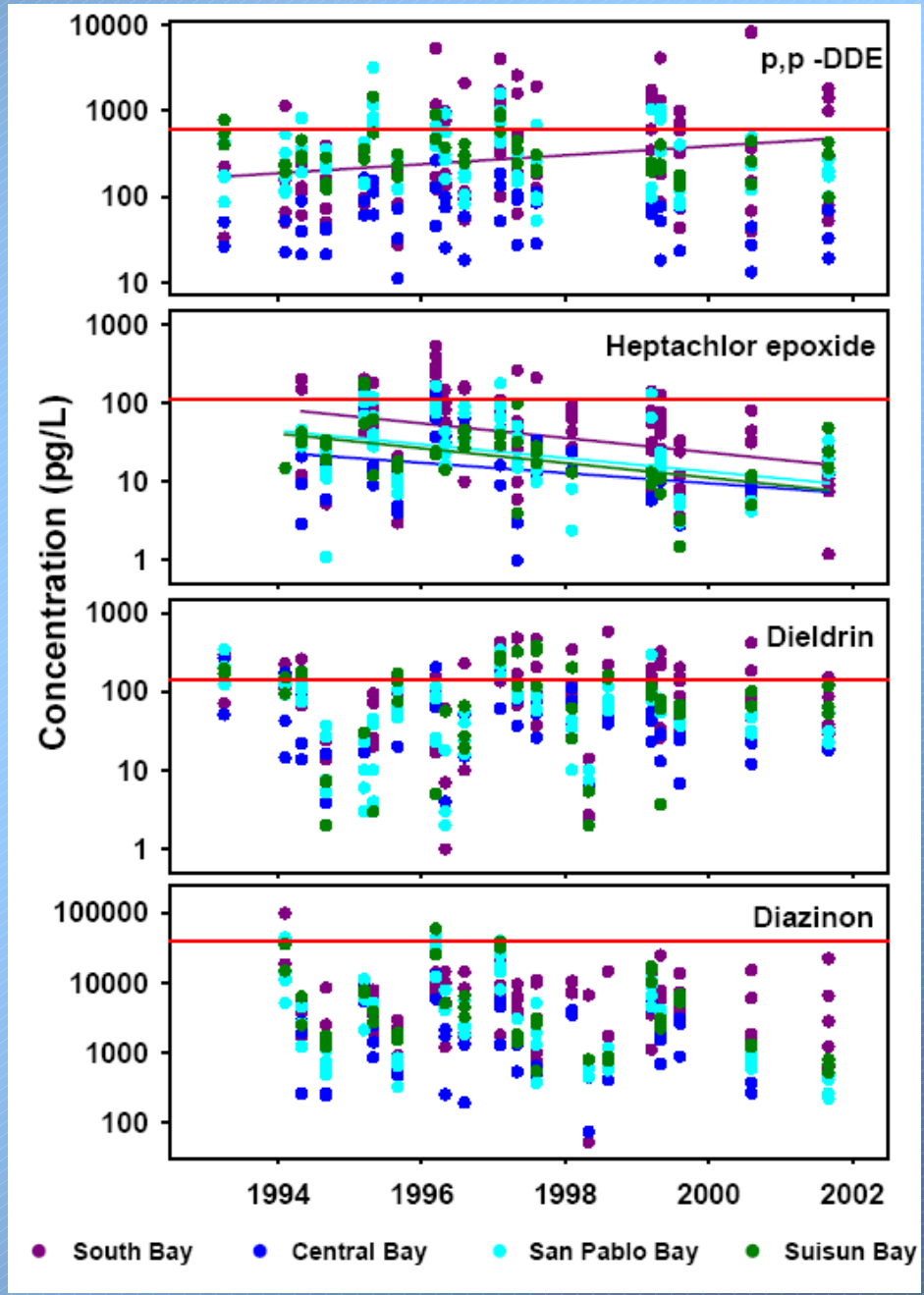


This figure illustrates how each contaminant category indicator is calculated from three metrics and converted to a score using a 100 point scale.

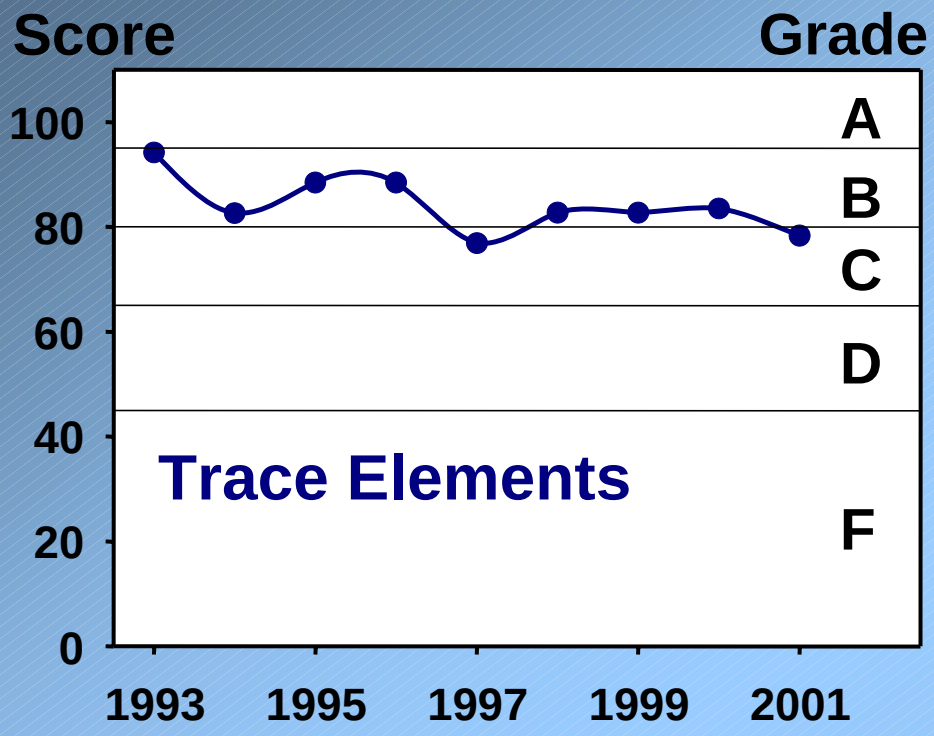
Pesticide Indicator

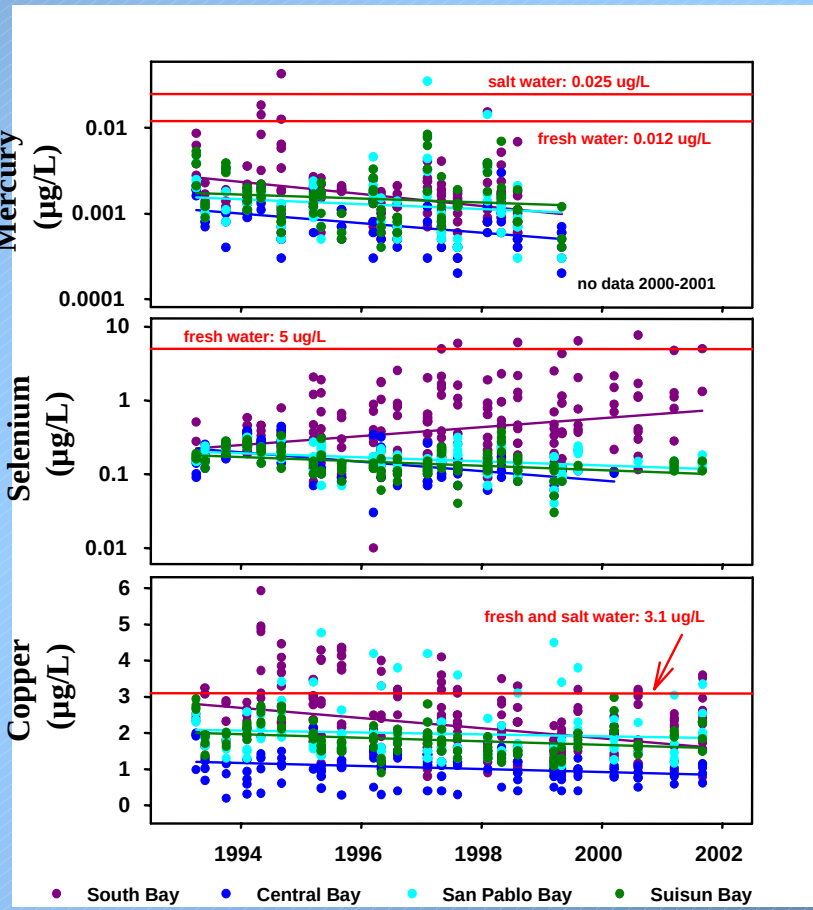
Key Findings:

- Received a B in 2001; Overall trend is “stable”
- Standards for most pesticides were met in most water samples
- Concentrations of diazinon, dieldrin, heptachlor epoxide, or DDT compounds exceeded standards in all years
- Contamination more severe in South, San Pablo Bays, and Suisun Bay
- Concentrations of most of the problem pesticides have not declined



Trace Elements Indicator

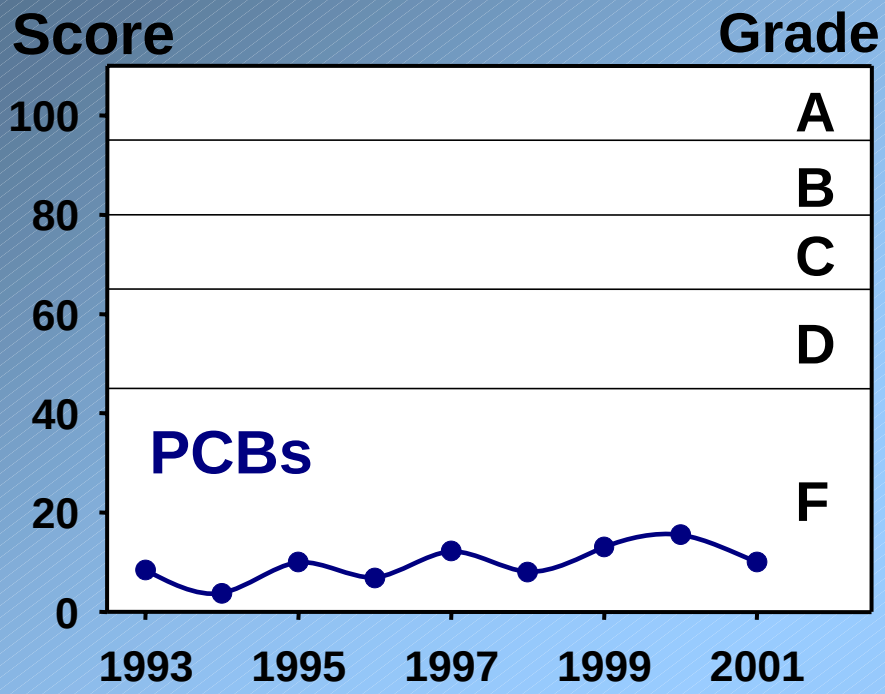


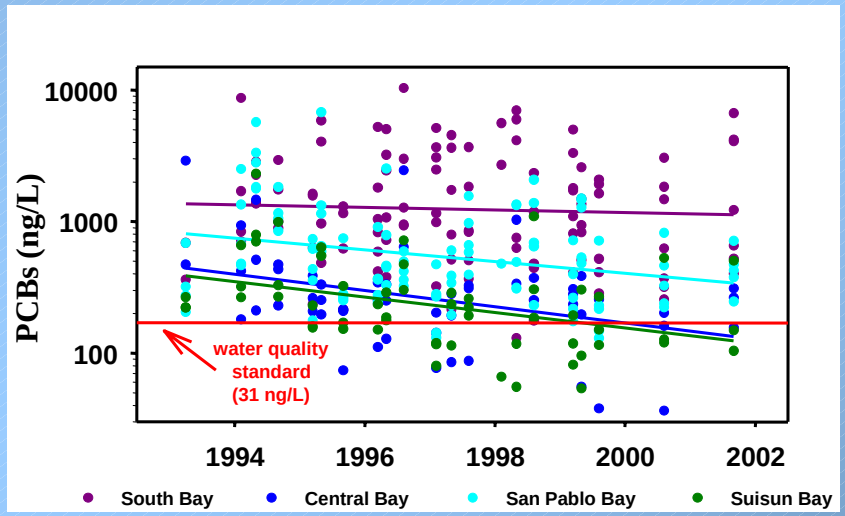


Key Findings:

- Received a C in 2001; overall trend is declining
- Standards exceeded exclusively in the South and San Pablo Bays
- Four trace elements standards were consistently exceeded: mercury, copper, selenium, and nickel
- From 1993-2001, an average of 10% (range: 2-18%) of all water samples exceeded the standard for one or more trace elements

PCB Indicator

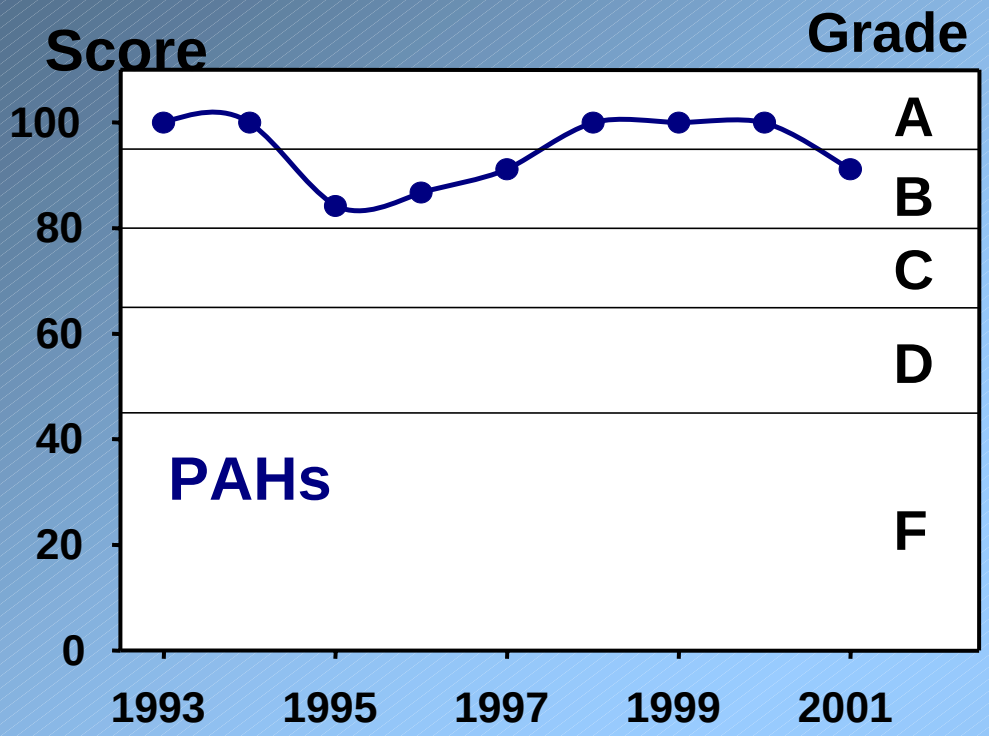


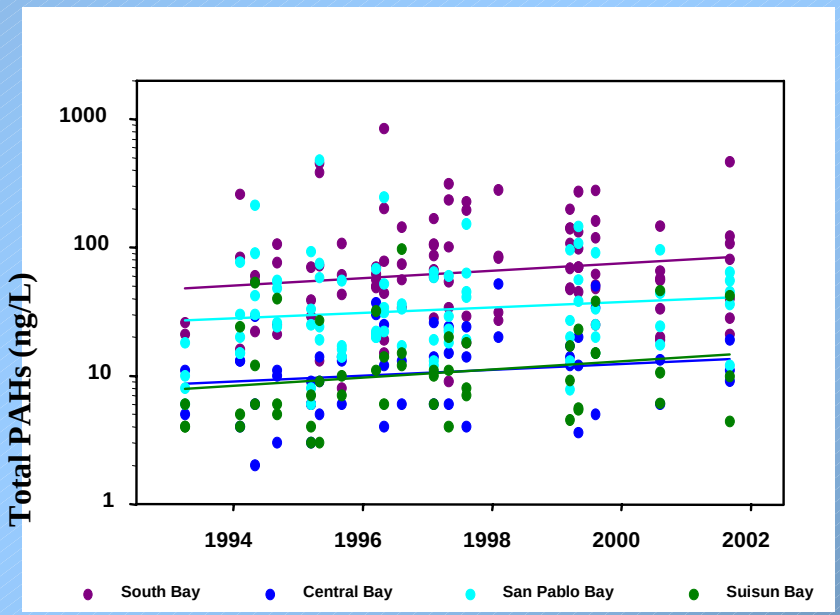


Key Findings:

- Received an F in 2001; overall trend is not declining
- Concentrations in San Francisco Bay exceeded standards every year, in every part of the Bay at nearly every sampling station
- The problem is particularly severe in the South Bay

PAH Indicator

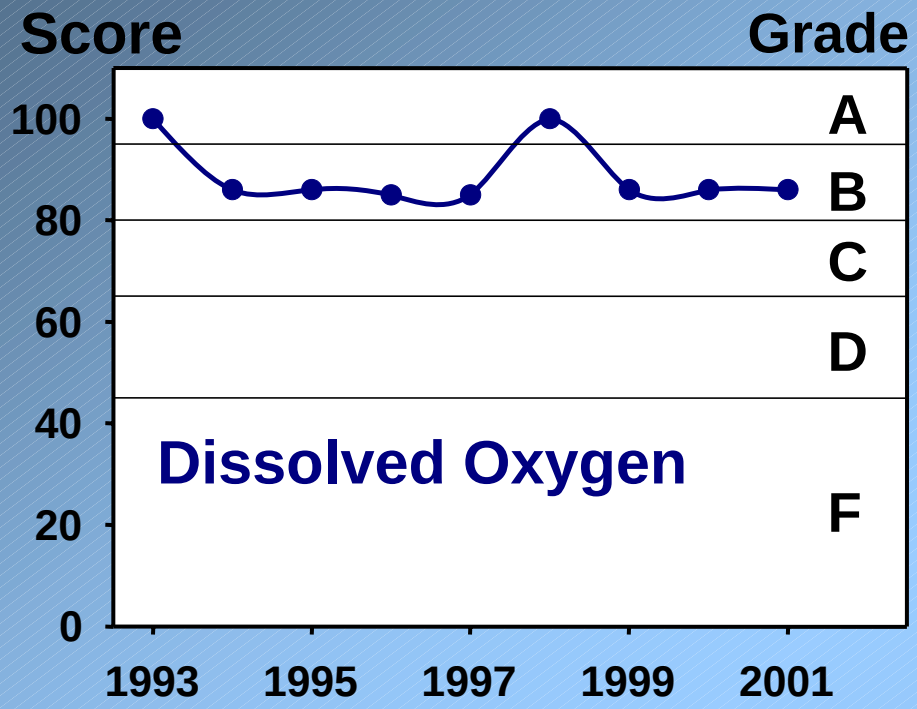


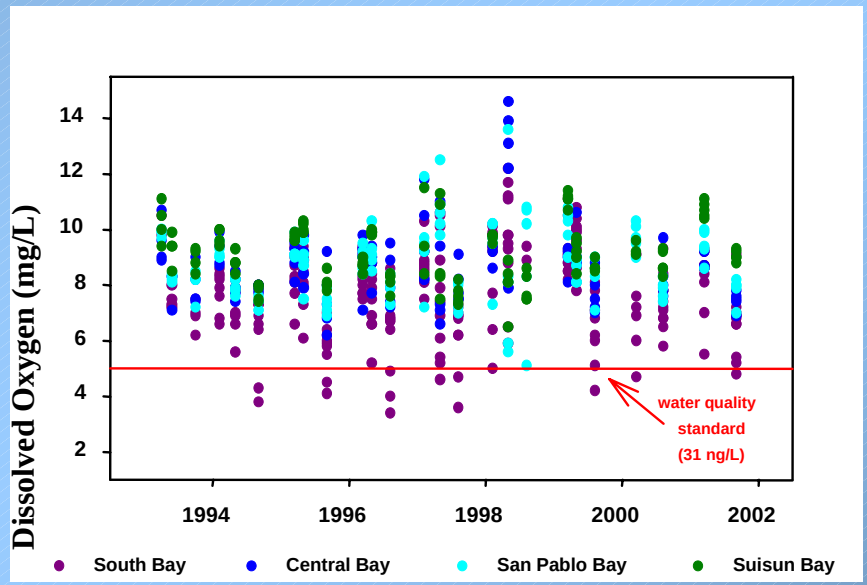


Key Findings:

- Received a B in 2001; overall trend neither increased nor decreased during the past decade
- Concentrations exceeded standards in four of nine years during the RMP survey
- Total PAH concentrations were highest in South Bay, intermediate in San Pablo Bay, and lowest in Central and Suisun Bays

Dissolved Oxygen Indicator





Key Findings:

- Received a B in 2001; trend varied but neither increased or decreased
- Concentrations were above the minimum standard in all areas of the Bay except the South Bay where they fall below the standards in nearly all years

Dissolved Oxygen – South Bay

- Method allows comparisons despite short term record.
- Historic USGS data indicate improvement in conditions in the South Bay during the past thirty years.

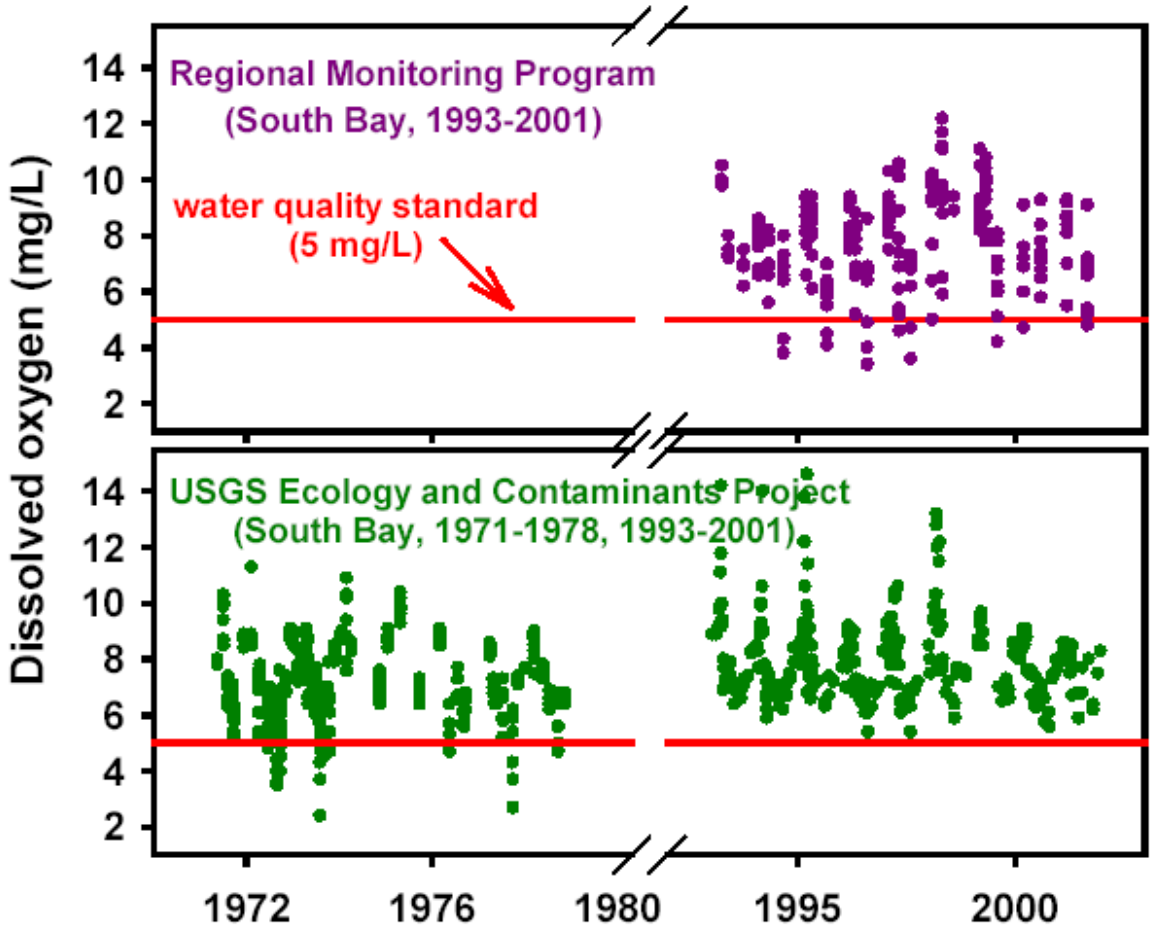
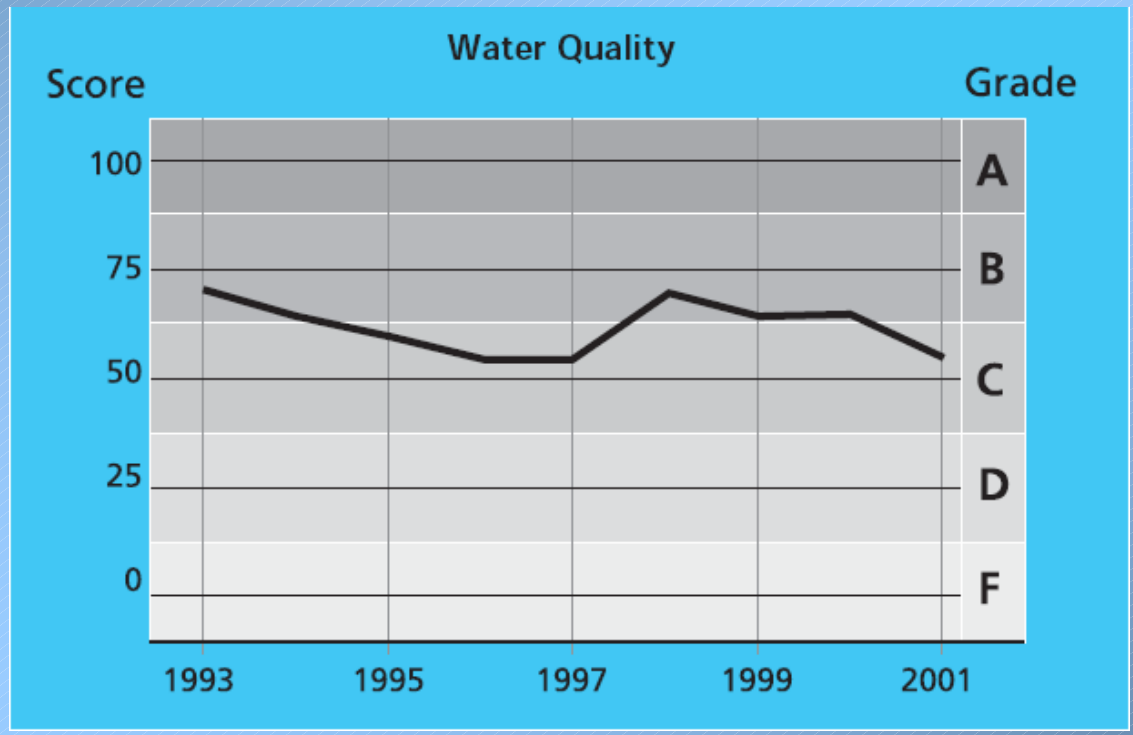


Figure 13. Dissolved oxygen concentration measured at South Bay sampling stations by the RMP and the USGS Ecology and Contaminants Program.

The Bay Water Quality Index

- 2001 score was 55 and grade was C. It has fluctuated from B-C indicating good to fair conditions, current trend is relatively “stable”.
- Open waters are cleaner, but standards are not met in parts of the Bay. Toxic sediments and storm runoff are a major problem.
- Localized long-term historic data indicate that for some constituents, conditions have improved, hence the upward arrow for the long-term trend.



Grade	Score	Long-term Trend	Short-term Trend
C	55	↑	↔

Features of the methodology

- Science based – literature review, expert panel and peer review
- Adaptable – can be used for all types of indicators incorporating standards (e.g., Sediment quality)
- Multi-metric index allows aggregation – more concise message
- Results of indicator are used to “grade” overall condition
- Multiple indicators facilitate comprehensive evaluation of pollutants by category
- Multiple layers of information to reach several audiences: public, managers, decision-makers, and scientists
- Method well established in Canada, facilitates regional comparisons

"Big Picture" Water Quality Conclusions

- Overall trends show no improvement in the last decade, but improvement since earlier water quality records
- Many contaminants exceed those considered potential health threats to wildlife and humans
- Areas most impacted generally South Bay and San Pablo Bay
- Persistent and widespread distribution of pollutants whose uses have been banned or phased out (i.e., PCBs)
- Impediment - Index measures concentrations of contaminants in open waters, not in sediments or stormwater runoff

Future Directions…

- Bay Region - update and refine index, additional datasets including sediments and longer term analyses
  - *Indicators Consortium (SFEP, SFEI, CEMAR, TBI and others)*
- Investigate feasibility to move the effort upstream – Delta and major tributaries
- Develop a long range plan for indicator refinement and updates
- Build partnerships for funding and indicator development
- Tie indicators to regulatory framework and policies including state and national level indicator efforts
- Tie to other bioassessment approaches (PEEIR, Scorecard)
- Use indicators as outreach tools
- Publish results to gain broader national peer review

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