"The interactions between tidal wetlands and pelagic areas are still not well understood."

—Charles Simenstad
University of Washington

"Eighty percent of our stream reaches are now behind impassable barriers. Only tiny remnant [chinook and steelhead] populations are left. We are going to have to do some creative thinking about how to preserve ESUs."

—Steve Lindley, NOAA

The Role of Science

Photo courtesy of David Hart and John Sanger

Why Track Environmental Performance?

BRUCE WOLFE
S.F. BAY REGIONAL WATER QUALITY CONTROL BOARD

The water board's mission is to preserve, protect, enhance, and restore the waters of the state for all. But it's clear we can't just say we're going to keep working to protect the Bay and expect to get all the funding we need to do it. Decision-makers and the public want to know how we're doing, they want to know what we've done, and they want to hear the message in easy-to-understand terms. "Restoring creeks" resonates better than "minimizing the hydrogeomorphic impacts to riverine functions"—indeed, Los Angeles passed a $500 million bond last year when it was pitched as restoration of the LA River rather than as controlling the impacts of stormwater runoff.

At the S.F. Bay Regional Water Quality Control Board, the Board members themselves make all the big decisions on permits, TMDLs, cleanup plans, and the like, but the staff carries out the mission by learning and understanding the impacts to our region's waters, determining whether those impacts are related to waste discharges, and, if the answer is "yes," recommending that the Board take the appropriate regulatory action. It is our job to assess whether the action taken gets the desired results.

TAKE HOME POINTS

- **In most cases we will not have certainty as to problem cause and will have to use a weight of evidence approach. Nonetheless, we need to track performance to move forward, changing our actions when needed.**
- **We must start science long before we can expect to make a decision.**
- **We need to be clear in our message about what environmental performance is needed and how we're going to track that performance: we need the public's trust and support.**

This used to be a fairly straightforward task. For example, in the 1960s and 1970s, when the water board became aware that parts of the Bay had high bacterial counts, we responded by requiring the waste dischargers to disinfect their effluents. In this instance the cost of compliance or environmental performance was relatively modest, and the results of that performance were clear and easy to track. Levels of coliform bacteria in the Bay dropped dramatically. We had a nice link between the environmental problem, the environmental performance required, and a measurable water quality result.

Another example is dissolved oxygen in South San Francisco Bay below the Dumbarton Bridge. The water board found that dissolved oxygen was at times well below what fish needed to survive, and studies indicated that the culprit was ammonia in sewage effluents from the three treatment plants in the area. Fish kills were a straightforward problem, as was the environmental performance needed: the Board required that those effluents receive additional biological treatment to convert ammonia to nitrate. Once new facilities went on line, tracking of the dissolved oxygen levels demonstrated the problem had been solved.

Today it's not always so simple. Issues that face us now—legacy pollutants, crashing fisheries, and emerging contaminants—are not as straightforward in terms of what we need to do, and how to measure progress, let alone success.

On the other hand, we have far better tools to assess the state of our waters. The restoration of Peyton Slough by Rhodia is a case in point. Peyton Slough was identified some years back as a toxic hot spot, due to extensive cooper and zinc-impregnated sediments in and adjacent to the slough. Rhodia, as successor to the parties responsible for the waste, responded to our requirements for cleanup with the innovative approach of moving the slough away from the contamination, rather than the other way around. In so doing, they're immobilizing the contamination, creating new wetlands, restoring other wetlands, improving circulation to McNabney Marsh, and a host of other benefits. It's an approach we probably wouldn't have accepted ten years ago, but their ability to demonstrate the anticipated environmental performance and how that would be tracked sealed the deal for us.

The Regional Monitoring Program, which is funded by the public, private waste dischargers, and dredgers and implemented by the San Francisco Estuary Institute, involves not only monitoring for compliance with water quality standards, but also interpreting the results in ways people can understand. But even with a tool like the RMP, there will always be issues that resist easy answers. An obvious one that we've been wrestling with for years is mercury in the Bay. We know mercury moves up the food web and concentrates in fish, and in people eating the fish. We also know mercury impacts bird populations by affecting their eggs. Relying on RMP data, our Board adopted a long-term cleanup strategy for mercury in the Bay, but the State Board remanded that strategy back to us. In this case, everyone agreed the science we relied on was appropriate and recognized to be the best available. Our study indicated that it could take up to 120 years for the Bay to fully recover, but that the actions we were requiring would reduce new loads of mercury by half in less than 20 years. Politics or no, 120 years was a measure of environmental performance the decision-makers found too easy to attack. We'll need to change our message as we move forward.

There are more issues we are now learning about that need to be fit into a structure of clarifying the environmental performance needed, simplifying the message, and tracking that performance. One is ammonia. We know that ammonia is no longer causing dissolved oxygen impairment, but there is some new research that indicates that it may be suppressing nitrogen uptake by diatoms.

We know that diatoms are extremely important at the base of the food web—they partly drive the biological productivity of the entire system. However, before we require all sewage treatment dischargers to provide the additional treatment needed to convert ammonia to nitrate, we will need more evaluation of environmental performance—do we know what action to take and how to track that action? Even if ammonia is shown to be a problem, we want to be sure that removing it does not create the opposite problem, that of nuisance levels of diatoms.

We need to be clear as to what our baseline is and/or what our endpoint is. Our Board's mission takes us in two directions—"preserve" and "protect," where we're trying to make sure we don't allow water quality to get any worse; and "enhance" and "restore," which implies that we improve water quality, but to what level? 1750? 1850? 1950?

We've classically focused more on "preserve" and "protect" than "enhance and restore," but it's clear through TMDLs, expanding needs for mitigation from project impacts, and just about every poster at this conference, that we need to ramp up "enhance and restore."

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What Should the Role of Science Be in the Estuary?

TIM QUINN
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

What are policy makers looking for from scientists? It is pretty straightforward. I'm looking for objective accurate information about the consequences of alternative policy choices. That sounds easy enough, but we did it wrong a great deal of the time.

There's a division of labor that is important to keep in mind. The policymaker's job is to choose amongst alternative outcomes that are available to them in difficult policy choices. The scientist's job is to make sure there is accurate information, and to protect the integrity of that information. Too often in California water you have people sitting at policy-making tables trying to cross over that line and control the science for their own negotiating advantage. Similarly you have scientists who cross the line, making judgments about what information should be out there based on what they think should happen in the proper realm of the policy maker. The policy maker shouldn't have control over the information flow; the scientist's job is to stay away from the policy choices.

The best way to drive that point home is to recall the development of the Bay-Delta Accord in 1994, which included the creation of CALFED, and was a major reversal of policy at that time. Up until December 1994 it was far from clear that we would be able to negotiate an accord because of how we were handling science—science as driven by political positions and negotiating positions. Betsy Rieke, the Assistant Secretary of Interior for Water and Science, recognized that it would be impossible to come to agreement if we continued to politicize the science. So she convened a science meeting in Monterey, pulling all the scientists and all the policy makers and most of the stakeholders into the same room. For the first time there were very short lines of communication between the scientists and the policy makers. All too often we try to separate those groups of people. The Accord was one of the few times in California water we got it right.

Good science done well is a conflict reducer: it gets people to agree on consequences, even if you don't like some of them. When you politicize science, you grow the conflict. I don't think the *San Francisco Chronicle,* the *Contra Costa Times,* or the *Sacramento Bee* are very good places to initially publish your conclusions and findings. But there's a lot of that going on and it's not a healthy thing for California water policy or for the environment. I'm hopeful that with all of the warning signs we're getting from the Estuary we will starting asking the right questions—did we get the facts right, did we do the right thing, set the right policy?

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Long-term, Large-scale Monitoring: Needs and Prospects

STUART SIEGEL
WETLANDS & WATER RESOURCES

Are we giving migratory birds more and better habitat? Are fish getting more food from productive marshes? Do we have more connected parcels reflected in greater overall species support? The only way to know is to monitor natural and restored wetlands beyond status and trends to data collection designs based on cause and effect models and scalable from specific sites to sub-regions to the Estuary. Monitoring is a way to observe change in the environment. With it, we can evaluate our past investments in resource restoration and management, prioritize and carry out the most effective future restorations, address potential problems, and support regional planning. Weaving science into estuarine management demands that we evaluate past investments, rebalance the focal point of our political capital when we learn what is more effective, and be prepared for surprises with early warnings of potential problems. At present, the San Francisco Estuary has no long-term, large-scale wetland monitoring in place, though several separate efforts contribute key elements.

TAKE HOME POINTS

- **Regional goals for restoration and species recovery need to be informed by monitoring.**
- **All monitoring needs to be science-based, driven by hypotheses, and informed by conceptual models.**
- **One size does not fit all. A suite of complementary efforts is essential.**
- **Easy access to information is vital.**
- **Funding is the number one impediment to monitoring.**
- **Avoid power struggles and collaborate to achieve best monitoring results.**

Monitoring is more than collecting data on status and trends – it is analyzing, integrating, applying, and distributing information. This list presents our most pressing monitoring needs for the Estuary.

1. Distribute monitoring results widely and easily via the internet to facilitate their utility.
2. Continue to develop unbiased lessons learned from older and more recent restorations; restoration evolution demands revisiting older projects periodically as lessons can change after project-specific monitoring ends.
3. Conduct field- and laboratory-based problem evaluation monitoring to support problem resolution.
4. Conduct periodic regional assessments combining remote sensing with focused rapid field assessments to inform regulatory program effectiveness and support planning initiatives.
5. Finish protocols for data collection, QA/QC, and analysis and develop decision trees for selecting protocols applicable to the many circumstances we encounter, so we do not keep reinventing the wheel and so that we have confidence in data.
6. For regional and sub-regional efforts, include conceptual models explaining how what is being monitored is linked to things that could change; monitoring data (QA/QC, storage, and public access); a data analysis sub-program (looks for trends, patterns, covariance, and frames the "why" research); and a research sub-program (tests the conceptual models and explains why you see what you do), and identifies clear, agreed upon goals and management questions amongst funders and major customers.

Funding is the major impediment to successful monitoring. Monitoring typically costs more than is desired, and decision makers often do not place high value on monitoring especially with competing demands for implementation dollars, leaving us not knowing whether "build it and they will come" is true and, if so, why. There is a lack of collaborative governance: many divergent views exist about monitoring and restoration; currently, no forum exists to address and resolve those views. We need information centralized and available. Aggregating results in a publicly accessible manner has not occurred, though a structure now exists (www.wrmp.org) that awaits a significant information upload effort.

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Evaluating Restoration Holistically

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In examining the success of tidal wetland habitat restoration, we need to evaluate how well we have restored ecological processes as well as community assembly, rather than basing our evaluations on the mere presence or the lack of detection of target species. Understanding ecological processes and the pace of tidal marsh restoration can help restoration project engineers evaluate the design and implementation of future restoration projects and manage unexpected outcomes of restoration projects in progress. Regulatory agencies need to establish empirical, yet meaningful performance criteria for the purpose of permitting and evaluation. Restoration objectives for tidal marshes are often framed with respect to special-status wildlife, fish, and plant species with relatively narrow requirements for particular habitat structure, habitat dynamics, or specialized sub-habitats. Aligning tidal marsh restoration projects to achieve these requirements is important to justify to the general public major investment of public funds.

These competing objectives provide a challenge to the development of restoration success criteria. We outline a framework for developing restoration performance criteria that considers multiple spatial scales (local project, project complex, regional, and Estuary-wide) and multiple temporal scales. We highlight a basic dilemma: mandated monitoring of restoration projects is generally short-term (less than two decades, often around five years), yet the time course for achieving most important ecological objectives associated with mature marsh community structure is generally long-term (over two decades). We emphasize the importance of biological criteria that reflect restoration of ecological processes and community assembly, rather than the mere presence or the lack of detection of target species. For example, for birds that breed in tidal marsh, desirable criteria include breeding density and achieved reproductive success at restoration sites. Finally, we recognize the need for cost-effective, efficient monitoring programs that can be sustained in the long-term, and the limitations of intensive but short-lived monitoring.

Recent studies of restoring wetland sites indicate the ecological value of intermediate seral stages (transitional states of restoration sites). It is therefore valuable to develop success criteria that focus on evaluating young restoration sites, both to enhance the ecological value of such habitat and to provide early evaluation of restoration practice in a timely fashion, so that corrective steps may be taken. We use recent studies of restored and restoring tidal marshes to illustrate conceptual performance criteria that assess success on short-term and long-term scales and support management decisions regarding all phases of restoration projects. In 2005, for example, young restoration marshes demonstrated similar reproductive success for song sparrows as mature tidal marshes. Young restoration marshes do not appear to be ecological traps.

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TAKE HOME POINTS

- **In evaluating restored marshes from the perspective of plants and animals comparisons should be made with multiple—and the most appropriate—reference sites.**
- **The same parameters must be measured.**
- **Habitat connectivity is important, and taking a regional perspective is vital.**
- **Long-term effort is needed—several years of data collection.**
- **Restoration success should not simply be judged as pass/fail. Asking what kind of success — or what kind of bottleneck prevented success — may be more informative.**
- **Tidal marsh restoration proceeds stage by stage. Monitoring and evaluation should be developed appropriately and include success criteria that focus on important ecological processes for intermediate restoration stages as well as mature sites.**

Fish Advisories and You

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The Office of Environmental Health Hazard Assessment (OEHHA) issues fish consumption advisories for local water bodies in California. Fish advisories are useful as environmental indicators of water quality, but they need to be put in context as a measure of change in the

TAKE HOME POINTS

- **There have been no significant changes in mercury concentrations in fish in the Estuary.**
- **Organic chemical concentrations are declining in the Estuary but not enough to affect consumption guidelines yet.**
- **New chemicals are being found in fish.**
- **Consumption guidelines are still protective of human health.**
- **We need to continue to educate and inform the public about contaminants in fish.**
- **We need to improve the effectiveness of our advisories.**
- **We need to continue to improve conditions in the Estuary.**
- **We need to continue to monitor, expand our efforts geographically, and update our advice with an emphasis on safe eating guidelines.**

San Francisco Estuary. The very first fish advisory in California (1971) was for striped bass in the Bay-Delta and advised fishermen to eat no more than one meal per week of striped bass due to mercury in these fish. That advisory was updated in 1985 (children and pregnant women were advised to consume NO striped bass from the Bay-Delta) and again in 1993, resulting in a 303(d) listing and TMDLs for mercury in the Bay and Delta and PCBs in the Bay. It also resulted in signs being posted around the Bay and communication efforts being increased. In 1994 specific advice was added for fish and shellfish from the Richmond Harbor Channel area based on data for pesticides and other chemicals. Later in 1994, the current advisory was developed using data from a Regional Board study. This advisory was based on mercury and organic contaminants (e.g., PCBs) in fish species from San Francisco Bay, and recommended that adults should eat no more than two meals per month of Bay fish and no striped bass over 35 inches. Women and children under six were advised to eat no more than one meal per month of Bay fish, and no large shark (over 24 inches) or striped bass (over 27 inches). The advisory was amended in 1996 to clarify that the same advice applied to striped bass and sturgeon in the whole Bay-Delta area.

Based on the decreasing meal recommendations it may at first appear that water quality in the Estuary has degraded since 1971. Since advisories, and their underlying data, do impact water management and agencies responsible for water quality through the 303(d) list and Total Maximum Daily Load process, it is important to understand these changes. Evidence indicates that in general concentrations of organic chemicals have decreased and that mercury concentrations in fish have remained about the same. Changes in the advisory are due to improvements in analytical methodology and new studies expanding our understanding of the toxicology of methylmercury and other chemicals.

The primary goal of fish consumption advisories is to provide information to the public so that people can reduce their exposure and risk to contaminants already in the environment, while still enjoying fishing as a natural resource and health benefits from fish consumption. Advisory awareness through outreach activities is a critical ongoing component for public health and safety because processes aimed at reducing chemical concentrations in fish take a long time.

OEHHA is working to move beyond focusing on water bodies with known or suspected contamination problems to identifying water bodies in which one can catch and eat more fish, and developing safe eating guidelines for them. This requires a coordinated California program to monitor a variety of chemical contaminants in fish from the water bodies in which people are catching them. This type of monitoring would provide a statewide baseline for contaminants, help identify emerging risks, and track trends in water quality as indicated by more fish that can be safely eaten from more water bodies.

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Do Contaminants Harm Estuarine Habitat?

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DAVIS BODEGA MARINE LABORATORY

For decades, managers have used chemical analyses and laboratory-based sediment toxicity tests (with standard test species) to predict the effects of contaminants in the Bay. However, the responses of organisms actually living in the Bay are what managers, scientists, and the public care most about. Managers and scientists alike have been frustrated by the lack of consensus on how pollutant effects should be characterized in fish, invertebrates, and plants of the Estuary. It is an opportune time for cooperative investigations that will lead to a solution to this problem.

The Pacific Estuarine Ecosystem Indicator Research (PEEIR) consortium advocates the development of an integrated portfolio of contaminant exposure and effects responses using indicator species selected for various habitat types. We developed a portfolio of techniques for salt marshes that are integrated within fish (mudsucker, *Gillichthys mirabilis*), invertebrate (shore crab, *Pachygrapsus crassipes*), and plant (cordgrass, *Spartina foliosa*, and pickleweed *Salicornia virginica*) indicator species. We performed sediment and tissue chemical analyses and analyzed biomarker responses in these species at five marshes in Northern and Southern California. A comparison to toxicity test responses and benthic population surveys was performed at a more limited number of stations. While the widely used Sediment Quality Triad approach is a useful screening tool, we found that this approach does not predict the range of effects in resident species. Specifically, we noted reproductive impairment in shore crabs and/or ovarian tumors and endocrine disruption in mudsucker fish at two sites where toxicity was either relatively low or nonexistent. We have also developed toxicity identification procedures that can be used to predict what chemicals cause endocrine disruption and other reproductive harm in fish.

Our Resident Species Portfolio approach is a first step in making monitoring of Bay species more practical, and hence minimizing extrapolations inherent in ecological risk assessment of contaminated sediments. Numerous emerging contaminants are being discovered, such as personal care products and flame retardants; techniques are needed to prioritize the contaminants that cause the greatest harm to aquatic life and to help focus regulatory action. Through highly integrated research and improved cooperation between research and management, it will be feasible to create a new paradigm for determining when and how contaminants impair the quality of our estuarine habitat.

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Gillichthys mirabilis

TAKE HOME POINTS

- **Contaminants cause harmful effects on fish and invertebrates—just because certain organisms are present in a marsh does not mean they have not been impacted. The fact that we don't measure contaminants in fish and invertebrates doesn't mean there aren't harmful effects.**
- **We need better knowledge of the effects of contaminants on resident species. We need to start monitoring their health. Such information will aid in regional monitoring and wetland restoration efforts.**
- **Sediment toxicity tests, chemical analysis, and invertebrate surveys are useful but limited tools. There are new methods available to discern contaminant effects in salt marshes.**
- **In the past, large-scale interagency efforts have usually not considered the impact of contaminants on species like the Delta smelt.**
- **We need a new, integrated approach linking ecology and toxicology. Integrated science is powerful and is the wave of the future.**

Linking Bay Health to National Ecosystem Indicators

ANITRA PAWLEY
THE BAY INSTITUTE

In October 2003, The Bay Institute released the first comprehensive report card for San Francisco Bay. The San Francisco Bay Index, part of the Ecological Scorecard project, illustrates a unique approach for interpreting science in clear and powerful public messages. Nearly 40 indicators were chosen based on a conceptual framework that ties condition to anthropogenic stressors. The indicators are aggregated into eight multi-metric indexes that track the Bay's environment (Habitat, Freshwater Inflow, Water Quality), its fish and wildlife (Food Web, Shellfish, Fish), our management of its resources (Stewardship), and its direct value to the people who use it (Fishable-Swimmable-Drinkable). Each index is illustrated by a letter grade, a numeric score that reflects the aggregated results of the component indicators for the most recent data period (e.g., Freshwater Inflow in 2004), and arrows indicating short-term (within the past 5 years) and long-term trends (over the past 20 or more years).

The 2005 update of the Scorecard's Bay Index allows us to reflect on recent changes in the Bay's health and to compare ecological conditions in different regions of the Estuary. In general, long-term downward trends have stabilized or are slowly being reversed for the Indexes that track the health of the Bay's environment. The Habitat, Freshwater Inflow, and Water Quality Indexes all showed some improvement, reflecting our ongoing investments for restoration of shoreline habitats and pollution control, as well as the wetter hydrological conditions in the last two years. In contrast, the Scorecard's measures for the Bay's aquatic biota were decidedly mixed. The condition of the upper Estuary's planktonic food web remained very poor and the Fish Index declined. Only the Shellfish Index improved, reflecting increases in the abundance of crabs and shrimp in the Bay. These biological indicators also tell another important story – the health of the Bay, as measured by the conditions and trends for its biota, varies dramatically along a geographic and environmental continuum in the Estuary. In the lower Estuary, Central and South Bays, indicators for phytoplankton, shrimp populations, and fish all showed fair and generally improving conditions. But in the upper Estuary, San Pablo and Suisun Bays, these same indicators were low and declining.

Indicator development is an iterative process that depends on sound science and sustained support. We now have a report card and framework approach that can serve as a basis for indicator refinement, but its success depends on continued use and refinement as our scientific knowledge evolves. Today, working as a coalition of national (San Francisco Estuary Project) and local entities (The Bay Institute, San Francisco Estuary Institute, Center for Ecosystem Management and Restoration), we continue to refine, augment, and improve upon this concept and approach. For example, the Water Quality Index is being evaluated, refined and expanded upon to become a Contaminant Index that incorporates measures of sediment quality. The Fish Index is being evaluated by a larger team of researchers and improved by adding additional data sources and sub-regional analyses. Wetland quality and bird resources are being evaluated to augment our

TAKE HOME POINTS

- **The San Francisco Bay Index synthesizes the results of nearly three dozen science-based indicators that measure the ecological health of the Estuary. Key to its success and media attention is its simple and easily understood Scorecard. However, the tiered approach for reporting results (2003 and 2005 reports and technical appendices) allows the reader to obtain a deeper view of condition for each attribute and component indicator (see www.bay.org).**

- **Multi-metric indexes and their component indicators, when organized in a consistent framework, can be used to evaluate and summarize ecosystem health across multiple geographic scales. The 2005 Bay Index covered the entire Estuary and, using several individual indicators, also detected and compared the variations in ecological conditions and trends in different regions of the Bay.**

- **Tracking ecosystem health through scientifically derived indicators is essential for long-term economic and political public support for the Bay's environment. Without such communication tools, the San Francisco Bay environmental and research communities will find it increasingly difficult to procure funds for restoration and monitoring in light of a reduction in available monies for environmental issues.**

current list of indicators. Additional indicator development efforts are occurring at the California Bay Delta Authority and at the state level. These efforts will inform and be informed by the "Indicators Consortium;" however, progress in this important work can be slowed by limited resources, data gaps, and political impediments.

Meanwhile, other large-scale ecological restoration programs across the nation, such as the National Estuary Program, are planning and developing suites of ecological indicators or "report cards." While our success is serving as one model for these efforts, it also challenges us to link our efforts to other national indicator frameworks to enable us represent and compare San Francisco Bay health to other large-scale ecosystems. Our involvement in other national level indicator efforts, ongoing research, and synthesis also offers important opportunities to improve the scientific underpinnings of the indicators and multi-metric indexes. Finally, increased visibility through widely supported, easily understood indicators will enhance public understanding of and support for San Francisco Bay conservation and restoration efforts.

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ECO-INDICATORS

An ecological indicator is a measurable characteristic related to the structure, composition, or functioning of an ecosystem.

Indexes are composed of multiple indicators and can be used just like economic indexes to summarize status and trends for a concise public communication tool.

THE SCORECARD'S BAY INDEX, 2005

AREA	GRADE	SUMMARY	SHORT TERM	LONG 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.	◀▶	▼

How Science Is Guiding Restoration of the South Bay Salt Ponds

LYNNE TRULIO
SAN JOSE STATE UNIVERSITY

The Science Program for the South Bay Salt Pond Restoration Project provides direct scientific input into planning for short-term and long-term project actions. The project's Science Team has worked to identify key scientific uncertainties associated with the project and, through technical workshops and focused literature reviews, has collated information on what is known and not known about these questions. Using this information, as well as material developed by the consultant team and stakeholders, the Science Team drafted an Adaptive Management Plan (AMP) for the Project. This draft AMP illustrates how monitoring and applied studies, beginning now in the planning stage, can be used to address uncertainties. The data produced during planning will be applied directly in the design of Phase I, to be implemented beginning in 2008. The draft AMP also describes how adaptive management will be integrated into project implementation to track the project's ecological and social goals and collect data to address key questions. Adaptive management—a cyclic process for learning from management decisions and applying that knowledge as we move forward—will help reduce uncertainty in such areas as mercury, sediment and mudflat dynamics, bird use of changing habitat, invasive and problem species, and benefits to non-avian species. Adaptive management is central to guiding the design and success of the project.

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PROJECT OBJECTIVES

Create, restore, and enhance habitats to:

- **Assist in recovery of special-status species.**
- **Maintain current migratory bird species.**
- **Support increases in native species abundance and diversity.**
- **Maintain or increase flood protection.**
- **Provide for wildlife-compatible public access.**
- **Maintain or improve water and sediment quality.**
- **Maintain or improve invasive or nuisance species management.**

TAKE HOME POINTS

- **The South Bay Salt Pond Restoration Project is ecosystem restoration on a landscape scale—15,100 acres.**
- **It is a long-term restoration project and will be implemented in phases over approximately 50 years. Planning is underway, and implementation of Phase 1 will begin in 2008.**
- **Adaptive management will tell us how far we can go along the way—how much tidal marsh we should restore, taking into account the fact that salt ponds are habitats in their own right.**
- **Adaptive management is not trial and error; it is based on an understanding of the system.**

DRAFT PROJECT ALTERNATIVES AS LANDSCAPE VISIONS