

**Maximizing the
Efficiency and Effectiveness of
Water Quality Data
Collection and Dissemination**

**and Ensuring that Collected Data are Maintained
and Available for Use by Decision-makers and the Public**

**Recommendations of the
California Water Quality Monitoring Council**

submitted to

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Foreword

Senate Bill 1070 (Kehoe, 2006) amended Water Code Section 13181(b) to require that the California Environmental Protection Agency (Cal/EPA) and the Resources Agency enter into a Memorandum of Understanding establishing the California Water Quality Monitoring Council (Monitoring Council) , to be administered by the State Water Resources Control Board. The MOU was signed November 26, 2007. SB 1070 requires that “the monitoring council shall review existing water quality monitoring, assessment, and reporting efforts, and shall recommend specific actions and funding needs necessary to coordinate and enhance those efforts.” The legislation goes on to say, “[t]he recommendations shall be prepared for the ultimate development of a cost-effective, coordinated, integrated, and comprehensive statewide network for collecting and disseminating water quality information and ongoing assessments of the health of the state’s waters and the effectiveness of programs to protect and improve the quality of those waters.” The first Monitoring Council task, as outlined in the legislation, is to report by December 1, 2008 to Cal/EPA and the Resources Agency its recommendations for maximizing the efficiency and effectiveness of existing water quality data collection and dissemination, and for ensuring that collected data are maintained and available for use by decision-makers and the public. This report fulfills this initial Monitoring Council responsibility.

Chapter 1: The Water Quality Data Access Problem

Water is California's most precious resource. It provides an essential lifeline that links agriculture, industry, the environment, and urban and rural interests throughout the state. With a growing population of more than 38 million, a limited supply of fresh water, and a range of impacts on both terrestrial and marine habitats and resources, the protection of water for beneficial uses is of paramount concern for all Californians. This concern is reflected in the numerous monitoring and assessment programs that track the condition of waters and related aquatic resources throughout the state. Conducted by a wide array of local, regional, state, and federal entities, these programs produce a wealth of data and information products that are vital to the public, managers, and scientists involved in water quality issues.

1.1 Water quality data are hard to find and use

Despite the volumes of data produced, the efforts of technical staff in many agencies, and the large amount of funds expended on monitoring, the state's system for providing ready access to these data is not adequate. Managers, scientists, and the public experience a common set of problems when trying to find, access, and use monitoring data and assessment results, including:

- The lack of user-friendly means of finding, accessing, viewing, obtaining, and working with monitoring data and assessment information
- Inconsistency in monitoring objectives and in the methods used to collect and assess data
- Inability to integrate data from different studies due to inconsistencies in the way they are formatted and stored in database systems
- Data gaps resulting from a mismatch between the data collected and the management questions that must be answered

As a result of these problems, the state cannot answer many of the most fundamental water quality questions, such as "Is the quality of the state's waters getting better?". Data from different studies cannot be integrated to produce more comprehensive assessments of condition or to create maps across wider areas. Users cannot search, select, and download subsets of data for more targeted studies. Relatively simple questions regarding the health of California's waters can be difficult to answer. In many cases, the large number of programs, databases, and datasets makes finding specific data types or reports a daunting task. As one example of the limitations the current system creates, Figure 1 presents a statewide picture of impaired water bodies, based on combining 303(d) listing assessment results from each of the nine Regional Water Quality Control Boards. Differences in methodology between Regional Water Boards result in dramatically different estimates of the extent of impairment, even when the underlying data are relatively similar. Such differences in assessment methods are often poorly documented, complicating the task of intelligently combining data from different studies, not just at the statewide scale, but at local and regional scales as well.

1.2 Bottom-up solutions will not work

The problems outlined above are not unique either to California or to water quality data in particular. They are inevitable wherever data from multiple sources, collected for different purposes and with a variety of methods, must be found, accessed, and integrated to create broader assessments or to address complex problems.

Solutions to such data access and integration problems often focus on technical issues such as consistency of methods, standardization of data formats, and development of large databases. These bottom-up approaches are more successful where the number of data types and/or participants is limited, a foundation of relevant technical standards already exists, or the consequences of failed integration are severe. Without these prerequisites, a primary emphasis on technical standardization can become a quagmire, undermined by a concentration on lower-level details that are not necessarily directly connected with users' needs. Such efforts thus run the risk of creating yet another layer of incompatibility (e.g., among competing database systems) without necessarily improving access to data and information products.

1.3 The Monitoring Council's solution to data access

The Monitoring Council believes that, while important, a primary focus on technical tools does not directly address the source of the access problem because it is not driven by end users' perspectives. The Monitoring Council's solution to the data access problem therefore is based on a top-down approach, centered on delivering data to those people who need it in ways that directly meet their highest-priority needs. The essential components of this concept include a template for web-driven, user-oriented data access portals that are developed and implemented by a series of issue-specific workgroups operating under the Monitoring Council's overall guidance and approval.

This process will promote efficiency by highlighting where (and only where) improved standardization of monitoring methods and data management approaches is necessary for meeting users' needs. Developing these standardized methods and approaches will be the responsibility of the issue-specific workgroups, working within general guidelines set by the Monitoring Council.

Chapter 2: The Water Quality Data Access Solution

The Monitoring Council proposes a vision that is centered on a coordinated set of entry points to web portals that would provide ready access to a variety of water quality-related data and assessment information. These portals are organized around themes (Appendix 1) that are framed as easily understood questions (e.g., Is It Safe to Swim In Our Waters?) that enable all users to readily find and then access the specific information in which they are interested. Users are more concerned with having access to data that can answer their questions about water quality than they are about which program(s) created that data. For this reason, the Monitoring Council believes that a system of theme-based web portals that simplifies and streamlines access will provide the structure and incentive to coordinate disparate monitoring programs and improve the technical infrastructure needed to support that coordination (e.g., databases, standardized methods). In addition, the existence of a set of web portals, all based on consistent design principles, will act to reduce conflicts and incompatibilities within the technical infrastructure as it continues to develop. The Monitoring Council's role is thus not redundant with those of existing monitoring programs and data integration efforts. Rather, the Monitoring Council, because of its unique and overarching perspective, is the place where issues of data access, program coordination, and standardization should be dealt with at the broadest level.

2.1 A four-part solution

The Monitoring Council has identified four key elements that are necessary to realize its vision of broader data access through theme-based web portals:

- A single, global point of entry to water quality data, and a design template for the complete set of theme-based web portals
- An organizational structure built on decentralized, issue-specific workgroups that operate within common policies and guidelines defined by the Monitoring Council
- Standardization of monitoring and assessment methods that achieves an appropriate balance between statewide consistency and regional flexibility
- Database and data management standards necessary for data access and integration

These four elements are described further in the following sections.

2.1.1 Broader access through web portals

The Monitoring Council's vision is that each theme or sub-theme (see Appendix 1) would have its own web-based portal providing a single, coordinated access point for data, assessment results, and supporting information. In order for such theme-based web portals to provide simple and straight forward access to water quality monitoring and assessment information, both the portals and the coordinated monitoring programs on which they are based, require certain attributes which can be defined with performance measures. The following six performance measures are adapted from USEPA's 2003 report Elements of a State Water Monitoring and Assessment Program (USEPA 2003):

- **Program strategy, objectives, and designs**

The portal must describe monitoring strategies, objectives, and designs in enough detail that users can make informed decisions about how and for what purposes the data can be used. Assessment questions must reflect the concerns of key audiences and the way data will be used to make decisions. Objectives must be specific enough to connect assessment questions

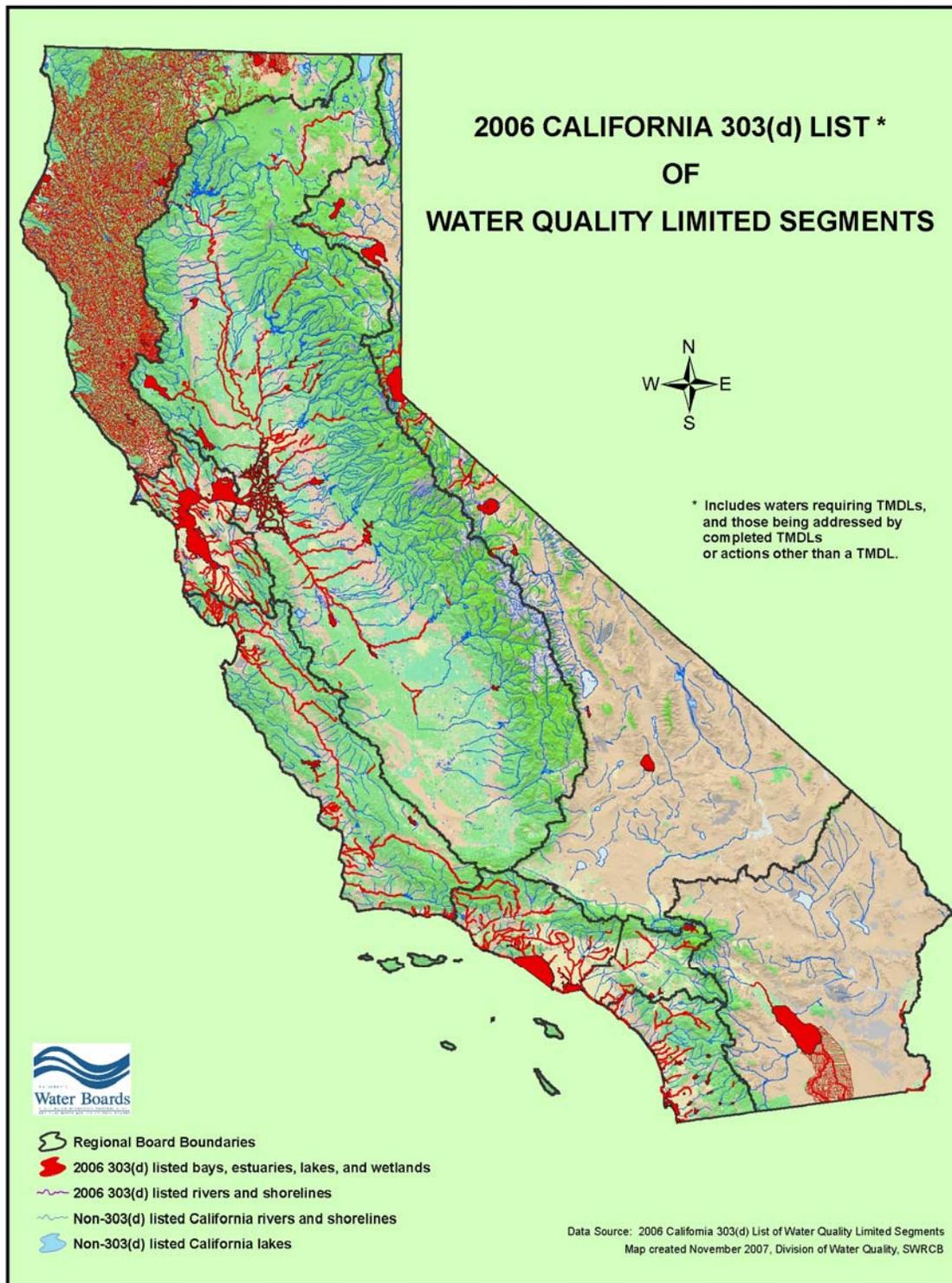


Figure 1. The existing picture of overall water quality in California, based on the set of 2006 303(d)-listed impaired water bodies identified by each Regional Water Quality Control Board. Because of differences in assessment methods, the implication is that the northwest portion of the state has the worst water quality in the state. However, this stems from the fact that the North Coast Region lists entire watersheds as impaired, while other Regional Water Quality Control Boards list smaller, individual water body segments.

to the operational details of monitoring designs. Program objectives and designs must be evaluated to ensure that monitoring data effectively answer the underlying strategic questions.

- **Indicators and methods**

The portal must describe indicators and methods in detail sufficient to inform users about the extent of standardization and any constraints on combining data from different programs. Indicators, sampling and analysis methods, and quality assurance benchmarks must be standardized and maintained at a scale (at least regional and preferably statewide) that is extensive enough to allow data from multiple studies to be combined to produce meaningful broader-based assessments.

- **Data management**

The portal must be based on distributed database systems that support extensive data integration and access, and all data must be processed according to clearly specified and broadly applied data management procedures. National and/or statewide data formatting standards should take clear precedence over new/developing, regional or local standards.

- **Consistency of assessment endpoints**

The portal must describe the assessment methods used to convert raw monitoring data into information on the condition of California's water resources and their beneficial uses. Assessment methods must be standardized to the greatest extent possible in order to support consistent statewide assessments. Where multiple assessment approaches are called for, the portal should explain the need for multiple methods and provide a means of integrating the separate results to create broader assessments.

- **Reporting**

The portal must support timely and consistent reporting of monitoring data and assessment results, along with the metadata needed to demonstrate adherence to standards and to ensure data are used wisely. Reports must be produced at a range of time scales appropriate to the concerns of managers, the public, and other audiences. In addition to formal reports prepared by monitoring and assessment programs, users have also come to expect the ability to prepare customized, or ad hoc, reports using interactive tools to query online databases.

- **Program sustainability**

Portals, and the programs they serve, must have the resources to actively participate in efforts such as methods development workgroups, laboratory intercalibration studies, and research and development into improved assessment methods. In addition, effective portals require investment in information technology infrastructure that improves users' capabilities to access, obtain, subset and/or combine, and work with a variety of monitoring data. This in turn depends on the allocation of staff and funding on a more permanent basis than is typical for many monitoring and assessment programs and the agencies and organizations that manage them.

2.1.2 A single, global point of entry

This system of theme-based web portals will be accessed through a single, global point of entry to all water quality monitoring and assessment information. A working test version of this website has been developed (Figure 2), designed around intuitively clear questions that are readily understood by managers, the public, and scientists:

- Is our water safe to drink?
- Is it safe to swim in our waters?

- Is it safe to eat fish and shellfish from our waters?
- Are our aquatic ecosystems healthy?
- What stressors and processes affect our water quality?

Each question will lead to a series of web pages for each theme (see Figure 3 for the draft page for swimming safety) that provide map-based access to summary assessment products and more detailed monitoring data, as well as tools for downloading data and conducting ad hoc queries and analyses. Links along the left-hand side of each page will enable users to access management, regulatory, and technical information specific to each theme. In the draft swimming safety portal (Figure 3), additional pages addressing more detailed questions link to

The screenshot shows the homepage of the California Water Quality Monitoring Council. At the top, there is a green header with the state logo (CA.GOV), the text "State of California ENVIRONMENTAL PROTECTION AGENCY RESOURCES AGENCY", and "CALIFORNIA WATER QUALITY MONITORING COUNCIL". A search bar is on the right. Below the header is a navigation menu with buttons for "Home", "Safe to Drink", "Safe to Swim", "Safe to Eat Fish", "Ecologic Health", and "Stressors & Processes". A green banner below the menu reads "My Water Quality - hosted by the Surface Water Ambient Monitoring Program (SWAMP) |".

The main content area is titled "Welcome to My Water Quality". It includes a sidebar on the left for "GOVERNOR SCHWARZENEGGER" with a "Visit his Website" link and a list of navigation links: "Ca/EPA", "The Resources Agency", "About the California Water Quality Monitoring Council", "State & Regional Water Boards", "Web Portal Partners", "Monitoring Programs, Data Sources & Reports", "Water Quality Standards, Plans and Policies", "Regulatory Activities", "Enforcement Actions", "Research", "About SWAMP", and "SWAMP Tools".

The main content area features several topic-based sections, each with an image and a brief description:

- IS OUR WATER SAFE TO DRINK?**: Safe drinking water depends on a variety of chemical and biological factors regulated by a number of local, state, and federal agencies. [More >>](#)
- IS IT SAFE TO SWIM IN OUR WATERS?**: Swimming safety of our waters is linked to the levels of pathogens that have the potential to cause disease. [More >>](#)
- IS IT SAFE TO EAT FISH AND SHELLFISH FROM OUR WATERS?**: Aquatic organisms are able to accumulate certain pollutants from the water in which they live, sometimes reaching levels that could harm consumers. [More>>](#)
- ARE OUR AQUATIC ECOSYSTEMS HEALTHY?**: The health of fish and other aquatic organisms and communities depends on the chemical, physical, and biological quality of the waters in which they live. [More>>](#)
- WHAT STRESSORS AND PROCESSES AFFECT OUR WATER QUALITY?**: Beneficial uses of our waters are affected by emerging contaminants, invasive species, trash, global warming, acidification, pollutant loads, and flow. [More>>](#)

At the bottom of the page, there is a green footer with the text "Back to Top | Help | Contact Us | Site Map".

Figure 2. Draft Monitoring Council homepage, designed as a global entry point to monitoring and assessment information for all theme and sub-theme web portals.

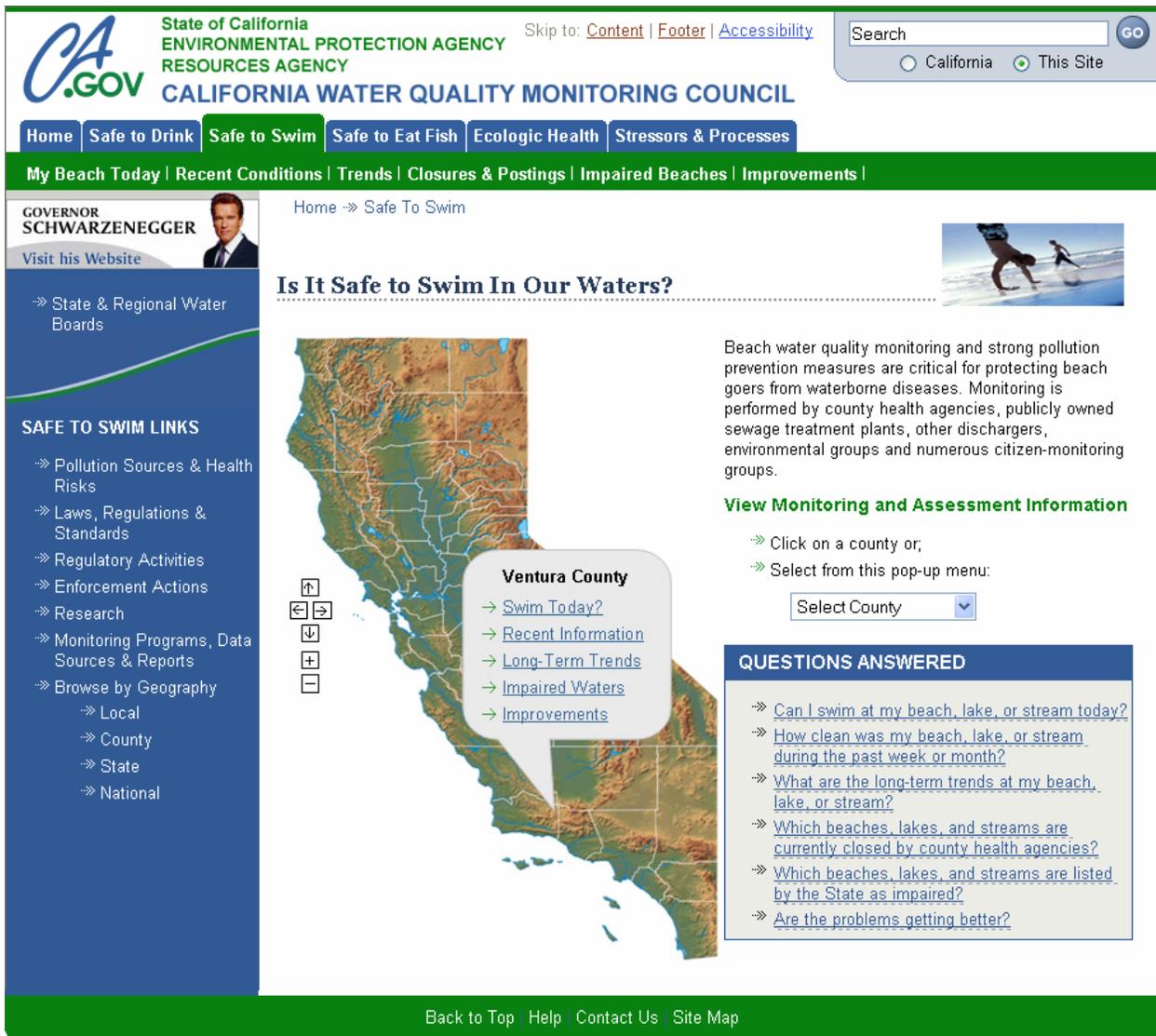


Figure 3. Draft Monitoring Council page for the theme “Is it safe to swim in our waters?”

websites maintained by a variety of entities, including the State Water Board, USEPA, and Heal the Bay. Being connected together through a single portal will provide both incentive and a mechanism for achieving greater standardization among related programs (as described below, Section 2.1.4).

2.1.3 A flexible organizational structure

The Monitoring Council proposes establishing an organizational structure based on theme-specific workgroups operating within common policies and guidelines established by the Monitoring Council. These workgroups should be staffed by issue experts representing key stakeholders and report periodically to the Monitoring Council, with the Monitoring Council acting as a clearinghouse for standards, guidelines, and collaboration. Workgroups would develop both the web portal devoted to their theme or sub-theme as well as underlying

monitoring and assessment methods and data management procedures, using the six performance measures described in Section 2.1.1 as performance measures. Workgroups would also be responsible for coordinating existing monitoring programs and achieving the standardization necessary to meet users' needs (see Section 2.1.4).

The California Wetlands Monitoring Workgroup has become the first such workgroup, formalizing its relationship with the Monitoring Council and bringing its monitoring design and web portal development efforts under the Council's overall review and guidance (see Section 2.2 for more detail). The Monitoring Council anticipates similar arrangements will be made with the additional high-priority themes described in Section 2.2. This organizational approach provides complementary benefits for all involved. For the Monitoring Council, workgroups provide increased leverage, specific scientific, management, and user expertise, established networks of relationships, and access to funding that it would be difficult for the Monitoring Council itself to duplicate. For workgroups, association with the Monitoring Council provides broader visibility, easier access to statewide information management infrastructure, assistance in developing technical monitoring and assessment tools, compliance with broader statewide guidelines for data access, and assistance in achieving compliance with new monitoring and data management standards (see Section 2.1.4 below).

For the workgroups to be effective in fostering and maintaining the integration of local and regional monitoring and assessment efforts, the entities responsible for those efforts must feel that they receive something of value in return. Given the limitations and instability in the budgets for state and federal monitoring programs, local and regional monitoring programs must be relied upon to provide additional baseline and broad-based monitoring data and to adhere to the standards necessary for the integration of those data and assessments. In return, the workgroup provides support and expertise to local monitoring and assessment efforts, including training, data management, and other tools. In this way, regional and statewide assessments of the health of our water resources will be made possible.

2.1.4 Standardization of core program elements

Lack of standardization is clearly one of the primary causes of many of the problems users experience with data access and integration. An important role for the Monitoring Council is therefore to help develop, promote, and implement statewide standardization of monitoring methods, assessment approaches, quality assurance protocols, and data formats. However, not every aspect of every monitoring program requires statewide standardization, and attempting to achieve such universal standardization would be inefficient and lead to resistance and rigidity. The Monitoring Council will therefore work with each individual workgroup to identify those core program elements that require statewide standardization in order to support comprehensive assessments, and those that can vary regionally based on local needs. Standards, particularly those related to quality assurance, may need to include multiple tiers to accommodate different levels of quality appropriate to different assessment needs. A tiered quality assurance approach has been proposed by the statewide Surface Water Ambient Monitoring Program (SWAMP) to allow standardization across a broad range of water quality projects.

The Monitoring Council will adopt three complementary approaches to ensure that standards are adopted and applied as envisioned: voluntary adoption, permit/grant/contract requirements, and legislation. Voluntary adoption can be achieved in some instances either in return for technical and programmatic assistance, or because the proposed standards provide clear benefits compared to current practice. In other cases, the Monitoring Council would recommend that the Secretaries of the Cal/EPA, Resources, and other agencies direct individual boards and

departments to adopt appropriate standards and to include requirements to implement those standards in the monitoring programs associated with NPDES and other permits, grant agreements and contracts over which it has authority. Where such approaches are not available, or are not effective, the Monitoring Council would pursue a legislative solution.

2.1.5 Improved data management

The Monitoring Council's goal is to foster centralized access to data (through theme-based web portals), increased comparability within and between data types, and the development of tools to improve data integration. This will require formal data management standards and protocols, combined with appropriate databases and other information technology infrastructure, all coordinated to reflect a common philosophy and purpose. The Monitoring Council is aware of the substantial challenges that stem from the large number of data sources, data types, and users, all with valid, and sometimes wide, differences in needs related to accuracy, precision, timeliness, and levels of quality assurance.

While theme based web portals allow for a single global point of entry to water quality data, the Monitoring Council is aware that centralizing all data in one or a few locations is infeasible and that attempting to do so would be a recipe for failure. The Monitoring Council therefore proposes identifying *regional access points* through data centers and distributed networks such as the California Environmental Data Exchange Network (CEDEN) and cataloging monitoring metadata using systems such as the California Environmental Resources Evaluation System (CERES). The pieces for a statewide data access and integration infrastructure are available, primarily in systems established by Cal/EPA, the Resources Agency, and USEPA (see Appendix 3 for additional detail), but they must be knit into a coordinated whole, rather than serving separate constituencies as they now do.

Data centers have an important role to play in promulgating formatting, quality assurance, and metadata standards, and there are a number of existing data standards that provide a useful starting point for this effort. In applying such standards in any particular instance, the Monitoring Council believes that data management protocols and data formats should be standardized at the highest level possible, with first priority given to federal data standards, the next to statewide standards, and the third priority to regional standards.

2.2 First steps

In order to assess the scope of the data access problem, and to determine a logical starting point for its efforts, the Monitoring Council assessed the current state of data access and integration across the state for each of the themes and sub-themes listed in Appendix 1. Using the six performance measures in Section 2.1.1 as performance criteria, the Monitoring Council developed an overall rating of the current status for each theme, supported by detailed fact sheets (see Appendix 2 for summary ratings and fact sheets). This review showed that, while only one theme (the surface water sub-theme in the "Is Our Water Safe To Drink?" theme) rated High on all six criteria, there are a number of sub-themes that rated at least Medium on all criteria. This provides support for the Monitoring Council's optimism that there is a productive starting point for undertaking the efforts needed to achieve SB 1070's goals. However, some themes rated Low on most or all criteria. This, combined with the sheer volume of programs, monitoring designs, and data, emphasizes the amount of sustained and coordinated effort needed to improve access to useful data and information products across all themes and sub-themes.

The Monitoring Council prioritized the themes for immediate action, using as criteria the level of concern to the public and managers, the results of the evaluation in Appendix 2, and the presence of attractive opportunities (i.e., low-hanging fruit) that would demonstrate the feasibility and utility of the theme-based web portal approach and the institutional structure the Monitoring Council proposes to support such efforts. The results of this prioritization exercise (see Appendix 4) identified four specific opportunities the Monitoring Council will focus in the immediate future:

- The groundwater sub-theme in the “Is our water safe to drink?” theme
- The sportfish sub-theme in the “Is it safe to eat fish and shellfish from our waters?” theme
- The coastal beaches, bays, and estuaries in the “Is it safe to swim in our waters?” theme
- The wetlands sub-theme in the “Are our aquatic ecosystems healthy?” theme

In addition, the State Water Board’s Surface Water Ambient Monitoring Program (SWAMP) has been defining comparability standards for water quality monitoring since 2003, including:

- A statewide status and trends assessment framework
- Leveraged partnerships with regional monitoring programs
- Sets of assessment thresholds, indicators, quality assurance and data management tools that foster data comparability

For this reason, access to SWAMP projects, products and tools will also be accessible via the Monitoring Council’s global entry website.

In each of the above cases, substantial progress toward achieving statewide standardization of monitoring and assessment methods, combined with the presence of existing workgroups and active interest in the web portal concept, make these the most promising near-term opportunities.

For each theme or sub-theme, the Monitoring Council will follow the same general approach:

1. Establish or foster the continued efforts of a collaborative workgroup of involved stakeholders, both in and out of state government agencies
2. Evaluate current systems and programs in terms of the portal and underlying monitoring and assessment program performance measures established by the Monitoring Council
3. Define elements to be standardized at statewide vs. regional scales
4. Define a common data infrastructure that permits examination of data across a variety of space and time scales
5. Develop detailed workplan to address shortcomings in each of the six performance measures

Detailed theme-by-theme actions are presented in Appendix 6. While each targeted sub-theme will require a somewhat different approach, depending on the technical and management issues involved, the proposal recently submitted to the State Water Board by the wetlands workgroup (see Appendix 5) is illustrative of the type of detail that would need to be developed. As one example of the way the Monitoring Council’s role would promote statewide consistency, the Monitoring Council recommends that the regional homepages described in the wetlands

proposal be replaced by, embedded within, or accessed through the sort of single, global entry point represented in the draft website shown in Figures 2 and 3.

An additional workgroup will also need to be formed to carry out the day to day management of the global entry web site and underlying data management infrastructure. A users group already exists for the SWAMP data centers and CEDEN. This group can be expanded to include additional partners. Once formed, the workgroup can assist the Monitoring Council and its recommendations can be promoted and standardized through the Monitoring Council.

2.3 A ten-year plan

This report represents the initial recommendations of the Monitoring Council, pursuant to California Water Code Section 13181(b). However, this is just the beginning. Water Code Section 13181(e) requires the State Water Board to develop, in coordination with the Monitoring Council, "a comprehensive monitoring program strategy that utilizes and expands upon the state's existing statewide, regional, and other monitoring capabilities and describes how the state will develop an integrated monitoring program that will serve all of the state's water quality monitoring needs and address all of the state's waters over time." The strategy is to be completed within a 10 year timeframe and must be comprehensive in scope and must identify specific technical, integration, and resource needs. Included in this strategy are a number of additional requirements:

- Water quality protection indicators that provide a basic minimum understanding of the health of the state's waters
- Quality management plans and quality assurance plans that ensure the validity and utility of the data collected
- Methodology for compiling, analyzing, and integrating readily available information acquired from regulated discharges, volunteer monitoring groups, local, state, and federal agencies, and recipients of state or federal funding for water quality improvement or restoration projects
- An accessible and user-friendly electronic data system with timely data entry and ready public access via the Internet, including geographic location information
- Production of timely and complete water quality reports and lists required under the Clean Water Act and the Beaches Environmental Assessment and Coastal Health Act of 2000
- An update of the State Water Board's SWAMP needs assessment that acknowledges the benefits of increased coordination and integration of information from other agencies and information sources

It is clear that the work of the Monitoring Council is not over. There is much yet to be done. And the recommendations of this report provide a foundation on which these future efforts can be built.

For this reason, the Monitoring Council urges that Cal/EPA and the Resources Agency accepts its initial recommendations and that the Monitoring Council continue in operation to oversee the implementation of the recommendations contained in this report and the development of the comprehensive integrated water quality monitoring program strategy outlined in the legislation. Developing the technical, organizational, and financial infrastructure needed to ensure the long-term sustainability of the Monitoring Council's standardization and data access efforts will be a

considerable task, requiring dedicated resources for planning, staffing, development, and maintenance.

2.3.1 Resources

Funding will be needed to implement the Monitoring Council's vision and for ensuring the sustainability of a comprehensive integrated water quality monitoring program for California. Acquisition of funding should be approached in a phased manner. Funds may be redirected or leveraged from existing monitoring efforts by eliminating redundancy or creating tradeoffs (e.g., reduce project or discharge monitoring to enhance regional assessments, as was done in the Southern California Bight program). Funding may be available through the National Water Quality Monitoring Council, federal agencies, foundations and other sources. The Monitoring Council will develop specific recommendations for funding, based on costs to achieve early theme development efforts.

Baseline funding will be needed for the development and maintenance of data centers, exchange networks, and other components of the data management systems. Initial funding for this effort has come from the State Water Board's SWAMP program, including \$500,000 annually for the establishment of four data centers and CEDEN. On December 2nd, the State Water Board will consider whether to provide up to \$4 million over three years to fund the four data centers and CEDEN. During this three year period, the data centers will determine a use fee that will allow the centers to be sustainable.

The user-driven theme-based water quality web portal concept, backed by the data centers and exchange networks such as CEDEN, involves establishing services that allow a variety of databases and users to "talk" to each other seamlessly, a difficult and time consuming operation. Developing and maintaining these systems over time will take significant resources (time, money, and expertise). Effectively integrating systems will require a significant commitment from the state.

Chapter 3: Recommendations and Next Steps

In summary, the California Water Quality Monitoring Council recommends the following actions to maximize the efficiency and effectiveness of existing water quality data collection and dissemination and to ensure that collected data are maintained and available for use by decision-makers and the public:

1. Create a system of web-based, user-oriented, data access portals to California's water quality monitoring and assessment information, developed and implemented by a series of decentralized, issue-specific workgroups operating under the Monitoring Council's overall guidance and approval
2. Portals are to be organized around themes that are framed as easily understood questions that deliver data to those people who need it in ways that directly meet their highest-priority needs, including
 - a. A map-based interface
 - b. Data and assessment information at a variety of space and time scales
 - c. Ad hoc data query and analysis tools
 - d. Ability to download raw data
3. A website that provides a single, coordinated, global point of entry to water quality data, assessment results, and supporting information and that provides a design template for the complete set of theme-based web portals; this will provide both incentive and a mechanism for achieving greater standardization among related programs
4. Monitoring and assessment information is managed through distributed, but federated, systems of databases and data centers linked through data exchange networks to centralized web portal access points
5. The portals and their underlying monitoring and assessment programs be developed and enhanced by the theme-based workgroups to achieve high scores in all of the following six attributes:
 - a. Program strategy, objectives, and designs that support informed decisions
 - b. Consistent and fully described indicators and methods
 - c. Integrated but distributed data management
 - d. Consistent assessment endpoints
 - e. Timely and complete reporting with multiple levels of access
 - f. Program sustainability with resources that support sharing of data and assessments beyond the scope of individual projects and programs
6. Standardization of monitoring and assessment and data management methods to increase comparability within and between data types and the development of tools to improve data integration that achieve an appropriate balance between statewide consistency and regional flexibility
7. Foster cooperative relationships between the Monitoring Council, theme-based workgroups, and regional and local monitoring programs through the exchange of training, support and tools in return for enhanced development and access to monitoring data that can be used for baseline and broad-scale assessments

8. Developing recommendations for long-term-sustainable funding mechanisms to support the above efforts, the ongoing work of the Monitoring Council, and the theme-based workgroups

In these ways, the Monitoring Council intends to provide the structure and incentives to coordinate disparate monitoring programs and to improve the technical infrastructure needed to support that coordination. The Monitoring Council is the place where issues of data access, program coordination, and methods standardization should be dealt with at the broadest levels. Detailed coordination, standardization and implementation will be provided by each theme-based workgroup.

For these goals to be achieved, the Monitoring Council must continue its efforts. Near term Monitoring Council actions include:

1. Working with initially identified workgroups, including the Wetlands Monitoring Workgroup, to implement the measures identified above
2. Conducting outreach to additional local, regional, state and federal agencies, non-government organizations, and other entities that are responsible for existing monitoring and assessment efforts
3. Coordinating the formation of stakeholder-based workgroups to support each theme or sub-theme

In the longer term, the Monitoring Council will develop recommendations for the full-range of issues necessary for California to achieve a comprehensive water quality monitoring program strategy from which the state is able to develop an overall picture of the health of the state's waters, establish priorities, evaluate the effectiveness of programs and activities to protect and improve water quality, report on its accomplishments, and to provided all of this information to its citizens.

Appendix 1: Major Themes and Subthemes

Major themes and subthemes relevant to water quality monitoring in California. Themes are presented as a series of questions that reflect the major concerns of managers, the public, and scientists.

- Is our water safe to drink?
 - Surface water
 - Groundwater (including wells)
 - Water at the tap
- Is it safe to eat fish and shellfish from our waters?
 - Sportfish
 - Shellfish
- Is it safe to swim in our waters?
 - Freshwater
 - Beaches, bays, and estuaries
- Are our aquatic ecosystems healthy?
 - Wadeable streams
 - Rivers
 - Lakes
 - Coastal waters
 - Shallow marine reefs
 - Intertidal
 - Subtidal benthos
 - Enclosed bays and estuaries
 - Wetlands
 - Fisheries
 - Anadromous fish
 - Freshwater fish
 - Marine fish
 - Invasive species
 - Harmful algal blooms
- What stressors and processes affect our water quality?
 - Loadings
 - Flows
 - Levels of contamination
 - Water
 - Freshwater
 - Marine
 - Sediment
 - Freshwater
 - Marine
 - Aquatic life
 - Freshwater
 - Marine
 - Landscape maps
 - Measures of climate change
 - Ocean acidification

Appendix 2: Theme-by-Theme Evaluations

Though effective portals have been developed for some of the themes and subthemes listed in Appendix 1, there are many others for which standardized monitoring and assessment programs, accessible through web-based portals, have not yet been developed. The evaluation presented here (with supporting detail in the fact sheets below) assesses the current status, for each theme and subtheme, of the extent to which they meet the criteria for effective portals described above. By identifying specific shortcomings for each theme and subtheme, this assessment provides a basis for establishing the detailed implementation priorities and plans outlined in Appendix 6.

The evaluation framework described in Table A2.1 establishes benchmarks, or performance measures, for the six attributes described in the body of the report.

Table A2.1. Criteria and rating benchmarks for the evaluation of current theme-based portals.

Evaluation criteria	Rating benchmarks / performance measures
Strategy, objectives, design	<p>Low: No core questions; no, or many undifferentiated, target audiences; poorly articulated or conflicting objectives; uncoordinated monitoring efforts not focused on questions or objectives</p> <p>Medium: Core questions and target audiences implicit in program design; objectives implicit but only partly standardized and not directly used to structure design effort</p> <p>High: Core questions standardized, clearly stated, and focused on specific audience(s); clearly stated and common objectives address standardized core questions and inform all aspects of design</p>
Indicators and methods	<p>Low: Indicators and methods uncoordinated, not validated; no QA procedures or plan</p> <p>Medium: Indicators and methods validated but not standardized statewide; QA procedures exist but are poorly matched to objectives and not standardized statewide</p> <p>High: Standardized, scientifically validated, and clearly documented indicators, methods, and QA procedures that match monitoring objectives</p>
Data management	<p>Low: No data management procedures or documentation</p> <p>Medium: Data management procedures exist but are not standardized statewide and only poorly support access to data</p> <p>High: Standardized and clearly documented data management procedures are standardized statewide and fully support access to data at multiple levels</p>
Consistency of assessment endpoints	<p>Low: No data analysis or assessment procedures used or documented</p> <p>Medium: Data analyzed but methods not standardized; assessment tools exist but not fully validated or</p>

Evaluation criteria	Rating benchmarks / performance measures
	standardized High: Data analysis methods and assessment tools fully validated, clearly documented, and standardized statewide
Reporting	Low: No reporting process or products Medium: Intermittent reports, available with some effort High: Readily available regular reports focused on core questions and objectives; ability to create user reports from multiple perspectives
Program sustainability	Low: No systematic program evaluation, planning, or long-term funding devoted to infrastructure needs related to standardization and data integration Medium: Intermittent internal program review and planning that may or may not include infrastructure needs; limited funding for infrastructure High: Regular external program evaluations and planning for all program needs

Table A2.2 presents an overall summary of how each theme and subtheme rates on the six evaluation criteria in Table A2.1, focusing primarily on the major statewide and/or regional programs that provide a basis for overall statewide assessments of condition. This systematic and global evaluation enables the status of all themes to be compared in relation to a consistent standard. This will help identify major redundancies and gaps in the current system of monitoring programs and portals, as well as help determine how close to or far from ideal the major themes and subthemes are. These ratings also provide a structure for developing the implementation plan in Chapter 3, i.e., defining what must be done to bring all ratings up to “high”.

There are several important insights to be gained from Table A2.2. First, there is a tremendous diversity of issues and related data types across the themes and subthemes, which serves to highlight the challenges involved in developing a comprehensive strategy that adequately addresses all data types. Second, there is an equivalent diversity in the ratings for themes and subthemes. While only one theme (the surface water subtheme in the Is our water safe to drink? theme) rated High on all six criteria, there are a number of subthemes that rated at least Medium on all criteria. This provides support for the Council’s optimism that there is a productive starting point for undertaking the efforts needed to achieve the Statute’s goals. Third, some themes rated Low on most or all criteria. This, combined with the sheer volume of programs, monitoring designs, and data, emphasizes the amount of sustained and coordinated effort needed to improve access to useful data and information products across all themes and subthemes.

Table A2.2. Summary ratings for each theme-based portal on each of the evaluation criteria. Evaluations apply to the entire theme / subtheme, not to individual programs or current websites. Supporting information is available in Appendix 1. Note that the evaluation of each theme and subtheme is matched with a set of specific implementation actions that are detailed in Appendix 2.

Theme-based portals	Strategy, objectives, design	Indicators and methods	Data management	Assessment endpoints	Reporting	Sustainability
<i>Is our water safe to drink?</i>						
Surface water	High	High	High	High	High	High
Groundwater	High	Medium	Medium	High	Medium	Medium
Water at the tap	Low	Low	Low	Medium	Low	Low
<i>Is it safe to eat fish and shellfish from our waters?</i>						
Sportfish	Medium	High	Medium	High	Medium	Low
Shellfish	High	High	Medium	High	High	Low
<i>Is it safe to swim in our waters?</i>						
Freshwater	Low	Medium	Low	Low	Low	Low
Beaches, bays, and estuaries	High	High	High	High	High	Low
<i>Are our aquatic ecosystems healthy?</i>						
Wadeable streams	High	High	Medium	High	Medium	Medium
Rivers	Low	Low	Medium	Low	Low	Low
Lakes	Low	Low	Low	Low	Low	Low
Coastal waters						
Shallow marine reefs	High	Medium	Medium	Medium	Medium	Low
Intertidal	High	Medium	Medium	Medium	High	Low
Subtidal benthos	High	High	Medium	Medium	Medium	High
Enclosed bays and estuaries	Medium	Medium	Medium	Medium	Medium	Medium
Wetlands	Medium	Medium	Medium	High	Medium	Medium
Fisheries						
Anadromous fish	Medium	Medium	Medium	Medium	High	Low
Freshwater fish	Low	Low	Low	Low	Low	Low
Marine fish						
Invasive species	High	Medium	Medium	Medium	Medium	Low
Harmful algal blooms	High	High	Medium	High	High	Low
<i>What stressors and processes affect our water quality?</i>						

Theme-based portals	Strategy, objectives, design	Indicators and methods	Data management	Assessment endpoints	Reporting	Sustainability
Loadings	Medium	Medium	Medium	Medium	Medium	Medium
Flows	Medium	Medium	High	High	High	Low
Levels of contamination						
Water						
Freshwater	Medium	Medium	Medium	Low	Low	High
Marine	Medium	Medium	Medium	Medium	Medium	Medium
Sediment						
Freshwater	Low	Low	Low	Low	Low	Low
Marine	Medium	Medium	Medium	Medium	Medium	Medium
Aquatic life						
Freshwater	TBD	TBD	TBD	TBD	TBD	TBD
Marine	High	High	Low	Medium	Low	Low
Landscape maps	NA	NA	NA	NA	NA	NA
Measures of climate change	High	NA	NA	Medium	High	Low
Ocean acidification	Low	Low	Low	Low	Low	Low

The following fact sheets for each theme and subtheme are intended to furnish background information that supports the summary ratings in Table 3 and also provide a starting point for the implementation plan presented in Appendix 6. Fact sheets are organized according to the following template:

- Title
- Website(s) (if applicable)
- Sponsor(s)
- Brief description, including purpose
- Agencies contributing data
- Evaluation in terms of the six criteria
- Additional monitoring programs that could be relevant

The evaluations focus primarily on the major statewide and/or regional programs that provide a basis for overall statewide assessments of condition. Additional programs that are more restricted in scope are simply listed, as secondary targets for subsequent phases of evaluation, standardization, and integration efforts in the implementation plan. Finally, any monitoring program that measures a constituent related to a theme or subtheme produces data that are potentially useful in assessment. However, these programs are so numerous, diverse, and, for the most part, restricted in spatial scope, that we have not included this larger set of monitoring programs in the following evaluation.

Drinking water safety

Drinking water safety is a concern for all bodies of freshwater, both surface water and groundwater, that may be sources of drinking water. Risks to human health are managed by state and local standards for permissible levels of certain contaminants. Surface water quality is monitored Statewide by the USGS National Water Quality Assessment program, as well as by a large number of NPDES and regional assessment programs. Groundwater quality, including wells, is monitored and tracked by the State Water Board's GAMA and GeoTracker programs. Drinking water systems that supply water to the tap are managed and monitored according to requirements set by the Department of Public Health's Drinking Water Program and Drinking Water Source Assessment and Protection Program.

Surface water

Website: NAWQA – <http://ca.water.usgs.gov/nawqa.html>; DWR State Water Project (SWP) – <http://www.womwq.water.ca.gov/GrabSamplePage/index.cfm>; CIWQS – <http://www.swrcb.ca.gov/ciwqs/>

Sponsor: NAWQA – US Geological Survey; SWP – DWR; CIWQS – State and Regional Water Boards

Description: Surface waters are monitored by an integrated, statewide monitoring program designed and implemented by USGS as part of its National Water Quality Assessment Program (NAWQA). NAWQA in California focuses on the Sacramento, San Joaquin, and Santa Ana river watersheds. NAWQA was initiated in 1991 to assess the status of and trends in the quality of freshwater streams and aquifers, and to provide a sound understanding of the natural and human factors that affect the quality of these resources. The Department of Water Resources also monitors chemical water quality monthly at 40 stations along the State Water Project. In addition, surface water quality, including for drinking water beneficial uses, is monitored throughout the state under the terms of individual NPDES permits for permitted discharges. These NPDES monitoring programs are typically completely independent and uncoordinated,

although they submit raw monitoring data, as well as assessment information on permit compliance, to the California Integrated Water Quality System (CIWQS) statewide database.

Evaluation:

1. Strategy, objectives, design: Both the USGS and SWP programs ask and answer clear questions, with specific audiences in mind. However, the objectives of the USGS program are also defined at a range of scales, from nationwide to basin-level, all related to the basic purpose of tracking patterns and trends in water quality. Designs for both the USGS and SWP are clearly defined, although the USGS design is also nested within nationally and regionally standardized frameworks. NPDES programs that address the drinking water beneficial use are site-specific and generally not standardized or coordinated regionally or statewide

Score: High

2. Indicators and methods: Indicators for the USGS program are well developed and standardized nationally and regionally. Quality assurance is a centrally important feature of all USGS programs, with formal procedures established and documented by the National Water Quality Laboratory. Additional, study-specific quality assurance issues are addressed in the methods section of each assessment report. Indicators and quality assurance methods for the SWP program are standardized statewide and well documented on the program's website. Indicators and quality assurance methods for NPDES programs are site-specific and generally not standardized or coordinated regionally or statewide

Score: High

3. Data management: Data management procedures for the USGS program are well established, standardized nationwide, and clearly documented. Data are housed in readily accessible databases and can be searched and downloaded from a variety of perspectives, including by drop-down lists of locations and data types, or through map-based interactive interfaces. The program's website has clear instructions and tutorials for public access and to provide data downloads to a variety of formats, including GIS. Data from the SWP are available for download only in tabular form and for individual months. NPDES permitted dischargers submit permit-mandated monitoring data and compliance assessments directly to the California Integrated Water Quality System (CIWQS) via Electronic Self Monitoring Reports (ESMR2). Data formats are standardized statewide and CIWQS provides a variety of query and data download functions.

Score: High

4. Consistency of assessment methods: A variety of analysis and assessment approaches are used by the USGS program to address questions at the national, regional, and basin-specific levels. These approaches are subject to both internal and external peer review. NPDES permitted dischargers provide compliance information to CIWQS in standardized formats; however the monitoring and compliance provisions of individual permits are site-specific and generally not standardized or coordinated regionally or statewide

Score: High

5. Reporting: USGS assessment reports are the primary vehicle for disseminating program results and are readily available on the program's website. These cover a wide range of topics related to water quality and the processes affecting it. However, there are no interactive features in these reports to enable users to focus on a specific area or directly obtain the underlying data through a link to the database. CIWQS provides a number of assessment reports with interactive ad hoc query tools that permit users to define the scope of each report and download the report. CIWQS is creating additional reports as prioritized by stakeholder working groups.

Score: High

6. Program sustainability: The USGS program does not undergo a formal external review, but its methods, designs, assessment approaches, and products are continually reviewed and commented on by peer reviewers, partners, and customers. In addition, year-to-year and longer-range planning occurs at the national and regional levels within USGS. This planning includes staffing and infrastructure needs, but is subject to the uncertainties of the federal budget process. CIWQS has developed a formal business plan that includes funding and staffing requirements.

Score: High

Additional monitoring programs: Other surface water programs that collect data potentially relevant to drinking water safety include several additional DWR programs such as the Municipal Water Quality Investigations (MWQI) in the Delta, a number of regional watershed monitoring programs, the Department of Pesticide Regulation's Surface Water Protection Program with its online database of pesticide detections at the county level, monitoring under waste discharge requirements for discharges to land, Title 27 discharge monitoring conducted by landfills, site cleanup and Department of Defense program monitoring, and surface water monitoring conducted by water purveyors.

Groundwater

Websites: GAMA – <http://www.waterboards.ca.gov/gama>; GeoTracker – <https://geotracker.waterboards.ca.gov/>

Sponsor: GAMA – State Water Board, US Geological Survey; GeoTracker – State Water Board

Description: GAMA is a cooperative program of the State Water Board and the USGS that addresses concerns about groundwater contamination and its impacts on public water wells and water supply. GAMA is a comprehensive ambient groundwater quality monitoring plan with the objectives of improving statewide ambient groundwater quality monitoring and assessment and increasing the availability of information about groundwater quality to the public. GeoTracker is a State Water Board database that centralizes locally-collected information about spills, groundwater contamination, and cleanup status. The State Water Board is developing an upgraded version of GeoTracker (GeoTracker 2.0) that will improve the integration between GeoTracker and a variety of groundwater monitoring programs, including GAMA, providing integrated analytical tools, maps, and reporting features.

Evaluation:

1. Strategy, objectives, design: Both programs ask and answer clear questions, with specific audiences in mind, but their strategies are not coordinated. GAMA's objectives are clearly stated on the program's website and in a number of descriptive and technical program documents. More general objectives (e.g., better understand and identify risks to ground-water resources) are then supplemented with detailed monitoring objectives linked to specific monitoring designs. GeoTracker's objectives are to gather, organize, and provide access to information on cleanup sites in California. The programs' objectives are not coordinated. GAMA is based on an integrated statewide design based on a division of the state into a number of groundwater basins ranked by a systematic prioritization process. The design is described in technical documents available on the program's website. GeoTracker does not itself conduct any monitoring. Data are submitted by local agencies in compliance with State Water Board regulations that require the electronic submittal of information on all cleanup actions. The programs' designs are not coordinated

Score: High

2. Indicators and methods: GAMA samples a standardized set of indicators sampled statewide. Indicators include a broader set of parameters, sampled at much lower

detection limits, than required by DHS. Indicators and sampling methods are described in technical documents available on the program's website. GeoTracker clearly defines information types in the electronic submission procedure; these include primarily programmatic information such as cleanup status. The programs' indicators are not coordinated. Quality assurance is a centrally important feature of all USGS programs such as GAMA, with formal procedures established and documented by the National Water Quality Laboratory. Additional, study-specific quality assurance issues are addressed in the methods section of each assessment report. GeoTracker includes no description of any quality assurance screening of submitted data, nor of how data are generated and evaluated at the local level. It is thus not possible to judge the quality of data in the GeoTracker database

Score: Medium

3. Data management: GAMA's data management procedures are well established, standardized statewide, and clearly documented. However, there are no query or download features to enable users to search, select, and download data. A planned link with the GeoTracker website will provide these functions. GeoTracker's data management procedures are not described on the website, but must be defined somewhere in order for the program to function. The system has an online tutorial that provides instructions for data access and download. GeoTracker 2.0 will incorporate new data management features that will improve the ability to transfer data among a variety of data systems

Score: Medium

4. Consistency of assessment methods: GAMA uses a variety of analysis and assessment approaches to address questions at the national, regional, and basin-specific levels. These approaches are subject to both internal and external peer review. GeoTracker conducts no analysis or assessment

Score: High

5. Reporting: GAMA uses assessment reports as the primary vehicle for disseminating program results and these are readily available on the program's website. Reports cover a wide range of topics related to program methods and monitoring and assessment results. However, there are no interactive features in these reports to enable users to focus on a specific area or directly obtain the underlying data through a link to the database. GeoTracker enables users to search the database by a variety of entry points, including county, groundwater basin, watershed, and address. Search results include maps, project status, and background information

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program evaluation or planning process. While GAMA is supported by grant funding, GeoTracker is supported by a number of funding sources that are more sustainable, and GeoTracker 2.0 has received funding from the Legislature

Score: Medium

Water at the tap

Website: <http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DWSAP.aspx>

Sponsor: California Department of Public Health (DPH)

Description: The Department of Public Health's Division of Drinking Water manages a number of programs related to the safety of drinking water and drinking water sources. In particular, its Drinking Water Source Assessment and Protection Program provides procedures for local water suppliers to use in assessing their drinking water sources. In addition, the Monitoring and Evaluation Unit of DPH's Drinking Water Program collects analytical results from laboratories

conducting assessments of local supplies, then compiles, evaluates, and reports on these monitoring data. However, the Department does not itself conduct monitoring of drinking water supplies or integrate such data to create a statewide overview or assessment.

Evaluation:

1. Strategy, objectives, design: Monitoring of drinking water supplies is focused on clear questions related to human health, and DPH provides guidance for monitoring objectives and designs. However, local monitoring and assessments are conducted independently and there is no oversight function to ensure that these local monitoring efforts comply with state guidelines

Score: Low

2. Indicators and methods: DPH furnishes a standardized set of indicators to structure local monitoring efforts. However, there is no apparent effort at statewide coordination of methods, laboratory intercomparison studies, or standardized approaches to quality assurance of data

Score: Low

3. Data management: DPH provides documented procedures for local agencies to upload their data to a statewide database. However, there are no apparent statewide guidelines or procedures that promote consistency in data management. While raw data can be downloaded from the DPH website, it is noted that data from all water suppliers may not be included, and there are no provisions for ad hoc queries or map interfaces to the data

Score: Low

4. Consistency of assessment methods: Monitoring data are compared to a consistent set of statewide water quality standards, with exceedances clearly defined. All assessments are performed on a site-specific basis and there is no apparent statewide summary assessment

Score: Medium

5. Reporting: The DPH website provides access to reports from local agencies, but their availability is dependent on local agencies' uploading their monitoring reports. In addition, there are no online tools for creating ad hoc reports, combining data from multiple reports, or applying standardized analysis or assessment tools

Score: Low

6. Program sustainability: There is no readily available description of a periodic program evaluation or planning process

Score: Low

Seafood consumption safety

Seafood consumption safety is a concern in streams, rivers, lakes, coastal waters, and bays and estuaries where sport and commercial fishing, and shellfish harvesting, have been designated as beneficial uses. Both federal and state agencies have jurisdiction over this issue, but only the federal Food and Drug Administration (FDA) sets specific action levels and these only for commercial fish. California's Office of Environmental Health Hazard Assessment (OEHHA) sets threshold levels for certain chemicals in sportfish as the basis for establishing site- and species-specific consumption advisories. Neither federal nor state agencies conduct systematic tissue monitoring for risk assessment. OEHHA, however, has used monitoring data collected for other purposes for its assessments. For example, OEHHA has used data from SWAMP's statewide assessments of sportfish tissue contamination. Although these studies were not originally designed to support human health risk assessment, efforts are underway to adapt the monitoring design to better support OEHHA's needs. A second program, coordinated by the Department of Public Health in cooperation with a number of academic and other

institutions, conducts statewide monitoring of shellfish and marine biotoxins in coastal waters and bays and estuaries.

Sportfish

Website: OEHHA Fish Consumption – www.oehha.ca.gov/fish/so_cal/index.html

Sponsor: Office of Environmental Health Hazard Assessment (OEHHA), State Water Board

Description: SWAMP's sportfish tissue assessment is intended to answer key questions about patterns of contamination in sportfish tissue in three major habitat types statewide – lakes, coastal environment, and streams. The major focus of this study is the 305(b) water quality assessment, not specifically human health risk assessment. Tissue data were obtained from a wide range of available sources to provide an initial statewide assessment and this was followed by a statewide survey of lakes in 2007 and 2008. The coastal habitat will be sampled next, followed by the stream habitat, before cycling back to lakes in subsequent years. There is the possibility that SWAMP's program could be revised to better address seafood consumption risk, but this has not yet occurred.

Evaluation:

1. Strategy, objectives, design: SWAMP's assessment asks and answers clear questions, with specific audiences (specifically 303(d) listing and 305(b) assessment) in mind; however, this strategy does not focus specifically on consumption safety, nor is it coordinated with those in the shellfish subtheme. While the program began with an assessment of all readily available data that passed a quality assurance screening, the statewide long-term monitoring design is a combination of probabilistic sampling intended to characterize statewide conditions and targeted sampling that focuses on the most popular fishing sites

Score: Medium

2. Indicators and methods: Indicators, i.e., tissue measurements, are standardized, with well-developed sampling and laboratory procedures. Quality assurance methods are well developed and described in the SWAMP QAPP. Data must meet SWAMP standards before entry into the SWAMP database

Score: High

3. Data management: Data management procedures are well established, but data have yet to be placed into a readily available format usable by OEHHA and the State and Regional Water Boards. Data are currently stored at SFEI and are not yet available online

Score: Medium

4. Consistency of assessment methods: OEHHA has developed a formal data analysis framework for the purpose of developing consumption advisories and is working closely with SWAMP to implement standardized assessment methods

Score: High

5. Reporting: Draft reports are being prepared for the initial phases of this program to meet SWAMP's 305(b) reporting responsibilities. OEHHA posts reports and consumption advisories on its website. The longer-term plan is to make all data available through an online interactive mapping tool being developed at SFEI for the Fish Mercury Project being funded primarily by CALFED

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program evaluation or planning process for either SWAMP or OEHHA, although SWAMP is currently developing a formal business plan

Score: Low

Shellfish

Website: Biotoxins and shellfish –

<http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Shellfish.aspx>.

Sponsor: Department of Public Health

Description: The Department of Public Health's Preharvest Shellfish Protection and Marine Biotxin Monitoring Program monitors commercial shellfish growing areas in conformance with the National Shellfish Sanitation Program. The program also monitors numerous points along the California coastline for marine biotoxins in shellfish and toxigenic phytoplankton in marine waters. Warnings are issued or quarantines are established as needed for recreational and commercial shellfish harvesting. These programs are separate and not coordinated.

Evaluation:

1. Strategy, objectives, design: The program asks and answers clear questions, with specific audiences in mind. The objective has been clearly stated and is to describe broad trends over time, and DPH's objective is to establish sanitary requirements for shellfish growing waters and to regulate commercial growing and harvesting to ensure shellfish are safe for human consumption. The monitoring design is based on national guidelines promulgated by the Food and Drug Administration, although these allow for a degree of local flexibility. Monitoring is conducted by a wide range of collaborating local partners and is more organized and consistent for shellfish growing sites than for phytoplankton and toxins in marine waters
Score: High (with a need for more coordination of phytoplankton and toxin sampling)
2. Indicators and methods: Taxonomic methods for phytoplankton identification and methods for the direct measurement of marine biotoxins are not standardized. However, NOAA is organizing a nationwide methods intercalibration study for 2009, with the goal of improving standardization of methods for species identification and estimating abundance, as well as for toxin identification and measurement. Laboratory quality assurance methods are defined in a national procedure manual, however, there is no readily available information on the degree to which these standards are met, or on data checking and validation methods further along the data path
Score: Medium
3. Data management: There is no readily available information on data management procedures. However, the program produces aggregated statewide reports, which requires that data be collected and housed in a statewide database. The program does not provide users a means to access and download data. However, it has recently implemented a statewide listserv to enable participants to more readily share data and results
Score: Medium
4. Consistency of assessment methods: Standardized data summarization approaches are used, with assessment thresholds applied to data on toxin levels in shellfish as a basis for regulatory decisions. However, there may be need to develop assessment thresholds for phytoplankton and toxins in marine waters
Score: High
5. Reporting: The program regularly produces monthly, quarterly, and annual reports, which are posted on the program's website. However, users cannot create reports based on individual criteria
Score: High
6. Program sustainability: There is no readily available description of a periodic program evaluation or planning process
Score: Low

Swimming safety

Swimming safety is a concern in streams, rivers, lakes, coastal waters, and bays and estuaries where body contact recreation has been designated as a beneficial use. Risks to human health are managed by freshwater and marine standards for permissible levels of a set of bacterial indicators. There is a coordinated program in place for assessing and reporting on risks in coastal waters and bays and estuaries, but no similarly coordinated activity for freshwater systems.

Freshwater

Website: NA

Sponsor: Local and, in some cases, regional water quality agencies.

Description: There is no web portal for freshwater monitoring data. There is little coordinated monitoring for human health risk in freshwater systems (i.e., streams, rivers, lakes) and no standardized assessment, reporting, or data access tools.

Evaluation:

1. Strategy, objectives, design: Freshwater monitoring (where it exists), focuses on a clear question, with specific local audiences in mind. The monitoring objective is to meet management / assessment needs and the public's interest in reliable, current information about water quality conditions where body contact recreation occurs. However, this objective is often poorly articulated. Monitoring designs often do not match the strategy and objectives, follow no standardized guidelines, and are not optimized for efficient information return
Score: Low
2. Indicators and methods: Indicators for all habitats are standardized and well developed, but there is no standardized or systematic quality assurance implemented for the various separate monitoring programs
Score: Medium
3. Data management: There are no systematic data management procedures or systems in place; all data are managed at the local county level. There is no process for aggregating data at the statewide level
Score: Low
4. Consistency of assessment methods: There are no consistent data analysis or assessment procedures established, other than simple comparisons to compliance thresholds
Score: Low
5. Reporting: Depending on the individual county, advisories are available via phone or are posted on the county website, for those counties that conduct monitoring. There are no summary reports at the regional or statewide level
Score: Low
6. Program sustainability: All program planning and management occurs at the county level and there are substantial differences in the levels of activity, staffing, and funding from county to county
Score: Low

Beaches, bays, and estuaries

Website: State Water Board Beaches –

[dhttp://www.waterboards.ca.gov/water_issues/programs/beaches/beach_water_quality/index.shtml](http://www.waterboards.ca.gov/water_issues/programs/beaches/beach_water_quality/index.shtml); Heal the Bay Beach Report Card – <http://www.healthebay.org/brc/statemap.asp>

Sponsor: State Water Board, Heal the Bay

Description: For coastal waters and bays and estuaries, both the State Water Board's Beach Water Quality website and the Beach Report Card system hosted at Heal the Bay's website aggregate shoreline monitoring data collected at the county level into a statewide database. However, Heal the Bay's website also applies a standardized risk-based water quality grading system to all data to generate report card grades that are presented on a map-based interface. The beach grading system was developed through a collaborative statewide effort.

Evaluation:

1. Strategy, objectives, design: Programs ask and answer a clear question for specific audiences. The monitoring objective is clearly articulated and related to monitoring designs. The objective is to meet management / assessment needs and the public's interest in reliable, current information about water quality conditions where body contact recreation occurs. Monitoring designs match the strategy and objective and follow guidelines established by the State Water Board's Beach Water Quality Workgroup. However, designs implemented by local and regional agencies are not fully standardized

Score: High

2. Indicators and methods: Indicators and sampling methods for all habitats are standardized and well developed; however, they are not fully described or referenced on available websites. Laboratory intercalibration studies have improved quality assurance at the regional level, but implementation is the responsibility of individual reporting agencies. These quality assurance procedures are not described on available websites, except in passing

Score: High

3. Data management: Data pathways and processing are well-developed and standardized among participants, although there is room for reducing duplication of effort between Hel the Bay and the State Water Board. A standardized set of data management tools enables local and regional agencies to load their data to a statewide database in a common format. However, these data management procedures and systems are not described on available websites. Underlying monitoring data are not available for download

Score: High

4. Consistency of assessment methods: Analysis and assessment for coastal waters and bays and estuaries follows standardized protocols agreed on by all parties; grading methods are described in detail on the Beach Report Card website, with reference to water quality standards. Assessment results are readily available on both the State Water Board's and Heal the Bay's websites

Score: High

5. Reporting: Packaged reports summarizing key indicators are available on the State Water Board website and interactive reporting tools on the Beach Report Card website at several levels of detail. The Heal the Bay system provides map-based entry for report cards and site history, as well as the ability to search lists by beach for closures and history. Beach grades are available via texting to cell phone or other hand-held device. The graphical history of grades and closures for each beach is also available

Score: High

6. Program sustainability: Monitoring is conducted by a variety of local agencies, each with its own planning and funding process. The State Water Board and Heal the Bay data aggregation efforts and websites are managed and funded separately. There is no readily available description for any of these programs of a periodic program planning or evaluation process

Score: Low

Status of aquatic life

The protection of aquatic life is a central part of the management and regulatory programs maintained by CalEPA and The Resources Agency. For example, the protection of aquatic life beneficial uses is mandated in NPDES discharge permits and the Department of Fish and Game monitors the status of many marine and freshwater fisheries stocks. Aquatic life is managed from both species-specific (e.g., Coho salmon) and a habitat (e.g., rocky reefs) perspectives.

Wadeable streams

Website: SWAMP Wadeable Streams Assessment –

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reports/assess_socal2004.pdf

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/factsheets/305breport2006.pdf

Sponsor: State Water Board

Description: This program, conducted by the Surface Water Ambient Monitoring Program (SWAMP), is intended to answer key questions about water quality and biological condition in wadeable streams statewide. A randomized design with standardized indicators provides the ability to assess overall water quality and ecological condition, estimate the proportion of wadeable streams falling into different categories of condition, and track changes in these measures over time. Monitoring results also help in prioritizing problem areas for further investigation. The program is implemented as a cooperative effort between the State Water Board and the Regional Water Boards.

Evaluation:

1. Strategy, objectives, design: The program asks and answers clear questions, with specific audiences in mind. The monitoring objective is to assess the percentage of stream miles falling into different condition categories and to track how those percentages change over time. The monitoring design is specifically tailored to match the strategy and objective. It is well-described, standardized, and implemented consistently statewide

Score: High

2. Indicators and methods: Indicators are centrally developed and standardized, with training available in field procedures. There is ongoing methods research to develop indicators applicable to a wider range of stream types, as well as to determine if CRAM (California Rapid Assessment Protocol) can provide equivalent results for less cost. Procedure manuals and indicator descriptions are available on the SWAMP website. Quality assurance is a central part of the program, with standardized methods and data required to meet SWAMP standards before entry into the SWAMP database

Score: High

3. Data management: Basic data management procedures are well established; however, SWAMP formats for bioassessment data have not been finalized. Nor have tiered quality assurance requirements been developed for the inclusion of monitoring data from other sources (e.g., regional monitoring and NPDES permit monitoring programs). Data from the SWAMP are stored in the BDAT / CEDEN database in a standardized format and are available for search and download to any interested user

Score: Medium

4. Consistency of assessment methods: Analysis and assessment follows detailed and standardized protocols described in the assessment report and in greater detail in a series of technical reports available on the SWAMP website. The assessment approach

allows for examination of status and trends at the statewide, regional, watershed, and site-specific level

Score: High

5. Reporting: A statewide assessment report is available on the SWAMP website. However, there are no interactive features to enable users to focus on a specific area or directly obtain the underlying data through a link to the database. In addition, the SWAMP website is not structured for ease of access to themes or program areas. The website is currently being redesigned to address these problems

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process, although the SWAMP as a whole recently underwent a thorough external evaluation and the program is developing a formal business plan

Score: Medium

Rivers

Website: NAWQA – <http://ca.water.usgs.gov/nawqa.html>; State 303(d) List – http://www.swrcb.ca.gov/water_issues/programs/tmdl/303d_lists2006_epa.shtml; Impaired Water Bodies – http://www.cacoastkeeper.org/impaired_waterbodies/

Sponsor: NAWQA – US Geological Survey; State 303(d) List – State Water Board; Impaired Water Bodies – California Coastkeeper

Description: See the description of NAWQA above (p. 12) in the Drinking Water – Surface Water subtheme. The periodic 303(d) listing process identifies water bodies and water body segments that do not meet designated beneficial uses pertaining to aquatic life (and other uses). While there is a statewide listing policy, it is applied somewhat differently within each regional board region. There is no coordinated statewide monitoring program for all beneficial uses, and listing decisions are made using all available data. California Coastkeeper provides these listings in a map-based interface that enables users to visualize listings by region and category of pollutant.

Evaluation:

1. Strategy, objectives, design: The State's 303(d) listing program asks and answers clear questions, with specific audiences in mind, and listings are used as the basis for management decisions about implementing specific responses, such as Total Maximum Daily Loads (TMDL) programs, to water quality problems. However, with the exception of NAWQA, there are no coordinated statewide monitoring programs for assessing rivers, with the result that data used in the 303(d) listing process for rivers is gathered for a variety of objectives, using a variety of monitoring designs. This requires regional board staff to conduct site-specific and ad hoc efforts to determine which data meet the objectives of the assessment and listing process

Score: Low

2. Indicators and methods: Other than for NAWQA, there are no indicators, sampling, or quality assurance methods that are standardized statewide

Score: Low

3. Data management: See the description of NAWQA and CIWQS data management protocols and tools above (p. 12) in the Drinking Water – Surface Water subtheme. However, there are a number of other data sources used in the periodic 303(d) assessment process. Each regional water board gathers and assesses all available data at the regional level and prepares a fact sheet explaining each listing that is then compiled with other fact sheets at the statewide level. However, there are no standardized data management procedures regional water boards must follow, local and

regional data are not necessarily input into a database in each region, and there is no mechanism for coordinating the underlying assessment data into a statewide database

Score: Medium

4. Consistency of assessment methods: NAWQA produces assessments using consistent methods statewide. While there are standardized water quality criteria for many parameters, regulatory targets may also differ widely across the state depending on each region's Basin Plan and the requirements of individual TMDLs. In addition, each regional water board may interpret the state's 303(d) listing criteria somewhat differently, with the result that assessments of impairment in rivers statewide do not reflect a consistent and standardized assessment approach

Score: Low

5. Reporting: NAWQA and CIWQS provide query and reporting products and tools that focus on water quality and not directly on measures of aquatic life. The State Board's 303(d) listing website provides tabular summaries and explanations of listings in each region, but does not provide access to the underlying monitoring data

Score: Low

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process

Score: Low

Additional monitoring programs: Other monitoring programs that collect data potentially relevant to the assessment of aquatic life in rivers include regional watershed monitoring programs such as those for the Sacramento, San Gabriel, and Los Angeles Rivers.

Lakes

Website: NA

Sponsor: NA

Description: There are no regional or statewide monitoring programs targeted at water quality or the ecological status of aquatic resources in lakes.

Evaluation:

1. Strategy, objectives, design: There is no statewide strategy for monitoring water quality or the ecological status of aquatic resources in lakes. However, each Regional Water Board's Basin Plan specifies water quality objectives that apply to surface waters in each region, including lakes

Score: Low

2. Indicators and methods: There are no statewide indicators or monitoring methods targeted specifically at lakes

Score: Low

3. Data management: There are no regional or statewide data management protocols specific to monitoring and assessment data from lakes

Score: Low

4. Consistency of assessment methods: There are no assessment methods targeted specifically at lakes

Score: Low

5. Reporting: There are no reports targeted specifically at lake water quality or the status of aquatic resources in lakes

Score: Low

6. Program sustainability: There is no readily available description of a periodic program evaluation or planning process

Score: Low

Coastal waters: Shallow marine reefs

Website: CDFG CRANE – <http://www.dfg.ca.gov/marine/fir/sss.asp#crane>; Reef Check – http://www.reefcheck.org/rcca/rcca_home.php

Sponsor: Department of Fish and Game; Reef Check

Description: CDFG's Cooperative Research and Assessment of Nearshore Ecosystems (CRANE) is a collaborative effort between the California Department of Fish and Game (CDFG), various universities, private organizations, and government programs to gather and report data for fishery management and performance of marine protected areas. In 2004, funding was available for a wide-scale survey and report of fish and invertebrate populations in shallow, rocky habitats accessible to divers (Monterey to San Diego, including the Channel Islands). Reef Check California aims to support the CRANE program by establishing a network of volunteers trained to carry out surveys of nearshore reefs providing data on the status of key indicator species.

Evaluation:

1. Strategy, objectives, design: The programs ask and answer clear questions, with specific audiences in mind. However, there is no direct link to management actions. Specific monitoring objectives are stated on the Reef Check website (but not the CRANE website) and are to assess the relative abundance and size distribution of target species and how these parameters are changing over time. This will permit the evaluation of population and community attributes at sites inside and outside of existing and proposed Marine Protected Areas and will provide insight into how different sites respond to newly imposed management measures. The monitoring design is standardized statewide and is described in CRANE's 2006 summary report and in detail on the Reef Check website. Both programs have scientific advisory teams who provide input and feedback to ensure the scientific quality of the programs' data

Score: High

2. Indicators and methods: Indicators are standardized statewide and are described in CRANE's 2006 summary report and on the Reef Check website. Basic quality assurance procedures are described very briefly in CRANE's 2006 report. A quality assurance plan, with detailed procedures, is posted on Reef Check's website. These procedures are included in Reef Check's 4 – 5 day volunteer training program, which includes both classroom and field training in the sampling and data management protocols

Score: Medium

3. Data management: The basic data flow is described in CRANE's 2006 report. Reef Check's data management procedures are well established and clearly defined, and include standardized data entry forms. The program has a designated full-time database manager. Summarized data (e.g., mean, standard error) are available as tables in a PDF document. However, there are no tools for searching or downloading raw data from either website or exporting them to other formats. Nor are the databases from the two programs integrated

Score: Medium

4. Consistency of assessment methods: Data analysis methods are described in CRANE's 2006 summary report and Reef Check's 2006 – 97 report, and consist of the preparation of summary descriptive statistics, correlation analyses, and multivariate pattern analysis. There are no assessment frameworks or thresholds for evaluating and comparing condition

Score: Medium

5. Reporting: Data summary reports and the 2006 analysis and assessment report are available on the CRANE website. Reef Check also produced a two-year report assessing data collected in 2006 and 2007. Analyses included basic descriptions of

abundance and distribution, as well as spatial pattern analyses. Users do not have the ability to define and run reports using their own criteria, nor are reports of the two programs coordinated or integrated

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process

Score: Low

Coastal waters: Intertidal

Website: <http://www.marine.gov/>

Sponsor: Cooperative interagency group

Description: The MARINE partnership of local, State, and Federal agencies, universities and private organizations monitors rocky intertidal sites along the coast of California, including the islands, on a long-term basis. It represents the largest program of its kind on the west coast. Many of the sites have been monitored consistently for 15-20 years. A standardized set of Core Protocols are used to monitor rocky intertidal habitat each fall and spring at 89 MARINE sites. These data are funded by multiple partners and are entered into a common database for analysis. Sites are spaced every 10 to 15 miles along the coast on the mainland and offshore islands. Continuous monitoring provides resource managers with early warnings of abnormal conditions, such as the discovery of the withering foot syndrome which has affected black abalone across the coast.

Evaluation:

1. Strategy, objectives, design: MARINE asks and answers clearly defined set of questions about status and long-term trends, as defined by an interagency Steering Committee. Specific monitoring objectives are not defined on the program's website, but can be inferred from the program's overall goals and the analysis approaches. The monitoring and sampling protocols are established by an interagency Science Panel. These are standardized statewide and described in detail on the program's website and in publications and reports accessible from the website. The monitoring design and sampling protocols are targeted directly at the program's goals to describe status and long-term trends

Score: High

2. Indicators and methods: Indicators and methods are standardized statewide, with allowances for regional differences in species distributions, and are described on the program's website and in reports and publications available from the website. Quality assurance is conducted by each program partner; however, quality assurance methods are not described on the program's website

Score: Medium

3. Data management: Data management protocols are established by a Database Panel, but are not described on the program's website or in any reports listed on the website. Data are transferred to a central database, which is currently being organized with standardized formats. Data are not available remotely but must be requested from the MARINE program

Score: Medium

4. Consistency of assessment methods: The program is working with state agencies in their evaluation of discharges into Areas of Special Biological Significance, and with monitoring of marine protected areas. Indices of intertidal community health being generated by MARINE will allow condition to be categorized and federal and state agencies to assess measures to reduce impacts to this critical shoreline habitat. The

website enables users to generate simple time plots of the abundance of individual species at specific sites

Score: Medium

5. Reporting: MARINe partners have produced a large number of reports and publication based on the program's monitoring data, and these are listed on the program's website

Score: High

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process

Score: Low

Coastal waters: Subtidal benthos

Website: Bight Program – <http://www.sccwrp.org/sitemap.html#Regional>; CCLEAN – www.cclean.org

Sponsor: Bight Program – Southern California Coastal Water Research Project (SCCWRP); CCLEAN – several dischargers and the Central Coast Regional Water Board

Description: Both the Bight Program in southern California and the Central Coast Long-term Environmental Assessment Network (CCLEAN) are comprehensive regional monitoring programs that focus on the condition of key indicators of ecosystem health, including subtidal benthos, along the nearshore shelf. Both programs also include elements designed to identify and quantify linkages between terrestrial sources of pollutants and effects in the marine environment. The Bight Program conducts a synoptic survey of the Southern California Bight once every four to five years, while CCLEAN conducts monitoring year-round on an ongoing basis.

Evaluation:

1. Strategy, objectives, design: Both programs ask and answer clearly stated questions, with specific audiences in mind. Both programs define specific objectives and link these to explicit monitoring and data analysis designs. Both programs provide detailed descriptions and documentation on their respective websites. However, the two programs operate in distinct parts of the state and are not coordinated in any way

Score: High

2. Indicators and methods: Both programs use indicators and monitoring methods that are standardized across their respective program activities within reach region, but are not standardized statewide. All sampling and analysis methods, as well as quality assurance procedures, are available on each program's website

Score: High

3. Data management: Data management procedures for both programs are well established, though they are not described on the programs' respective websites. CCLEAN does not provide data download capabilities. The Bight Program website allows users to map stations according to measurement type or broader survey type, and to download entire surveys (e.g., infaunal abundance) of particular data types. However, the mapping function is limited and not linked to the data download function. There are no readily available options to query the database and select subsets of data for specific locations or times

Score: Medium

4. Consistency of assessment methods: Assessment methods are consistent within each program. The Bight Program has developed standardized assessment thresholds for infaunal communities that allow them to be subset into different categories of impact. The CCLEAN program has not developed or applied similar assessment tools

Score: Medium

5. Reporting: Both programs regularly produce detailed assessment reports and make them available on their respective websites. However, neither program provides ad hoc query tools that would enable users to produce customized reports
Score: Medium
6. Program sustainability: Both programs have a medium- to long-term funding base that reflects the results of internal planning processes. However, this information is not provided on the programs' websites
Score: High

Coastal waters: Enclosed bays and estuaries

Website: Sediment Quality Objectives (SQO) –

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reports/sedimentqual_bays_estuaries.pdf ; http://www.swrcb.ca.gov/water_issues/programs/bptcp/sediment.shtml; RMP – <http://www.sfei.org/rmp>; IEP – <http://www.iep.water.ca.gov/>; Bight Program – <http://www.sccwrp.org/sitemap.html#Regional>

Sponsor: SQO – State Water Board, RMP – San Francisco Estuary Institute (SFEI); IEP – multiple state and federal agencies; Bight Program – SCCWRP

Description: There are four major programs that focus, with some degree of overlap, on bays and estuaries. The only one that is statewide is the State Water Board's sediment quality objectives program. This is a multiyear effort to develop and implement objectives for enclosed bays and estuaries that protect aquatic ecosystems and human health from the direct (e.g., toxicity) and indirect (e.g., health impacts from eating contaminated seafood) effects of sediment contamination. The program has focused primarily on the development of an impact assessment framework and associated thresholds, monitoring methods, and standardized assessment tools. The program conducted a statewide assessment of sediment quality, using available data, to demonstrate the applicability of the approach and obtain an initial estimate of the percentage of the area of bays and estuaries falling into different categories of impact. The new objectives will be included in permits and will form the basis of expanded monitoring requirements. Two of the remaining programs focus on the San Francisco Bay and Delta, the San Francisco Estuary Institute's Regional Monitoring Program (RMP) for San Francisco Bay and the Interagency Ecological Program (IEP). The RMP is funded by a consortium of dischargers in the region and managed by a Steering Committee including consortium members and the Regional Water Board. The program focuses on a set of questions related to the management of contaminant impacts and aquatic resources. The IEP is funded and managed by a consortium of several state and federal agencies (US EPA, US Army Corps of Engineers, US Bureau of Reclamation, National Marine Fisheries Service, US Geological Survey, US Fish and Wildlife Service, Department of Water Resources, Department of Fish and Game, State Water Board). The IEP focuses primarily on the impacts to the Delta of water withdrawals and has developed several long-term datasets tracking the status of key ecological resources. These programs are not yet well integrated.

Evaluation:

1. Strategy, objectives, design: All programs ask and answer clear questions, with specific audiences in mind. All programs state clear objectives, with some defined in greater detail, and there are substantial differences in objectives across all four programs. Monitoring designs also differ substantially, largely due to differences in program objectives and in the structure and dynamics of large vs. small bays and estuaries. For example, the SQO only loosely defines monitoring requirements, while the other three programs have well-established monitoring designs. Monitoring objectives and designs are well described on the programs websites and their respective designs have not been integrated

Score: Medium

2. Indicators and methods: Indicators for the sediment quality objectives program are standardized statewide and well developed and described in summary form in the statewide assessment report and in greater technical detail in a series of reports available on the State Water Board's sediment quality objectives website. Indicators and methods for the other three programs are standardized within each program, and described on their respective websites, but are not well coordinated or standardized across programs

Score: Medium

3. Data management: Data management procedures are well developed for the IEP, RMP, and Bight Program and all data are available on the programs' respective websites. Data from the statewide SQO assessment are currently housed at SCCWRP and procedures have not been established for ongoing capture of new sediment quality data, maintenance of the database, or inclusion of the database in the BDAT/CEDEN system. Data from the RMP and IEP are readily accessible through a variety of map-based and menu-driven query and download tools that enable users to define subsets of data. The IEP data are housed in and directly accessible from larger data repositories such as CEDEN and BDAT. The Bight Program website allows users to map stations according to measurement type or broader survey type, and to download entire surveys (e.g., infaunal abundance) of particular data types. However, the mapping function is limited and not linked to the data download function. There are no readily available options to query the database and select subsets of data for specific locations or times

Score: Medium

4. Consistency of assessment methods: Analysis and assessment methods for the sediment quality objectives program follow detailed and standardized protocols described in summary in the statewide assessment report and in greater technical detail in a series of technical reports available on the State Water Board's website. The other three programs also describe their assessment methods, but use program-specific approaches that are consistent within each program but not coordinated or standardized across programs. The sediment quality objectives program is the only program that has defined formal, regional and statewide assessment thresholds for categorizing condition. All programs have formal mechanisms in place to manage the development, review, validation, and updating of their assessment approaches

Score: Medium

5. Reporting: A statewide sediment quality objectives assessment report is available on the State Water Board's sediment quality objectives and SWAMP websites. However, there are no interactive features to enable users to focus on a specific area or directly obtain the underlying data through a link to the database. Plans for future reporting have not been developed. The other three programs provide a large number of reports on their respective websites that address a range of issues related to contamination, anthropogenic sources, and ecological status. None of the programs have the capability to interactively produce user-defined reports

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process for the sediment quality objectives program. The other three programs have formal planning and evaluation processes overseen by management committees. However, these planning processes are independent of each other

Score: Medium

Wetlands

Website: CRAM – <http://www.cramwetlands.org/>; Wetland Tracker - <http://www.wetlandtracker.org/>; California Wetlands Information System – <http://ceres.ca.gov/wetlands/>

Sponsor: CRAM and Wetland Tracker – State Water Board; Wetlands Information System – Resources Agency

Description: The California Rapid Assessment Method (CRAM) is a standardized, cost-effective tool for assessing the health of wetlands and riparian habitats. CRAM software guides users through assessment procedures that are applicable to all wetland types. It is designed for assessing ambient conditions within watersheds, regions, and throughout the State. It can also be used to assess the performance of compensatory mitigation projects and restoration projects. The CRAM portal provides a mechanism for independent monitoring programs to apply the method and enter their data into a centralized system. CRAM data and results are also accessible through the State Water Board's Wetland Tracker, which is intended to eventually become the portal for entry into all wetlands monitoring and assessment data for the state. A proposal is currently pending before CalEPA to fund further development of Wetland Tracker, intended to make it the central web portal for wetland mapping, monitoring, and assessment information. The Wetlands Information System is a directory that links to other programs and data sources related to wetlands. It does not contain any tools that would enable users to directly access, integrate, or work with data from these other sources.

Evaluation:

1. Strategy, objectives, design: The program asks and answers a clear question, with specific audiences in mind. The monitoring objective is to provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and related policies, programs and projects throughout California. There is a three-level monitoring design, recommend by the Wetlands Recovery Project. However, this is not universally applied and individual monitoring programs with somewhat different designs can all enter their data into the CRAM database.

Score: Medium

2. Indicators and methods: Indicators and monitoring methods are well developed and standardized, though they are in the last phase of field testing and final revision. The schedule for training sessions is posted on the CRAM website, as are detailed methods manuals and user guides. There is no systematic quality assurance applied to data submitted to the site. Funds exist (104b3 and CIAP) to develop regional "audit teams" of trained CRAM experts for coastal regions that will provide third-party review of selected CRAM results by re-CRAMming the sites.

Score: Medium

3. Data management: Data management procedures are well established and data are housed in a database maintained by SFEI. The CRAM methodology is being field tested and finalized and the CRAM database is being updated regularly to reflect these adjustments and will not be integrated with BDAT / CEDEN until it has stabilized. The database has preprogrammed routines for remote data entry by participants. At this time, there are no tools for search, selecting, and downloading data, although this functionality is included in the CIAP project that begins this fall. The funded task includes downloading by site, combination of sites, wetland type, watershed (Cal Water 2), congressional district, Water Board, and statewide.

Score: Medium

4. Consistency of assessment methods: CRAM is level 2 of a three-level assessment strategy for wetlands that begins at the landscape level and ends at the detailed site level. Assessment thresholds are well developed and standardized statewide. Software

to apply the CRAM metrics and user manuals are available for download from the program's website. The CRAM database will eventually be merged with the Wetland Tracker database to allow users to visualize extent and condition assessments simultaneously. For each wetland type, at each of several scales, Wetland Tracker will generate a "report" of the size-frequency of all wetland polygons, the size-frequency of the wetland polygons for projects, the CRAM condition frequency (by attribute and site score) for all sites, and for project sites.

Score: High

5. Reporting: The website has a Google Maps interface that displays all wetlands in the system. Clicking on specific sites brings up summary information for that wetland and a chart of CRAM scores. Wetlands can also be selected from a drop-down list of available sites and viewed regionally via the interactive mapping function of Wetland Tracker (www.wetlandtracker.org), although not all wetland scores are visible at every scale. However, no reports summarizing and synthesizing results have been prepared. Access to these and other information about wetlands will be centralized through a main wetlands portal, perhaps CERES, that has not yet been decided

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process, although program planning is managed by the Wetlands Monitoring Council.

Score: Medium

Fisheries: Anadromous fish

Website: CalFish – www.calfish.org/portals/2/Home/tabid/70/Default.aspx

Sponsor: The Resources Agency, Department of Fish and Game, Department of Water Resources, Coastal Conservancy, Caltrans, Pacific States Marine Fisheries Commission, NOAA Fisheries

Description: This coordinated, state and federal interagency effort is intended to create, maintain, and enhance high quality, consistent data that are directly applicable to policy, planning, management, research, and recovery of anadromous fish and related aquatic resources in California, and to provide data and information services in a timely manner in formats that meet the needs of users. Its primary intent is to centralize access to fisheries and habitat monitoring and assessment data in California. This will make it much easier to develop and maintain statewide data standards and promote further development of related data programs.

Evaluation:

1. Strategy, objectives, design: The portal's overall strategy is broad but clearly stated. Monitoring objectives are defined by each of CalFish's cooperating agencies and vary depending on each agency's mission and the goals of specific programs. Monitoring objectives are available through links to agency programs provided on the website. As for monitoring objectives, monitoring designs are defined by CalFish's cooperating agencies and vary depending on individual program goals. Designs for many programs are available through links provided on the website

Score: Medium

2. Indicators and methods: Monitoring indicators focus on measures of abundance and distribution and the cooperating agencies work to standardize these across programs. However, there is no information about standardization efforts directly available on the website. Quality assurance procedures are established and implemented by each cooperating agency. There is no information about quality assurance directly available on the website

Score: Medium

3. Data management: Data management procedures are established and implemented by CalFish's cooperating agencies. In addition, there is a broader effort among CalFish's participants to standardize formats to improve access to and integration of data from multiple sources. The website provides links to published data collection and documentation standards and encourages their broader use. Users are able to view data via two basic methods: querying the database tables directly or querying the data geographically. The geographical queries are made possible with an interactive on-line mapping system. This system also provides access to a broad array of framework data (political boundaries, hydrography, quad maps, and many more) that make the spatial data even easier to analyze and understand. Because the tabular and geographical databases are linked, users can move easily between the two systems

Score: Medium

4. Consistency of assessment methods: Given the wide range of issues related to anadromous fisheries, there is no single statewide assessment approach adopted by all agencies. Instead, data analysis and assessment is conducted by CalFish's cooperating agencies to meet their specific needs. However, the website provides descriptions of and links to assessment tools that may be of use to broader audiences, such as a method, developed by the Department of Fish and Game Information Services Branch for deriving salmonid distribution from existing observation data and creating GIS layers identifying this distribution. As another example, the interactive mapping tool enables users to map a wide variety of abundance and distribution data against various habitat, water quality, and management parameters

Score: Medium

5. Reporting: CalFish produces no reports of its own, though a variety of assessment reports are available from each of the cooperating agencies. CalFish does allow users to search the integrated database and create custom reports on population trends and counts, distributions, migration barriers, and fish genetics, as well as view information on individual monitoring programs, hatcheries, and habitat restoration projects

Score: High

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process

Score: Low

Fisheries: Freshwater fish

Website: Wildlife, Fish, & Plant Information & Programs –

<http://www.dfg.ca.gov/about/wildlife.html>; IEP – <http://www.iep.ca.gov/>

Sponsor: Wildlife, Fish, & Plant Information & Programs – California Department of Fish and Game; Interagency Ecological Program (IEP) – Department of Water Resources, State Water Resources Control Board, Department of Fish and Game, US Bureau of Reclamation, US Geological Survey, National Marine Fisheries Service, US Army Corps of Engineers, USEPA

Description: The Wildlife, Fish, & Plant website provides information on the range of resource management programs conducted by the Department, with links to biogeographic data, habitat restoration efforts, and grant programs. The IEP conducts extensive monitoring in the Sacramento – San Joaquin Estuary. The IEP's efforts include a combination of long-term trend monitoring and focused shorter-term studies focused on specific problems.

Evaluation:

1. Strategy, objectives, design: There is no overarching monitoring strategy or set of objectives that organizes the information presented by Fish and Game's Information & Programs website. This is rather a catalog that brings a varied collection of disparate

efforts together for ease of reference. The IEP is a coordinated, formally designed, long-term monitoring and assessment program charged at looking at the ecological effects of water withdrawals on the Delta. Goals and objectives are clearly described, and linked to a monitoring design targeted at answering specific questions. Freshwater fish are a central focus of the IEP. However, there is no similar program that focuses on freshwater fish statewide (with the partial exception of anadromous fish, above)

Score: Low

2. Indicators and methods: The IEP uses regionally standardized methods and has an established quality assurance program. However, there is nothing similar for freshwater fish statewide (with the partial exception of anadromous fish, above)

Score: Low

3. Data management: The IEP has well-developed data management procedures that comply with CEDEN standards, and the program's data are housed in the Bay Delta and Tributaries (BDAT) Project site, which is a part of the California Data Exchange Network (CEDEN). BDAT / CEDEN protocols are well described, and the BDAT site contains interactive tools that allow users to search, subset, download, and work with raw monitoring data. BDAT also provides links to specialized web applications outside of the BDAT site. While this may provide a model for a larger, statewide data system that includes data on freshwater fish, the IEP site focuses only on the Delta, and there are no other regional systems of this scope that include freshwater fish elsewhere in the state

Score: Low

4. Consistency of assessment methods: IEP applies consistent analysis and assessment tools to issues related to the Delta. However, there are no similar assessments conducted statewide, and no widely accepted tools to use in such an assessment, were the data available

Score: Low

5. Reporting: The IEP prepares numerous reports, both on its long-term monitoring program and the special studies focused more directly on specific issues. However, while there are ad hoc query tools for selecting subsets of the data, there are no ad hoc reporting tools that enable users to apply different assessment methods to the data. In addition, there are no statewide assessments of the status freshwater fish, nor are there methods that allow users to create their own reports at the statewide scale

Score: Low

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process

Score: Low

Fisheries: Marine fish

Website: Department of Fish and Game Marine Region – <http://www.dfg.ca.gov/marine/>

Sponsor: Department of Fish and Game

Description: The Department of Fish and Game manages a wide range of programs and projects related to marine habitat and sport and commercial fisheries. The primary monitoring activity for marine fisheries is the collection of catch statistics for both sport and commercial fisheries. Commercial catch is more thoroughly monitored, while routine monitoring of sport catch focuses primarily on commercial party boats, leaving an important data gap related to the large numbers of fishermen fishing individually. There is fisheries-independent data for only some commercial species that are the focus of stock assessment efforts.

Evaluation:

1. Strategy, objectives, design: Data collection for sport and commercial fish catch has a clear strategy and well-defined objectives (i.e., track spatial patterns and temporal trends)

in catch). Monitoring designs are well established and implemented in a standardized way statewide. There are important data gaps related to fishery-independent survey data for many sport and commercial species, as well as to life history data needed for stock assessments

Score: Medium

2. Indicators and methods: Both indicators and sampling methods for catch statistics have been clearly defined. There are ongoing concerns about data quality due to the well-known problems in acquiring accurate catch and landings data in marine fisheries. Indicators and methods for stock assessments are less well defined and must be adapted to the distribution and life history characteristics of each species. Monitoring protocols for stock assessments have been developed for only some species of concern

Score: Medium

3. Data management: Catch statistics for both sport and commercial fisheries, for current and past years, are readily on the Department's website. However, data are presented as pdf copies of printed tables for individual years, with no tools that enable users to subset or combine data by area or species, or to acquire it in digital format. Data files must be requested directly from the Department

Score: Medium

4. Consistency of assessment methods: Assessment of catch statistics and other related data is performed in the fishery management plans prepared for individual species and updated periodically. These plans have not been completed for all commercially or recreationally important species. Fishery management plans follow a standard format, although there are differences in assessment methods related to species-specific differences in life history characteristics and other key factors

Score: Medium

5. Reporting: Reporting consists primarily of the fishery management plans and periodic updates to these

Score: Medium

6. Program sustainability: The Department has conducted an evaluation of the status of commercial and sport fisheries which resulted in a set of priorities for developing new fishery management plans. However, there is no readily available description of the level of funding needed for this effort and whether such funding is available

Score: Medium

Invasive species

Website: Invasive Species Program – <http://www.dfg.ca.gov/invasives/>; Marine Invasive Species Monitoring Program – <http://www.dfg.ca.gov/ospr/about/science/misp.html>

Sponsor: Department of Fish and Game

Description: The Invasive Species Program is involved in efforts to prevent the introduction of these species into the state, detect and respond to introductions when they occur, and prevent the spread of non-native invasive species that have become established. The program focuses on addressing the ways by which the species are introduced by human activities and emphasizes prevention of additional introductions, in coordination with other government agencies and non-governmental organizations. The Marine Invasive Species Program is a component of the overall Invasive Species Program, and is a multi-agency effort to control the introduction of Non-Indigenous Species (NIS) from the ballast of ocean-going vessels. The Department conducts monitoring studies to determine the level of invasion in the coastal and estuarine waters of the state, and monitor for new introductions to determine whether the program's ballast control measures are effective. The program also manages a database with the name and location of every known non-native species on the California coast.

Evaluation:

1. Strategy, objectives, design: The program has a clear strategy and objectives that focus on specific mechanisms of species introduction. This has provided the basis for a statewide coastal survey and for building relationships with other state and federal programs. The coastal survey was conducted over a five-year period using a straightforward monitoring design to develop a baseline, with continued monitoring now ongoing

Score: High

2. Indicators and methods: Reports of invasive species are collected from a wide variety of sources in addition to the survey conducted by the marine component of the program. There are no established data collection or quality assurance standards for data reported to the program from outside sources

Score: Medium

3. Data management: The program maintains the California Aquatic Non-Native Organism Database (CANOD), which includes information about the pathway of introduction (e.g. ballast water, hull fouling, etc.), date of introduction, locations observed, and native region of each species. CANOD will be refined in the future as more surveys for non-native aquatic species are completed. The entire database can be readily downloaded, but there are no online tools for ad hoc queries, data subsetting, or mapping

Score: Medium

4. Consistency of assessment methods: The program's monitoring element provides simple summaries of occurrence and abundance that are presented in a consistent format for the entire state. One statewide assessment has been completed, based on data from 2000, but there have been no subsequent statewide assessments

Score: Medium

5. Reporting: One report based on coastal data from 2000 has been completed and is available online. In addition, the program's website links directly to the websites of other state and federal programs related to invasive species. However, there are no reports from freshwater aquatic habitats, and no online assessment tools that enable users to create their own customized reports or assessments

Score: Medium

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process

Score: Low

Harmful algal blooms

See Shellfish, under Seafood Consumption Safety, above

Stressors and processes

Loadings

Website: RMP – <http://www.sfei.org/rmp/>; CCLEAN – www.cclean.org; Bight Program – <http://www.sccwrp.org/sitemap.html#Regional>

Sponsor: Regional Monitoring Program in San Francisco Bay – San Francisco Estuary Institute; CCLEAN – several dischargers to the coastal zone and the Central Coast Regional Water Board; Bight Program – Southern California Coastal Water Research Project

Description: The RMP in San Francisco Bay, CCLEAN along the central coast, and the Bight Program in southern California are three established regional programs that routinely estimate loadings of a variety of contaminants to San Francisco Bay and the coastal zone. These are the

only programs in the state that produce regionally comprehensive estimates of loadings by source category; they accomplish this by aggregating data from individual discharges. In addition, individual dischargers estimate loadings to surface waters, both inland and along the coast, but, with the exception of the three program mentioned, none of these data are aggregated into regional estimates. In addition, there is no comprehensive effort to estimate loadings statewide.

Evaluation:

1. Strategy, objectives, design: The three programs have clearly defined strategies and objectives that are similar across all three, i.e., estimate annual loadings of key contaminants from major sources. Monitoring designs are standardized to some extent within regions, but there has been no effort to standardize designs statewide, for example, in terms of the intensity of sampling over time. There are no efforts focused on freshwater analogous the three large marine/estuarine regional programs

Score: Medium

2. Indicators and methods: Lists of constituents monitored, and methods for sampling, estimating flows, and calculating loads are standardized to some extent within regions, although there remains room for additional standardization. However, there is no ongoing effort to standardize indicators and methods statewide, especially for freshwater

Score: Medium

3. Data management: Data management procedures are coordinated and standardized within each regional program. However, there is no ongoing effort to standardize data management across regions, and each regional program differs markedly in the variety and sophistication of online tools it provides for queries, data downloads, mapping, and other functions. However, the three programs, taken together, include the majority of loadings to the state's coastal zone. There are no analogous databases that collect data on loadings to freshwater

Score: Medium

4. Consistency of assessment methods: Data analysis and assessment methods are standardized within each regional program, but are not coordinated across the three programs. There are no regional or statewide assessments efforts focused on loadings to freshwater

Score: Medium

5. Reporting: Each of the three regional programs regularly reports on loadings to surface waters of a variety of contaminants from major source categories. Reports are readily available from each program's website, but there is no reporting for either freshwater or the state as a whole

Score: Medium

6. Program sustainability: Each of the three regional programs has a planning and evaluation process; however, there is nothing analogous for freshwater or for other portions of the coastal zone not covered by the three programs

Score: Medium

Flows

Website: CDEC – <http://cdec.water.ca.gov/>

Sponsor: Resources Agency

Description: The California Data Exchange Center (CDEC) installs, maintains, and operates an extensive hydrologic data collection network including automatic snow reporting gages for the Cooperative Snow Surveys Program and precipitation and river stage sensors for flood forecasting. CDEC provides a centralized location to store and process real-time hydrologic

information gathered by various cooperators throughout the State. CDEC then disseminates this information to the cooperators, public and private agencies, and news media.

Evaluation:

1. Strategy, objectives, design: The program meets well-defined information needs of specific audiences. The program's monitoring objectives are to provide real-time hydrologic information. There is no standardized monitoring design applied statewide. CDEC obtains and organizes data provided by a wide range of cooperative partners, each with its own monitoring design
Score: Medium
2. Indicators and methods: The basic set of hydrologic indicators is well defined and methods are standardized to some degree across the major participating agencies. CDEC's emphasis on the provision of real-time data for specific decision-making needs precludes the application of rigorous quality checks of the data. The time required for such quality assurance would make the data substantially less useful to the program's customers. The level of quality assurance is appropriate to the needs of the users and, after much discussion, the program decided that correcting inaccuracies in the data and releasing revised datasets would not be worth the effort. The program's website notes that data are preliminary in nature. However, the level of quality assurance applied to the data is not documented on the program's website
Score: Medium
3. Data management: Data management procedures are well defined and systematically applied. CDEC operates a data exchange program with various federal and state agencies and other public agencies. This data exchange program involves the automated transfer and receipt of data and information via network connections. Automated query routines permit searches by station, parameter, and a variety of other entry points
Score: High
4. Consistency of assessment methods: There is little analysis or assessment, since CDEC's primary purpose is to ensure the ready availability of real-time hydrologic data. However, an automated data plotting tool enables users to prepare graphs of query results. The program's website has clear instructions and is suited for both public access and to provide data downloads for analysts and researchers
Score: High
5. Reporting: CDEC's website provides access to a large number of reports, the majority of which are data reports on various aspects of hydrologic condition. There are no provisions for interactive reports except as noted under Data Management
Score: High
6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process
Score: Low

Levels of contamination: Freshwater

Website: SWAMP – http://www.waterboards.ca.gov/water_issues/programs/swamp/; see also Surface Water under Drinking Water Safety

Sponsor: SWAMP – State Water Board; see also Surface Water under Drinking Water Safety

Description: The Surface Water Ambient Monitoring Program (SWAMP) monitors chemical contamination in freshwater as one aspect of its statewide wadeable streams assessment. Chemical contamination is measured as one aspect of a suite of indicators including macroinvertebrate communities, aquatic toxicity, and physical habitat characteristics. While the

program is integrated statewide, it does not include other freshwater habitats (e.g., lakes) and only monitors once per year.

Evaluation: (see also Surface Water under Drinking Water Safety)

1. Strategy, objectives, design: The SWAMP strategy, objectives, and design are well thought out and described in detail on the program's website. However, there is little coordination between SWAMP and other programs that monitor surface water contamination. This is because the primary focus of SWAMP's wadeable streams program is the overall status of streams, with a focus on the bioassessment indicator rather than only on chemical contamination. In addition, there is room for additional coordination between larger regional and statewide efforts and the more localized aquatic chemistry monitoring conducted by NPDES permittees and other dischargers
Score: Medium
2. Indicators and methods: SWAMP indicators and methods are standardized statewide. However, there is room for improved coordination with other large regional and statewide programs, as well as with more localized programs conducted by NPDES permittees and other dischargers
Score: Medium
3. Data management: SWAMP has established detailed data management protocols for data it collects, all of which is readily available in an online database. However, SWAMP has not yet developed the tiered data quality and data management objectives needed to enable other data sources to readily submit their data to the SWAMP database. In addition, the issue of whether chemical monitoring data should reside in the SWAMP database or in CIWQS had not been resolved
Score: Medium
4. Consistency of assessment methods: SWAMP has a well-developed method for integrating the several indicators that are part of the wadeable streams assessment. However, there is no statewide assessment protocol for combining data from existing major monitoring programs into a coordinated statewide assessment
Score: Low
5. Reporting: There are no statewide assessment reports that focus on contamination in fresh water and that include data from the several major monitoring programs that measure aquatic chemistry
Score: Low
6. Program sustainability: SWAMP and the other major programs have well-developed planning processes
Score: High

Levels of contamination: Marine waters

Website: CCLEAN – www.cclean.org; Bight Program – <http://www.sccwrp.org/sitemap.html#Regional>; SCCOOS – <http://www.sccoos.org/>; CenCOOS – <http://www.cencoos.org/>

Sponsors: CCLEAN – several dischargers to the coastal zone and the Central Coast Regional Water Board; Bight Program – Southern California Coastal Water Research Project; SCCOOS – Southern California Coastal Ocean Observing System; CenCOOS – Central and Northern California Coastal Ocean Observing System

Description: Both CCLEAN, in central California, and the Bight Program, in southern California, coordinate the regional efforts of several ocean dischargers. They conduct routine water quality sampling in the near coastal zone, prepare assessment reports on coastal water quality, and make the raw data available to outside users. The two ocean observing systems (SCCOOS and

CenCOOS) collect data from networks of coastal and ocean buoys and sensors, as well as provide links to data gathered by other programs.

Evaluation:

1. Strategy, objectives, design: Each of the four major programs has a well-defined strategy, set of objectives, and monitoring design. However, the programs have different purposes and are not coordinated. For example, CCLEAN and the Bight Program focus primarily on describing and understanding the impacts of coastal discharges, while the two observing systems have a much broader scope and intend to provide a wide range of data that might be suited to a variety of problems

Score: Medium

2. Indicators and methods: CCLEAN and the Bight Program apply indicators and methods that are standardized regionally for all program partners, and conduct a comprehensive set of quality assurance checks on all data before using them in assessments. In contrast, the two observing systems include data collected with a wider variety of methods, and by other partners, with less emphasis on standardization across program partners

Score: Medium

3. Data management: The programs, with the exception of CCLEAN, make raw and processed data available on their websites. However, each program developed its database independently and, while there has been progress toward regional data comparability, there has been little effort at the statewide level. Thus, there is no single web portal that provides access to all marine water quality data statewide. In addition, each website provides users with a different range of tools for querying, subsetting, mapping, and downloading data

Score: Medium

4. Consistency of assessment methods: CCLEAN and the Bight Program conduct formal regional assessments of the condition of marine waters. Their assessment approaches and methods have undergone external review and have been revised and improved over time, though the two programs have not coordinated with each other. The two observing systems, in contrast, focus more on gathering and providing data, rather than on conducting ongoing assessments to address specific management questions

Score: Medium

5. Reporting: CCLEAN and the Bight Program have formal, well-developed reporting procedures that result in thorough reports made available on their respective websites. The two observing systems have a more ad hoc reporting process, depending on the number and type of data products or special studies being produced or undertaken at any one time

Score: Medium

6. Program sustainability: All four programs have planning and evaluation processes, although these are not well described on all websites

Score: Medium

Levels of contamination: Freshwater sediment

Website: NA

Sponsor: NA

Description: There are no regional or statewide monitoring programs that focus on contamination of sediment in fresh water

Evaluation:

1. Strategy, objectives, design: There is no regional or statewide strategy for monitoring contamination in freshwater sediment, nor are there any monitoring programs or designs focus on this issue
Score: Low
2. Indicators and methods: There are no standardized indicators or methods for use in monitoring this issue
Score: Low
3. Data management: Because there is no regional or statewide monitoring effort, there are no database systems or data management procedures focused on this issue
Score: Low
4. Consistency of assessment methods: There are no coordinated or standardized assessment methods applicable to contamination of freshwater sediment
Score: Low
5. Reporting: There are no regional or statewide reports on contamination in freshwater sediment, nor is there a mechanism in place for producing such reports
Score: Low
6. Program sustainability: There is no planning or funding devoted to this issue at present
Score: Low

Levels of contamination: Marine sediment

Website: CCLEAN – www.cclean.org; Bight Program – <http://www.sccwrp.org/sitemap.html#Regional>

Sponsors: CCLEAN – several dischargers to the coastal zone and the Central Coast Regional Water Board; Bight Program – Southern California Coastal Water Research Project

Description: Both CCLEAN, in central California, and the Bight Program, in southern California, coordinate the regional efforts of several ocean dischargers. They conduct routine sediment sampling in the near coastal zone, prepare assessment reports on coastal sediment quality, and make the raw data available to outside users.

Evaluation:

1. Strategy, objectives, design: The two programs have well-defined strategies, sets of objectives, and monitoring designs. However, the programs, while similar in purpose, are not coordinated, and there is no comprehensive statewide strategy
Score: Medium
2. Indicators and methods: CCLEAN and the Bight Program apply indicators and methods that are standardized regionally for all program partners, and conduct a comprehensive set of quality assurance checks on all data before using them in assessments. However, the two programs are not coordinated, and there are no indicators and methods that are standardized statewide
Score: Medium
3. Data management: The Bight Program makes raw and processed data available on its website, while CCLEAN's data is only available on request. While there has been good progress toward regional data comparability, there has been little effort at the statewide level. Thus, there is no single web portal that provides access to all marine sediment data statewide
Score: Medium
4. Consistency of assessment methods: CCLEAN and the Bight Program conduct formal regional assessments of the condition of marine waters. Their assessment approaches and methods have undergone external review and have been revised and improved over time, though the two programs have not coordinated with each other. However, there is no statewide approach to assessment

Score: Medium

5. Reporting: CCLEAN and the Bight Program have formal, well-developed reporting procedures that result in thorough reports made available on their respective websites. However, there is no statewide reporting effort

Score: Medium

6. Program sustainability: Both programs have planning and evaluation processes, although these are not well described on their websites

Score: Medium

Levels of contamination: Freshwater aquatic life

[need to find FWS, USGS statewide efforts on selenium, etc.]

Website: See Sportfish, under Seafood Consumption Safety

Sponsor: See Sportfish, under Seafood Consumption Safety

Description: See Sportfish, under Seafood Consumption Safety. While the bulk of attention paid to contamination of aquatic life in freshwater habitats is focused on human health, there is concern about effects on upper trophic level organisms of contamination in aquatic foodwebs.

[say more about selenium, etc.]

Evaluation: (see also Sportfish, under Seafood Consumption Safety) [complete evaluation when know more about FWS, USGS, etc.]

1. Strategy, objectives, design: Indicators and methods:
2. Data management:
3. Consistency of assessment methods:
4. Reporting:
5. Program sustainability:

Levels of contamination: Marine aquatic life

Website: Mussel Watch – NA; Bight Program – <http://www.sccwrp.org/sitemap.html#Regional>

Sponsor: Mussel Watch – State Water Board; Bight Program – SCCWRP

Description: The California Mussel Watch Program, which has just begun sampling, is based on NOAA's historical Status and Trends Program and is being conducted in coordination with NOAA. The program's goal is to continue the earlier time series of broad measures of coastal contamination. The Bight Program monitors contaminant levels in tissue of a number of demersal fish and macroinvertebrate species as part of its broader periodic regional monitoring program. There is no coordination between the two programs.

Evaluation:

1. Strategy, objectives, design: Both programs ask and answer clear questions, with specific audiences in mind. Monitoring objectives for Mussel Watch have been clearly stated by the National Status and Trends Program and are to track larger-scale patterns and longer-term trends in contamination of aquatic life in the coastal zone. The monitoring design was established by the National Status and Trends Program and has been updated with new sites selected in coordination with the MARINE intertidal monitoring program. The monitoring design is described in work plans for the northern and southern California components of the program, but is not available online. Monitoring objectives and designs for the Bight Program are based on probabilistic sampling and are described in detail on the program's website

Score: High

2. Indicators and methods: Mussel Watch indicators are well defined and standardized both nationally and statewide, and sampling methods are defined in standard operating procedures that are part of the workplans. Quality assurance methods are well defined

and standardized both nationally and statewide. Indicators and methods for the Bight Program are standardized regionally and well defined

Score: High

3. Data management: The California Mussel Watch program has only recently been restarted and data management procedures have not yet been established. Data management procedures for the Bight Program are well established and data are available for download from the program's website. However, map-based interfaces and other tools for manipulating data online are not yet available

Score: Low

4. Consistency of assessment methods: Data analysis methods for Mussel Watch are standardized nationwide and consist primarily of descriptive summaries of patterns and trends. There are no assessment thresholds used to categorize condition. The State Water Board and NOAA are still in discussions regarding who will conduct data analysis. The Bight Program's data analysis and assessment methods are also well developed and standardized regionally

Score: Medium

5. Reporting: The newly reconstituted Mussel Watch program has not yet produced reports or developed a formal reporting strategy. The Bight Program, however, produces comprehensive reports after each periodic survey

Score: Low

6. Program sustainability: There is no readily available description of a periodic program planning or evaluation process for the Mussel Watch or the Bight Program

Score: Low

Landscape maps

Website: Numerous state and federal websites presenting maps of landforms, habitat types, landuse, and many other data types

Sponsor: Mapping databases are sponsored by a range of federal and state agencies

Description: There is an extremely wide variety of mapping data available for a range of uses. Most of these are constructed in accordance with federal and state geographic mapping standards, and many are available through data exchanges and catalogs such as CEDEN and CERES. However, there is no readily available statewide inventory of mapping data that includes all major data sources.

Evaluation:

The six performance criteria used for the other themes and subthemes do not apply directly to map products. For example, assessment methods and reporting procedures are not relevant to mapping efforts. The following comments briefly summarize issues of data access and data integration related to mapping efforts. There is no single access point that provides a coordinated view of available map products and mapping efforts. While most efforts comply with one or another of the major geodata standards, and there are statewide committees addressing comparability issues, there is no mechanism to ensure that mapping efforts necessarily comply with such standards.

Measures of climate change

Website: California Climate Change Portal – <http://www.climatechange.ca.gov/>; California Climate Change Research Center – <http://www.climatechange.ca.gov/research/index.html>

Sponsor: State of California

Description: The Climate Change Portal provides a wide range of information about activities related to reducing greenhouse gas emissions and changing management practices to reduce the causes and impacts of climate change. The portal provides links to the climate change

action plans of each major California government agency, as well as to federal government and academic programs. The portal also includes a link to a webpage that provides information on a variety of research areas, including monitoring, analysis, and modeling to improve understanding of how climate is affecting California now and what its future impacts might be.

Evaluation:

1. Strategy, objectives, design: There is no single coordinated monitoring program that focuses on measuring the progress of and impacts of climate change. Rather, the Climate Change Research Center provides links to reports that compile and analysis historical climate measurements, compare regional models, and develop future climate scenarios for California. These reports have been prepared by a variety of authors and agencies. These reports reflect a clear strategy of describing past change and providing a basis for making and evaluating predictions of future change.
Score: High
2. Indicators and methods: The state's climate change programs do not identify a single list of indicators, nor do they define monitoring methods for measuring these indicators. Instead, they focus on analysis and assessment of data gathered by other programs and projects. There is a focus on improving modeling methods, but there is less of a focus on improving monitoring of indicators of change.
Score: NA
3. Data management: The program does not house any data or provide links to data. The program allows users to download analysis and assessment reports that are based on data from other sources, but these sources are not directly identified except in each individual report.
Score: NA
4. Consistency of assessment methods: The reports provided by the Research Center use a wide variety of assessment methods. While there is no set of preferred or standardized methods, one of the Research Center's main goals is to identify the most effective assessment methods for monitoring, modeling, and predicting the effects of climate change. However, there is no readily available description of the criteria or mechanism to be used to prioritize or otherwise choose among alternative assessment methods.
Score: Medium
5. Reporting: The portal provides organized access to a large number of relevant reports.
Score: High
6. Program sustainability: There is no readily available description of a program evaluation or planning process
Score: Low

Ocean acidification

Website: NA

Sponsor: NA

Description: There are a number of research and preliminary monitoring programs conducted by NOAA and by individual researchers and research institutions. However, there is no coordinated monitoring or assessment program that corresponds to the European Project on Ocean Acidification (EPOCA).

Evaluation:

1. Strategy, objectives, design: There currently is no formal monitoring strategy or program, although there have been proposals for and discusion of a national monitoring and assessment strategy.
Score: Low

2. Indicators and methods: While the basic geochemistry of acidification is understood, and measurement of ocean pH is well standardized, indicators of impacts on potentially susceptible species and ecosystem processes are not well developed, nor is there yet a broadly coordinated program to develop these methods.
Score: Low
3. Data management: Data on ocean acidification are not yet available from a single access point. Data must be obtained from individual researchers and/or institutions currently conducting research and monitoring.
Score: Low
4. Consistency of assessment methods: Assessment approaches and methods are being developed. There is no coordinating mechanism at present to organize these efforts in the US.
Score: Low
5. Reporting: Reporting currently consists of research papers published in the scientific literature and summaries of symposia convened to discuss the issue. There is no single source for finding and obtaining these publications.
Score: Low
6. Program sustainability: There is some planning for a larger-scale, better coordinated national research program, but it is still in its early stages. There is no such effort at the state level.
Score: Low

Appendix 3: Data Management Options

Many entities have tried to build large, comprehensive, multi-departmental database systems to store and manage all participating agencies' data related to water use, water diversions, water quality, flow, and aquatic resources. These projects usually fail because monitoring programs are diverse, and comparability with other data sets is rarely, if ever, considered. At both the state and federal level, agencies are moving away from a single database model, and relying on federated systems linked through data exchange networks. Through these networks standardized data can be accessed and/or aggregated comprehensively. In these distributed systems each data provider is responsible for maintaining their data, but the data from multiple entities can be accessed through a common portal, such as the single, global point of entry website proposed by the Monitoring Council.

There are challenging issues related to the design and implementation of such distributed systems to meet the data access and data integration goals envisioned in the Statute. For example, there are no design elements generic to all web or data portals and data and information types vary widely, depending on the theme or subtheme. The foundation of the Council's recommended approach is to identify *centralized access points*, through data centers and catalogs such as CEDEN and CERES, to *distributed networks* of datasets. Such data centers and catalogs have an important role to play in promulgating formatting, quality assurance, and metadata standards. The Council believes that essential pieces for a statewide data access and integration infrastructure are available, primarily in systems established by CalEPA, Resources Agency, and USEPA. In addition, there are a number of existing data and metadata standards that provide a useful starting point for this effort, but they must be knit into a coordinated whole, rather than serving separate constituencies as they now do. The Council believes that the most effective approach to improving the current data access infrastructure is to standardize data management protocols and data formats at the highest level possible, with first priority given to federal data standards, the next to statewide standards, and the third priority to regional standards.

The following discussion describes several pieces of the current information management infrastructure that illustrate the sorts of tools and approaches available, and that will likely be valuable building blocks for the Council's efforts. These are the California Environmental Data Exchange Network (CEDEN), the California Environmental Resources Evaluation System (CERES), and the Environmental Protection Agency's National Environmental Information Exchange Network (NEIEN).

Both CEDEN and NEIEN can be used to create homes for distributed monitoring data and for linking into a network of datasets that are now separate. CEDEN focuses primarily on ambient water quality monitoring data and supports data management, sharing, and integration by promoting standardized monitoring designs and data formats, improved data quality, and enhanced system interoperability. CEDEN accomplishes this in part by providing educational, quality assurance, and organizational assistance, and thus includes a service component in addition to its information system infrastructure. In addition, CEDEN works with a set of regional data centers and establishes mechanisms for linking them into the statewide CEDEN network. NEIEN focuses on similar goals at the national scale, by developing national standards for key data types (e.g., species names, analyte descriptions) and providing open source web services for linking external systems together. NEIEN has established links with other national data systems such as the USGS National Water Information System (NWIS) and is targeting a wide range of data types including (but not limited to) air releases, pesticides, drinking water, land

use restrictions, hazardous waste and hazardous materials. NEIEN has a consensus-based institutional framework for modifying these standards and technologies as needed. NEIEN also includes data and information types in addition to ambient water quality monitoring data, which are CEDEN's focus, and plans to include additional types in the future.

CERES takes a somewhat different approach than that taken by CEDEN and NEIEN. Rather than emphasizing standards and interoperability, CERES fulfills a catalog function, with the goal of providing information about and access to as wide a range of environmental databases and data types as possible. CERES therefore stresses the importance of developing adequate metadata to help ensure that monitoring data are used wisely.

Web services are a relatively new software technology that facilitates the linking and integration of disparate datasets and software tools. For example, CEDEN is linked to NEIEN via web services and additional data systems now outside of CEDEN can be linked using the NEIEN web services protocols. This approach has the potential to help meet the Statute's data sharing goals by expanding the scope of datasets and data systems that could be integrated with CEDEN and NEIEN. However, such integration would need to be evaluated on a case by case basis for institutional and technical feasibility and cost, since implementing a web services approach demands careful attention to underlying issues of system interoperability and data comparability. In addition to web services, other technologies will in all likelihood be required to accomplish the Statute's goals. These technologies, their cost, and the effort to implement them would also need to be determined on a case by case basis.

Accomplishing this level of standard setting and integration on a statewide basis will require a large amount of sustained effort and the evaluation of detailed technical options in the context of users' needs. For example, portals may access data by linking directly to query tools of other websites or through server-side programming which queries for specific data from other websites and presents it in the portal in customized way. As another example, if data must be acquired and displayed in real time, this would involve using available API's or perhaps application-to-application data communications, such as web services. This presumes such tools are available, that permission to connect to these resources has been granted, and that the necessary work to define user identities and their format requirements has been accomplished. If such tools are not available, as in the case of websites that only present data through interactive web-interface query tools, a screen-scraping could be programmed to extract the necessary data. In contrast, if the workgroup finds that real-time data access is not needed, data may be acquired by other means. data. As another example of the sorts of technical issues that must be resolved, different topics may require different data refresh rates. Where the data can be gathered in a batch mode, agreements might be made with data providers for periodic data transfers, using ftp or web services. In addition, connection and data retrieval time, the operation of network links, and requirements for temporary storage of retrieved data must all be addressed and resolved. As the wetlands data portal proposal (Appendix 5) illustrates, these are just a few examples of the range of detailed technical issues that must be resolved as the data management and data integration strategy for each theme and subtheme is defined.

Appendix 4: Prioritizing Themes for Initial Action

The theme-by-theme evaluation identifies specific shortcomings in the existing system of monitoring programs and theme-based portals that will be resolved as part of the ten-year implementation plan called for in the Statute. However, all themes and subthemes cannot be addressed immediately, and implementation must therefore be prioritized to optimize the effectiveness of available resources, address issues of most concern to managers and the public as soon as possible, take advantage of existing infrastructure, and build momentum and support for the overall concept of expanding the use of theme-based portals.

The Council considered three key factors in prioritizing portals for future attention (Table 4):

- Level of concern to the public and managers
- Level of effort involved (based on the evaluation in Chapter 2)
- Near-term opportunities (i.e., low-hanging fruit) involving interested monitoring / assessment programs, immediate sources of funding, or situations that demonstrate technical methods or institutional arrangements that further the goals of the Statute

The Council judged that improving access to monitoring data and assessment results related to drinking water safety is the paramount concern to the greatest number of people, with seafood consumption safety and swimming safety the next priority. In general, the status of aquatic life is a lower priority, although there are specific subthemes, such as anadromous fishes and their habitat, or shallow marine reefs, that rise to a higher priority at certain times and places for some audiences. The level of effort needed to meet the goals of the Statute for each portal is rated on four-point scale, based largely on the ratings in Table 3. The greater the number of “High” ratings for any given theme or subtheme, the lower the effort involved. However, it is important to note that a portal that currently rates “High” because it is well standardized may not comply with whatever standards the Council eventually adopts for ensuring data comparability and integration. Thus, the actual level of effort involved in addressing each portal will depend on future decisions about data standards and other infrastructure. Subthemes that have expressed an interest in an association with the Council’s activities, have access to independent sources of funding, and/or have an institutional infrastructure to promote coordination and access are rated as the best opportunities.

Table 4. Summary results of the prioritization exercise. For each criterion, lower numbers represent a higher priority. The overall priority is the simple average of the individual ratings on three separate criteria.

Prioritization Criteria				
Theme-based portals	Level of concern	Level of effort	Opportunity	Overall priority
<i>Is our water safe to drink?</i>				
Surface water	1	1	3	1.7
Groundwater	1	2	1	1.3
Water at the tap	1	3	2	2.0
<i>Is it safe to eat fish and shellfish from our waters?</i>				
Sportfish	2	2	1	1.7

Prioritization Criteria				
Theme-based portals	Level of concern	Level of effort	Opportunity	Overall priority
Shellfish	2	1	2	1.7
<i>Is it safe to swim in our waters?</i>				
Freshwater	2	4	3	3.0
Beaches, bays, and estuaries	2	1	1	1.3
<i>Are our aquatic ecosystems healthy?</i>				
Wadeable streams	3	1	1	1.7
Rivers	3	3	3	3.0
Lakes	3	4	3	3.3
Coastal waters				
Shallow marine reefs	3	1	2	2.0
Intertidal	3	1	2	2.0
Subtidal benthos	3	1	2	2.0
Enclosed bays and estuaries	3	2	2	2.3
Wetlands	3	2	1	2.0
Fisheries				
Anadromous fish	2	2	2	2.0
Freshwater fish	3	4	3	3.3
Marine fish	3	3	3	3.0
Invasive species	3	2	3	2.7
Harmful algal blooms	3	1	1	1.7
<i>What stressors and processes affect our water quality?</i>				
Loadings	3	4	4	3.7
Flows	3	1	4	2.7
Levels of contamination				
Water				
Freshwater	3	4	4	3.7
Marine	3	2	4	3.0
Sediment				
Freshwater	3	4	4	3.7
Marine	3	2	3	2.7
Aquatic life				
Freshwater	3	4	4	3.7
Marine	3	3	2	2.7
Landscape maps	3	3	2	2.7
Measures of climate change	2	1	3	2.0
Ocean acidification	2	4	3	3.0

Appendix 5: Proposal for Wetland Data Portal

Wetland Data Portal For SWAMP Data Centers

A Proposal to the State Water Resources Control Board
From the Wetland Tracker Development Team
July 31, 2008

Proposal Amount: \$1,000,000
Duration: Three years
Grantee: Aquatic Science Center. ASC is a Joint Powers Authority created by the State Water Resources Control Board and the Bay Area Clean Water Agencies to assist with the efficient delivery of scientific, monitoring, and information management support.
Contact: Joshua N. Collins, Ph.D.
San Francisco Estuary Institute
7770 Pardee Lane, Oakland CA
Phone 510 746 7365
Email josh@sfei.org

Goal

Make SWAMP Data Centers the public library for all data necessary to assess the performance of policies, programs, and projects for protecting wetlands and riparian resources in California. This project will not reach this goal, but will make significant progress towards it.

Relevance

The Surface Water Ambient Monitoring Program (SWAMP) of the State Water Board has been developing regional Data Centers as nodes on the California Environmental Data Exchange Network (CEDEN) to improve the management and public access to water quality data. At the same time, the State and Regional Water Boards have been cooperating with other State and federal agencies to increase the State's capacity to implement recent federal guidance on wetland monitoring and assessment ("ten elements letter," USEPA 2006) by developing a comprehensive wetland monitoring toolkit. The toolkit includes protocols for mapping wetland and riparian habitats (www.wrmp.org/protocols.html), tracking wetland and riparian projects under the State's 401/WDR Program (www.wetlandtracker.org/about.htm#trackerform), the California Rapid Assessment Method (CRAM) for assessing wetland health (www.cramwetlands.org), and standard protocols for assessing selected wetland functions (www.wrmp.org/protocols.html). In addition, the Wetland Tracker information system (www.wetlandtracker.org) is being developed to manage and visualize data generated by these tools. The Development Team for the State Wetlands and Riparian Protection Policy and the Wetlands Monitoring Working Group of the California Water Quality Monitoring Council seek to implement these monitoring tools, subject to their review, through a variety of state and federal programs. The State Water Board and the Monitoring Council are especially interested in building wetlands data into the Data Centers and providing public access to the data through a web-based portal. This is a proposal to help meet these needs by moving data generated by the

toolkit and other methods into the Data Centers, and by making Wetland Tracker the public portal for accessing wetlands data.

Data Center Wetland Content

All publically funded, regional, wetlands data can eventually be accessible through the Data Centers via Wetland Tracker. A model approach will be piloted by the Bay Area and North Coast Data Center at SFEI, subject to advice and review by all Data Centers, SWAMP, CEDEN, and Wetland Monitoring Working Group.

Wetlands data include any data collected within wetlands or about wetlands. They can be maps, images, text, and tabular records. According to the USEPA guidance on wetland monitoring and assessment (USEPA 2006), wetlands data can be classified into three Levels:

Level 1 consists of inventories of habitats, projects, and related information in a GIS that can be used to characterize the geographic distribution and abundance of wetland resources (the State Wetland Inventory is the main Level 1 dataset);

Level 2 consists of assessments of the wetland condition, functional capacity, or general health based on field indicators (CRAM is the Level 2 tool for California);

Level 3 consists of intensive, quantitative measures of specific wetland processes, functions, services, or stressors (data on contaminant concentrations, flood-frequency, bird density, carbon flux, etc. are examples of Level 3 data).

There are many existing Level 1-3 datasets in every region of California. Some of these data are collected using statewide standard methods with QAQC procedures. Other data are collected using multiple methods with various degrees of QAQC. In general, data collection methods are not standardized across programs and projects unless there is a need to compare the results to a threshold value for decision making, such as a water quality standard. Since few standards have been promulgated for wetlands, few wetland monitoring methods have been standardized. There are many non-standardized Level 3 data collected by local agencies, special districts, NGOs, and the private sector that could provide important insights into wetland condition and function, but are not being compiled in any public or private database, and are therefore not generally accessible.

To realize the potential of Data Centers to help protect wetland and riparian resources, they need to provide access to most, if not all scientifically credible data about wetlands. The readiness of the Data Centers to meet this challenge varies with wetland type. The State Wetland Inventory and Wetland Project Inventory (Level 1 data), plus CRAM results (Level 2 data) are already viewable via Wetland Tracker, although not all of the data upload and download functions are ready for public use. A few standardized Level 3 data for wetland water quality, sediment quality, and biological toxicity can be uploaded and downloaded through SWAMP or a few regional monitoring programs designed for certain agencies and research groups, and can be readied for broader access and public viewing with relative ease. However, providing access to the wealth of other credible Level 3 wetland data that don't fit into existing standard formats for data management or viewing will require new tools.

This proposal embraces the concept of providing access to scientifically credible wetland data regardless of its spatial and temporal extent. The Wetland Tracker will therefore need to access, or point to, many different databases, in addition to the primary databases of the Data Centers and CEDEN. In concept, the Data Centers can serve as regional conduits of data and information stored within the Data Centers and elsewhere, much as in a modern branch library.

Wetlands Data Portal

The Wetland Tracker will be converted into the Data Center portal for wetland data and information. This will not interfere with any of the other existing or pending functions of the Wetland Tracker. The original and continuing main purpose of the Wetland Tracker is to enable the State to assess net changes in the distribution and condition of wetlands within watersheds, regions of the State, Congressional Districts, and statewide. The Wetland Tracker is also being developed to support the State's 401/WDR program by providing public access to application forms, past and proposed projects, permit information, etc. Because of these previous and ongoing development efforts, the Wetland Tracker already has many of the desired attributes and functions of a Data Center portal:

- helps implement the USEPA guidance for wetland monitoring and assessment (USEPA 2006) by tracking the location, condition, selected functions, and stressors of wetlands and wetland projects;
- is consistent with the State's interest in open source engineering (CPRC 2004);
- is being developed by Data Center staff and water quality experts with oversight by regional and statewide advisory groups;
- supports user-defined data queries;
- enables public uploads and downloads of selected data types.

There is considerable risk in trying to make Wetland Tracker do all things for all people interested in wetlands. Instead, the Wetland Tracker will focus on providing the most fundamental data (i.e., the data needed to support and assess the largest array of wetland policies and programs) in the most useful formats. This means that the Wetland Tracker will continue to focus on viewing and accessing basic information about the distribution and condition of wetlands and related projects (Level 1 and Level 2 data) using interactive maps. This functionality is best understood by using the Wetland Tracker (www.wetlandtracker.org).

Additional functionality for viewing and accessing Level 1 and Level 2 data, including summary reports, is being developed over the next 3 years with current funding from USEPA, the State Water Board, and the Resources Agency. A more complete description of this functionality can be found in the workplans for these projects. This forthcoming functionality will meet most of the anticipated needs for viewing, accessing, and downloading the main Level 1 and Level 2 data (i.e., State Wetland Inventory, 401/WDR project and permit information, CRAM scores). Most of these data already exist within the Data Centers and therefore can be delivered in detail and in summary with relative ease.

Providing access to the wealth of Level 3 wetland data via the Wetland Tracker is essential but a considerable challenge. Wetland Tracker has minimal functionality for uploading Level 3 data at this time, and no functionality for viewing or querying them. Wetland Tracker only provides links to a few Level 3 datasets that have been uploaded as attribute files for projects. The simplest approach to providing more access to Level 3 data would be to provide links to more datasets. This would satisfy the fundamental need of making more Level 3 data available. However, it makes far less progress than possible at this time to integrate these data into wetland protection and management.

The need is to help Data Center clients or users find the Level 3 data that is relevant to their interests. A suitable, proven approach has already been developed. Consider Amazon.com as an example. When purchasing a book, users are offered other books that may be of interest to them. These offerings are not just picked at random from Amazon's database. Nor do these offerings represent a complete list of Amazon's books. Instead, complex, intelligent algorithms

are used to extract those books that are, or might be, most relevant to the user's preferences. Thus, by analyzing how a user's behavior relates to that of previous users, Amazon is able to offer items that the user might never have found otherwise.

Similar mechanisms can be used for accessing Level 3 data through Wetland Tracker. The two metrics that probably best define a dataset's relevance to a user's interest are place (geospatial location) and subject (keywords). Other metrics may be identified as the Data Centers and their portals develop. These concepts are explained more fully below in part D of the basic workplan.

One large benefit of providing access to Level 3 data using these intelligent technologies is that the Data Centers can track the abundance of data and the frequency of their selection in relation to their subject matter and location. This information can be used to help identify types of Level 3 data that should be standardized. For example, the Data Center could determine that plant diversity is monitored at most wetland mitigation projects, but that the data are incomparable because of inconsistent methodology. Tracking Level 3 data is likely to improve their quality.

Basic Workplan

A. Web Site Design

A Data Center home page will be developed with input from existing Data Centers, SWAMP staff, and other advisers as appropriate. The purpose of the Data Center home page will be to inform users about the Data Centers and to guide them to the regional Data Centers.

Regional Data Center home pages will also be designed. The design will be consistent from one region to another, although some regional variation will be accommodated. The purpose of each regional Data Center home page will be to guide visitors to the data portals and related web sites.

The creation of the overall and regional Data Center home pages is an essential, but minor part of the proposed work.

B. Level 1 (inventories)

Data Upload and Storage

There are two primary types of Level 1 data at this time. One type consists of the maps of wetland and riparian areas, plus accompanying attribute files that comprise the State Wetland Inventory. The other type consists of the maps of 401/WDR projects, plus accompanying attribute files, including the maps of wetlands and riparian areas within the project boundaries.

There is already a process to update the Level 1 dataset for projects through the 401/WDR program. However, 401 staff have determined that the update process must be automated to be sustainable. To meet this need, an online mapping tool with a tutorial will be added to Wetland Tracker to help the 401 applicants and staff produce standard habitat maps that are consistent with the permit requirements.

The protocols for mapping wetlands and riparian areas for the State Wetland Inventory are based on the State's to assess the no-net-loss and net-gain policies, to map the approximate scope of the Wetland and Riparian Protection Policy, and the needs of local agencies to track the performance of their local stream and wetland protection ordinances. Updating the inventory should involve local agencies. In concept, local agencies could make the updates if they were

trained to use the protocols and if the Data Centers were able to accept the updates. The online mapping tool that will be developed for mapping projects through the 401/WDR program will not be adequate for large-scale updates of the Inventory. To enable local agencies to update the Inventory, the mapping protocols and GIS-based riparian model will be packaged with the supporting datasets and a tutorial for independent use outside the Data Centers. Also, a process for accepting the local updates into the Data Center will be developed.

For all Level 1 data, the best storage strategy for long-term access and management will be developed and implemented, taking into consideration the existing open-source technology that has been used to store these data to-date.

Data Query and Retrieval

User-defined queries will be made available for querying the Level 1 data based on geographic area, time period, wetland type, project types, etc. Maps and project summaries will be available for downloading by the user, for example, as a JPEG, KML, or Excel file.

Data Visualization and Reporting

This task will build upon the regional project summaries already available for wetland projects (e.g., www.wetlandtracker.org/ba/summaries.htm) by also reporting important information on the net change in the condition and extent of wetlands for user-defined areas. Users will also be able to visualize the results of custom queries. For example, a user might hand-pick five wetland projects to be displayed on the Wetland Tracker base map.

To assist with 305b reporting and to help track net change in wetland acreage, a graphing function will be developed that plots the size-frequency distribution of all wetlands of a selected type, and distribution of the same wetland type for wetland projects, for watersheds and regions. This will enable the State to assess overall net change in acreage and the contribution of projects to that change.

C. Level 2 (CRAM)

Data Upload and Storage

An on-line upload tool for submitting CRAM data is now available at (www.cramwetlands.org). The CRAM user community has developed numerous recommendations for improving the functionality of eCRAM, the field-to-PC software version of CRAM. Most of these recommendations are about improving existing functionality to make it friendlier. Being able to edit the digital field map of assessment areas, create and store multiple maps for a single assessment site, access a photo library of reference conditions, and enable batch uploads are typical solutions to practical problems commonly encountered by users. This task will implement these solutions. A mechanism for exchanging CRAM data with other information management systems, such as SWAMP and CEDEN especially, will also be developed.

Data Query and Retrieval

The current static display tool will be replaced by user-defined queries for accessing the data by , wetland type, location, timeframe, identified stressors, etc. Maps and output from queries will be available for downloading by the user as a JPEG, KML, or Excel file.

Data Visualization and Reporting

A primary visualization and reporting need is to better integrate CRAM assessments with the Wetland Tracker interface. In essence, all the visualization and reporting functions that exist now at the CRAM website will be migrated to Wetland Tracker. The Development Team of the State Wetland and Stream Protection Policy has also recognized a need to expand the summaries of CRAM results to include user-defined summaries based on wetland type and geographic scope. CRAM scores will be color-coded by percentile and viewable by wetland type.

To assist with 305b reporting and to help track net change in wetland acreage, a graphing function will be developed that plots the frequency of CRAM Attribute scores and Site scores of all wetlands of a selected type, and for wetland projects of the same wetland type, for watersheds and regions. This will enable the State to assess overall net change in condition and the contribution of projects to that change.

D. Level 3 (assessments of processes, functions, services, or stressors)

Data Upload and Storage

Wetland Tracker allows users to submit Level 3 data files of any type, regardless of their format, and to provide web links (URLs) to data available elsewhere on the web. This flexibility is necessary to capture as much credible Level 3 data as possible, given that most of it is collected using a variety of methods for any given data type or subject. It increases the functions of the Data Centers to provide access to data from standardized datasets (e.g., SWAMP and RMP data) and from wetland projects that use a variety of databases or separate Excel spreadsheets.

However, at this time, only files and URLs pertaining to 401 projects have an upload location. This functionality will be expanded to Level 3 data for non-project datasets, including SWAMP and the Regional Monitoring Program for Water Quality (RMP), with a focus on three datasets as a demonstration. The three Level 3 datasets being considered at this time are the intertidal mercury sentinel species data for San Francisco Bay, the sediment contaminant data from the 2002 EMAP wetland intensification survey, and a suitable SWAMP dataset.

This task will evaluate the various formats of Level 3 datasets and determine the best storage strategy for long-term access and management, taking into consideration the SWAMP database structure and a storage strategy that is independent of format and project or program.

Data Query, Retrieval, and Visualization

User-defined queries will be enabled, based on geographic area (location), time period, and subject matter. This task builds on the existing RMP web query tool (www.sfei.org/RMP/report) by adding data from other projects and programs.

To query Level 3 data by location, the Wetland Tracker interface will include a “smart panel” that displays links to Level 3 data that were collected within the geographic extent of the Wetland Tracker map display. As the user pans across or zooms into and out of the map, the panel content will change. As a default, any Level 3 data that are available for the particular wetlands and/or projects encompassed by the map window will be displayed first. An option to expand the search area will be included so that the user can look for Level 3 data for adjoining locations. Clicking on a link in the panel will add points or polygons to the display map showing more exactly where the data were collected. These points or polygons will utilize pop-up balloons or mouse-over events to display basic information about the associated data, including links for

downloading the data if they are available, and supporting documentation, such as monitoring reports. The user will also be able to view individual charts (e.g., bar charts, line plots, histograms, etc.) for the available datasets.

All the wetlands datasets, or links to them, will also be accessible by keyword searches and user-defined time periods, using existing, open-source, search technologies. Users will be able to enter keywords or time periods into a dialogue box and retrieve a list of the associated Level 3 datasets. Once a dataset or link is selected, the data collection site or sites can then be mapped. A keyword or time search could yield results outside the map display, in which case the map would automatically expand to include the places where the selected data were collected.

E. Project Coordination and Reporting

This task includes costs for project management, coordination meetings, progress reporting, and final reporting. The coordination aspects of this project will be significant, given that the results must be consistent with the needs of multiple agencies, regional Data Centers and their partners.

Estimated Budget

Task	Estimated Budget
A. Web Site Design	\$5,000
B. Level 1: Online mapping tool	\$150,000
B. Level 1: Develop mapping tutorial and package mapping protocols	\$125,000
B. Level 1: Level 1 data storage	\$10,000
B. Level 1: Level 1 data query and retrieval	\$50,000
B. Level 1: Level 1 data visualization and reporting	\$50,000
C. Level 2: Enhancements to eCRAM	\$25,000
C. Level 2: Level 2 data query and retrieval	\$30,000
C. Level 2: Enhancements to Level 2 reporting summaries	\$20,000
C. Level 2: Reporting of net change in wetlands	\$35,000
D. Level 3: Developing Level 3 data retrieval and visualization tools	\$300,000
E. Project Coordination and Reporting	\$200,000
Total	\$1,000,000

Appendix 6: Theme-by-Theme Implementation Actions

These specific implementation actions are based on the theme-by-theme evaluations summarized in the fact sheets in Appendix 2.

Drinking water safety

Surface water

- | | |
|---------------------------------------|--|
| 1. Strategy, objectives, design: | Improve coordination of strategy, objectives, and designs for NPDES programs statewide |
| 2. Indicators and methods: | Improve standardization of core indicators and methods for NPDES programs statewide. Evaluate utility of coordinating across USGS and NPDES programs |
| 3. Data management: | Evaluate utility of linking USGS and CIWQS systems. Improve query and data download capability for SWP and other DWR sites |
| 4. Consistency of assessment methods: | Improve consistency of assessment for NPDES programs statewide, including thresholds for categorizing condition |
| 5. Reporting: | Develop interactive reporting features on USGS and DWR |
| 6. Program sustainability: | Coordinate planning and evaluation of NPDES programs statewide |
| Additional programs: | Evaluate utility of including additional programs in portal |

Groundwater

- | | |
|---------------------------------------|--|
| 1. Strategy, objectives, design: | Coordinate GAMA and GeoTracker objectives and designs |
| 2. Indicators and methods: | Include quality assurance information in GeoTracker portal |
| 3. Data management: | Add query and download features to GAMA portal, perhaps through link to GeoTracker. Include information on data management procedures on GeoTracker portal |
| 4. Consistency of assessment methods: | No actions needed |
| 5. Reporting: | Develop interactive reporting features on GAMA portal |
| 6. Program sustainability: | Provide description of program planning and evaluation |

Water at the tap

- | | |
|----------------------------------|---|
| 1. Strategy, objectives, design: | Expand description of a statewide strategy and use as the basis for coordinating local objectives and designs |
|----------------------------------|---|

- | | |
|---------------------------------------|--|
| 2. Indicators and methods: | Improve standardization of sampling and analysis methods. Develop statewide quality assurance procedures |
| 3. Data management: | Improve capture of local agencies' monitoring data; develop map-based interface and query tools |
| 4. Consistency of assessment methods: | Combine local assessments into a statewide assessment report |
| 5. Reporting: | Improve capture of local agencies' reports. Develop online tools for creating ad hoc reports using standardized assessment tools |
| 6. Program sustainability: | Provide description of program planning and evaluation |

Seafood consumption safety

Sportfish

- | | |
|---------------------------------------|---|
| 1. Strategy, objectives, design: | Modify SWAMP design to better meet OEHHA's information needs |
| 2. Indicators and methods: | Develop quality assurance tiers that reflect users' analysis and assessment needs |
| 3. Data management: | Create data formats and online database, as well as web portal with interactive mapping and data query tool |
| 4. Consistency of assessment methods: | Complete development of standardized assessment methods and include these on new web portal |
| 5. Reporting: | Develop web-based ad hoc reporting capability |
| 6. Program sustainability: | Develop program planning and evaluation process and include description on new web portal |

Shellfish

- | | |
|---------------------------------------|--|
| 1. Strategy, objectives, design: | Improve coordination of phytoplankton and toxin monitoring designs |
| 2. Indicators and methods: | Cooperate with NOAA in effort to improve methods standardization. Develop quality assurance procedures and provide information on data quality on web portal |
| 3. Data management: | Provide description of data management procedures on web portal |
| 4. Consistency of assessment methods: | Develop assessment thresholds for phytoplankton and toxins in marine waters, if needed |
| 5. Reporting: | Develop capability to create ad hoc reports based on users' criteria |
| 6. Program sustainability: | Develop program planning and evaluation process and include description on new web portal |

Swimming safety

Freshwater

- | | |
|---------------------------------------|---|
| 1. Strategy, objectives, design: | Develop basic monitoring strategy, objectives, and design using Beach Water Quality Workgroup approach as a model |
| 2. Indicators and methods: | Improve standardization of core indicators and methods for NPDES programs statewide |
| 3. Data management: | Develop statewide database modeled on that for beaches |
| 4. Consistency of assessment methods: | Improve consistency of assessment methods |
| 5. Reporting: | Develop reporting capability modeled after that for beaches |
| 6. Program sustainability: | Develop program planning and evaluation process |

Beaches, bays, and estuaries

- | | |
|---------------------------------------|--|
| 1. Strategy, objectives, design: | No actions needed |
| 2. Indicators and methods: | Incorporate improved indicators when they are developed |
| 3. Data management: | Streamline data flow among monitoring groups, county health agencies, State Water Board, and Heal the Bay; |
| 4. Consistency of assessment methods: | No actions needed |
| 5. Reporting: | Reformat State Water Board's Beaches and Clean Beaches Initiative webpages to reflect Monitoring Council's design approach |
| 6. Program sustainability: | Develop program planning and evaluation process |

Status of aquatic life

Wadeable streams

- | | |
|---------------------------------------|--|
| 1. Strategy, objectives, design: | No actions needed |
| 2. Indicators and methods: | Develop suite of IBIs applicable to broader range of habitats. Complete methods comparison with CRAM |
| 3. Data management: | Complete formats for bioassessment data. Develop tiered quality assurance requirements to facilitate the capture of additional monitoring data |
| 4. Consistency of assessment methods: | No actions needed |
| 5. Reporting: | Develop interactive query and reporting features. Complete redesign SWAMP website in terms of major themes and subthemes |
| 6. Program sustainability: | Complete and implement SWAMP business plan |

Rivers

1. Strategy, objectives, design: Develop statewide strategy and objectives for river monitoring; improve coordination of river monitoring designs
2. Indicators and methods: Improve standardization of core indicators and methods for key river monitoring programs statewide. Evaluate utility of coordinating across USGS and other programs
3. Data management: Evaluate utility of linking USGS, CIWQS, and 303(d) data management systems. Provide access to data underlying the 303(d) listings and develop integrated query and data download capability
4. Consistency of assessment methods: Develop standardized assessment approach, including thresholds for categorizing condition. Improve statewide consistency of 303(d) listing approaches applied to rivers
5. Reporting: Develop coordinated statewide assessments of rivers. Improve assessment reports that provide the underlying rationale for 303(d) listings
6. Program sustainability:
Additional programs: Develop program planning and evaluation process
Evaluate utility of including additional programs in portal

Lakes

1. Strategy, objectives, design: Develop statewide strategy, objectives, and monitoring designs for lakes. Identify local and regional efforts and improve their coordination
2. Indicators and methods: Develop a core set of standardized indicators and sampling methods for statewide assessment. Develop quality assurance procedures
3. Data management: Develop database
4. Consistency of assessment methods: Develop standardized assessment methods for core aspects of lake status
5. Reporting: Develop format for a statewide assessment report; prepare the report
6. Program sustainability: Develop program planning and evaluation process

Coastal water: Shallow marine reefs

1. Strategy, objectives, design: No actions needed
2. Indicators and methods: Standardize quality assurance methods across all program partners. Include detailed quality assurance methods on websites
3. Data management: Standardize data management procedures across all

- | | |
|---------------------------------------|---|
| | program partners. Describe data management procedures more fully on websites. Develop query and data download tools |
| 4. Consistency of assessment methods: | Develop assessment approach, including thresholds for categorizing condition |
| 5. Reporting: | Improve coordination of reporting methods and formats across program partners. Produce statewide assessment reports. Develop capability to produce user-defined reports |
| 6. Program sustainability: | Develop program planning and evaluation process |

Coastal waters: Intertidal

- | | |
|---------------------------------------|---|
| 1. Strategy, objectives, design: | No actions needed |
| 2. Indicators and methods: | Standardize quality assurance methods across all program partners. Include detailed quality assurance methods on websites |
| 3. Data management: | Standardize data management procedures across all program partners. Describe data management procedures more fully. Develop query and data download tools |
| 4. Consistency of assessment methods: | Develop assessment approach, including thresholds for categorizing condition |
| 5. Reporting: | Improve coordination of reporting methods and formats across program partners. Produce statewide assessment reports. Develop capability to produce user-defined reports |
| 6. Program sustainability: | Develop program planning and evaluation process |

Coastal waters: Subtidal benthos

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| 1. Strategy, objectives, design: | Improve coordination of monitoring designs |
| 2. Indicators and methods: | Standardize indicators and sampling, analysis, and quality assurance methods across programs |
| 3. Data management: | Standardize data management procedures as needed across programs. Describe data management procedures more fully. Develop improved query and data download tools for both programs |
| 4. Consistency of assessment methods: | Adapt assessment approaches as needed and apply standardized assessment approach statewide |
| 5. Reporting: | Produce statewide assessment reports. Develop capability to produce user-defined reports |
| 6. Program sustainability: | Describe planning and evaluation process on programs' websites |

Coastal waters: Enclosed bays and estuaries

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| 1. Strategy, objectives, design: | Improve coordination of monitoring objectives and designs |
| 2. Indicators and methods: | Improve coordination and standardization of indicators and methods. Describe quality assurance methods more fully on program websites |
| 3. Data management: | Develop procedures for aggregating sediment quality data at the statewide level. Improve integration of different program databases, perhaps using CEDEN or BDAT as a central repository. Describe data management procedures more fully. Develop improved query and data download tools, especially for Bight Program and sediment quality objectives program |
| 4. Consistency of assessment methods: | Develop standardized assessment methods in addition to sediment quality. Apply standardized assessment approach statewide |
| 5. Reporting: | Improve coordination at the regional level, particularly in the San Francisco Bay / Delta area. Produce statewide assessment reports. Develop capability to produce user-defined reports |
| 6. Program sustainability: | Describe planning and evaluation processes on programs' websites. Improve coordination of planning at regional and perhaps statewide level |

Wetlands

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| 1. Strategy, objectives, design: | Continue working through the California Wetlands Monitoring Council to finalize statewide strategy, objectives, and monitoring design. Ensure regional and statewide designs are coordinated |
| 2. Indicators and methods: | Continue working through the California Wetlands Monitoring Council to finalize indicators, sampling methods, and quality assurance procedures |
| 3. Data management: | Implement the database and web portal development plans outlined in the proposal to the State Water Board |
| 4. Consistency of assessment methods: | Finalize CRAM and other assessment methods being developed through the California Wetlands Monitoring Council |
| 5. Reporting: | Develop statewide assessment reporting framework. Produce statewide assessment report |
| 6. Program sustainability: | Continue developing program evaluation and planning process. Describe these processes on program's website. |

Fisheries: Anadromous fish

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| 1. Strategy, objectives, design: | Improve coordination among various program's objectives and monitoring designs |
| 2. Indicators and methods: | Improve standardization of indicators and methods. |

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| 3. Data management: | Resolve data quality issues related to specific sampling methods (e.g., mark-recapture) |
| 4. Consistency of assessment methods: | Continue improving standardization and comparability of data formats, as well as coordinated access to the variety of datasets |
| 5. Reporting: | Develop statewide assessment framework that integrates across separate assessments currently conducted by separate agencies |
| 6. Program sustainability: | Prepare statewide assessment report |
| | Describe planning and evaluation process on programs' websites |

Fisheries: Freshwater fish

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| 1. Strategy, objectives, design: | Develop statewide strategy, objectives, and monitoring designs for freshwater fish. Identify local and regional efforts and improve their coordination |
| 2. Indicators and methods: | Develop a core set of standardized indicators and sampling methods for statewide assessment. Develop quality assurance procedures |
| 3. Data management: | Develop database |
| 4. Consistency of assessment methods: | Develop standardized assessment methods for core aspects of freshwater fish status |
| 5. Reporting: | Develop format for a statewide assessment report; prepare the report |
| 6. Program sustainability: | Develop program planning and evaluation process |

Fisheries: Marine fish

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| 1. Strategy, objectives, design: | Use existing fisheries management strategies and objectives to develop an expanded monitoring program that would collect all data needed for stock assessments and other management activities |
| 2. Indicators and methods: | Develop monitoring protocols for all managed species, especially those that require stock assessments. Evaluate data quality issues associated with problems such as undersampling of sport catch, lack of data on actual location of catch, and aggregated landings data |
| 3. Data management: | Develop capability to present data in digital format to enable queries, downloading, and other functions. Develop map-based interfaces |
| 4. Consistency of assessment methods: | Develop fishery management plans and stock assessments for all managed species |
| 5. Reporting: | Expand reporting to provide more complete descriptions of patterns and trends in abundance, responses to climate change and other impacts, and effectiveness of fishery management plans |
| 6. Program sustainability: | Describe planning and evaluation process on |

program's website

Invasive species

1. Strategy, objectives, design: Continue statewide monitoring of marine areas. Consider expansion to additional freshwater sites
2. Indicators and methods: Establish standardized data reporting and quality assurance procedures for data submitted by other parties
3. Data management: Develop map-based interface and ad hoc query and data download tools
4. Consistency of assessment methods: Develop and implement plans for additional statewide assessments, with expanded analysis of patterns and trends, particularly focusing on the success of management efforts. Integrate freshwater and marine assessments
5. Reporting: Prepare more frequent reports on results of statewide assessments
6. Program sustainability: Describe planning and evaluation process on program's website

Harmful algal blooms

See Shellfish, under Seafood Consumption Safety, above

Stressors and processes

Loadings

1. Strategy, objectives, design: Use the three existing regional programs as a template for developing monitoring plan for loadings to freshwater and for portions of the coastal zone not yet covered by the regional programs. Improve coordination among existing programs
2. Indicators and methods: Identify core set of indicators for statewide assessment. Improve standardization of sampling, laboratory analysis, flow monitoring, and loadings estimation methods
3. Data management: Create a web portal that links to the three regional programs and develop ability to access and integrate data from these programs. Expand portal to include data on loadings to freshwater and other portions of the coastal zone not yet covered by regional programs
4. Consistency of assessment methods: Develop a statewide assessment approach applicable to all regions of the state and all source categories
5. Reporting: Aggregate existing reports to create template for statewide report; produce more extensive reports as additional data are included in the statewide data portal

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| 6. Program sustainability: | Describe planning and evaluation process for the statewide effort on the portal |
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Flows

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| 1. Strategy, objectives, design: | Improve coordination and standardization of monitoring designs |
| 2. Indicators and methods: | Expand documentation of data quality issues |
| 3. Data management: | No actions needed |
| 4. Consistency of assessment methods: | No actions needed |
| 5. Reporting: | No actions needed |
| 6. Program sustainability: | Describe planning and evaluation process for the statewide effort on the portal |

Levels of contamination: Freshwater

(See also Surface Water under Drinking Water Safety)

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| 1. Strategy, objectives, design: | Develop a statewide strategy and coordinated design for addressing contamination in freshwater |
| 2. Indicators and methods: | Develop standardized list of indicators, sampling and analysis methods, and quality assurance procedures |
| 3. Data management: | Improve coordination of the several databases that currently house freshwater chemistry data. Promote the submission of permittee monitoring data to SWAMP and/or CIWQS expand the amount of data in statewide databases |
| 4. Consistency of assessment methods: | Develop statewide assessment method for combining and integrating data from existing programs |
| 5. Reporting: | Develop format for statewide assessment report; produce report |
| 6. Program sustainability: | Describe planning and evaluation process for the statewide effort on the portal |

Levels of contamination: Marine waters

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| 1. Strategy, objectives, design: | Develop a statewide strategy and coordinated design for addressing contamination in marine waters, building on existing programs |
| 2. Indicators and methods: | Develop standardized list of indicators, sampling and analysis methods, and quality assurance procedures, building on existing programs |
| 3. Data management: | Improve coordination of the several databases that currently house marine contamination data. Identify and/or create a central access point for data, using one of the several existing databases or perhaps CEDEN |
| 4. Consistency of assessment | Develop statewide assessment method for combining |

- methods: and integrating data from existing programs
5. Reporting: Develop format for statewide assessment report; produce report
 6. Program sustainability: Describe planning and evaluation process for the statewide effort on the portal

Levels of contamination: Freshwater sediment

1. Strategy, objectives, design: Develop a statewide strategy and coordinated design for addressing contamination in freshwater sediment
2. Indicators and methods: Develop standardized list of indicators, sampling and analysis methods, and quality assurance procedures
3. Data management: Develop data management procedures and a database to hold monitoring data, when they are collected
4. Consistency of assessment methods: Develop statewide assessment method
5. Reporting: Develop format for statewide assessment report
6. Program sustainability: Develop a planning and evaluation process

Levels of contamination: Marine sediment

1. Strategy, objectives, design: Develop a statewide strategy and coordinated design for addressing contamination in freshwater sediment
2. Indicators and methods: Develop standardized list of indicators, sampling and analysis methods, and quality assurance procedures
3. Data management: Develop data management procedures and a database to hold monitoring data, when they are collected
4. Consistency of assessment methods: Develop statewide assessment method
5. Reporting: Develop format for statewide assessment report
6. Program sustainability: Develop a planning and evaluation process

Levels of contamination: Freshwater aquatic life

7. Strategy, objectives, design: TBD
8. Indicators and methods: TBD
9. Data management: TBD
10. Consistency of assessment methods: TBD
11. Reporting: TBD
12. Program sustainability: TBD

Levels of contamination: Marine aquatic life

1. Strategy, objectives, design: Improve coordination between the Mussel Watch and Bight Programs

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| 2. Indicators and methods: | Improve coordination between the Mussel Watch and Bight Programs |
| 3. Data management: | Develop data management procedures and a database to hold Mussel Watch data, when they are collected. Develop ability to access both Mussel Watch and Bight Program data from a single access point, and improve comparability of data from both programs |
| 4. Consistency of assessment methods: | Improve coordination between the Mussel Watch and Bight Programs |
| 5. Reporting: | Improve coordination between the Mussel Watch and Bight Programs |
| 6. Program sustainability: | Describe planning and evaluation process for the statewide effort on the portal |

Landscape maps

Improve overall coordination of mapping and standards setting efforts. Develop a single entry point to facilitate access to map products. Develop a mechanism for tracking and promoting compliance with standards to improve data comparability.

Measures of climate change

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| 1. Strategy, objectives, design: | No action needed |
| 2. Indicators and methods: | No action needed |
| 3. Data management: | No action needed |
| 4. Consistency of assessment methods: | Provide description of criteria being used to evaluate and prioritize assessment methods |
| 5. Reporting: | No action needed |
| 6. Program sustainability: | Describe planning and evaluation process for the statewide effort on the portal |

Ocean acidification

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| 1. Strategy, objectives, design: | Participate in national effort to develop a strategy for monitoring and assessment. Develop a statewide monitoring program |
| 2. Indicators and methods: | Participate in and/or fund research into improved methods for monitoring impacts on susceptible species and ecosystem processes |
| 3. Data management: | Create data portal and system for ensuring data are loaded to or accessed through the portal |
| 4. Consistency of assessment methods: | Participate in and/or fund research into improved assessment methods |
| 5. Reporting: | Provide a catalog that describes and links to the full range of research reports on acidification |
| 6. Program sustainability: | Develop a planning and evaluation process for the statewide effort as it develops |