# Chapter 5. DATA MANAGEMENT, ASSESSMENT, AND REPORTING

## INTRODUCTION

A vast array of data are being collected and analyzed in the San Francisco Bay-Delta area and its associated watershed by federal and state agencies, universities, private institutions, scientists and technicians. CMARP will build upon these existing efforts to provide CALFED with the information needed to make management decisions and to provide feedback to the public, government agencies and elected officials about the effects of CALFED actions. CMARP will facilitate making this information available to managers and other interested parties in a meaningful and understandable format and will work to resolve those monitoring, analysis and reporting gaps which exist between the needs of CALFED and the information that is currently available.

This chapter is organized into the following sections: Information Requirements, Coordination between CALFED and Existing Programs, Information Gathering and organization, CMARP Quality Assurance, Indicator Selection, Analysis and Integration, Reporting, Conclusions, and Examples and Tables. This chapter focuses on the various tasks that need to be accomplished and leaves the discussion of who will accomplish these tasks to the Institutional Structure chapter (Chapter 6). The Implementation chapter (Chapter 7) contains a discussion on early implementation tasks for data management, assessment and reporting.

## INFORMATION REQUIREMENTS

**Audience for CMARP Reports**

CMARP must meet the information needs of a wide and diverse set of people including CALFED Program Managers, the CALFED Policy Group, the CALFED Ops Group, CALFED Agencies, Scientists, Stakeholders, Legislative Staff, and the public. In general, the level of detail desired by each group is expected to be different as shown in Figure 5-1. The process, therefore, must be both robust and flexible to address these diverse needs.

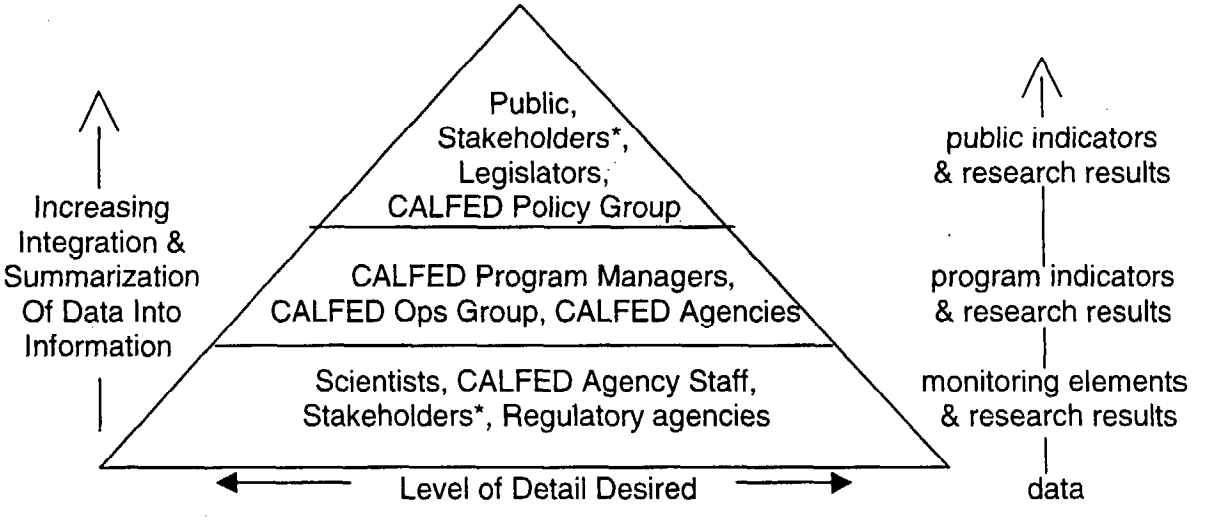



Figure 5-1. Level of Detail Desired by Different Audiences of CMARP Information and Reports. (Note: * While some stakeholders are expected to be interested mainly in basic summarized information about the system, other stakeholders are involved either in the actual collection of data or are very interested in information at all levels of the system. Consequently they are included at all levels of the diagram)

**Information needs of the three groups**
The anticipated needs of each level of the triangle are summarized below.

The Public, Stakeholders, Legislators and the CALFED Policy Group (top of the triangle) are expected to be interested in questions about the "big picture" and less concerned with the details of monitoring and research. Primarily this group's information needs are anticipated to be:

- actions CALFED has taken
- status of CALFED program goals and objectives
- status and trends of indicators of ecosystem health, water quality, water supply reliability, and levee system integrity
- new issues that have arisen
- new information that influences Stage II implementation decisions
- financial accountability
- the effect of CALFED actions on the individual person
- location of more detailed information
- clear method for making concerns known

Some of the needs of this group will have to be addressed through a joint effort between CALFED programs elements and CMARP – for example, in a joint annual report.

CALFED Program Managers, CALFED Ops Group and CALFED agencies (middle of the triangle) need additional information on which to make their decisions. Their additional information needs are anticipated to be:

- specific information upon which to base decisions
- status of individual CALFED project/action goals and objectives
- status of those factors (pressure/stressors) that influence valued system components
- what adaptive management actions could be used to improve knowledge of the system
- what uncertainties for managers have been removed through research
- what level of confidence is attached to information and results
- status of program meeting compliance and mitigation regulations
- computer models and geographic information system (GIS) as tools for decision-making
- a forum to communicate with scientists

Scientists, agency staff, and some stakeholders (the base of the triangle) work with very detailed information. This group's needs are anticipated to be:

- access to research and monitoring results of other scientists and agency staff, preferably through greater publication of results in peer reviewed journals rather than only in "grey" literature such as technical reports
- general access to data, metadata and reports
- increased communication and collaboration with other researchers, stakeholders, and agency staff
- a forum to communicate with managers

**Historical Data Needs**
CALFED Program Managers have already been using existing data and information to meet their information needs. The following list of historical data needs was gathered mostly from a survey of CALFED program managers and is subject to revision, as more information becomes available. However, this list is a good base on which to begin building the CMARP data management, assessment, and reporting process.

- Data from the Municipal Water Quality Investigations Program from the DWR Division of Planning and Local Assistance
- USGS flow and water quality data for the Delta and tributary streams
- USBR EC data in the Delta and flow and quality data for the CVP
- State Water Project water quality and flow data from DWR Division of Operations and Maintenance

- IEP data, all water quality data collected by DWR and other agencies in the Delta.
- Water quality monitoring data from the City of Stockton
- Water quality and flow data from Contra Costa Water District, Santa Clara Valley Water District, North Bay Aqueduct contractors, and Metropolitan Water District (all SWP contractors)
- Water Quality: data collected through the Sacramento Regional Comprehensive Monitoring Program (Sacramento Watershed Monitoring Program) and DWR's Water & Environmental Monitoring and Northern and Central California Water Management Programs
- Hydrology: stream flows, for as many systems within the Central Valley as possible. Progression of water development projects- dams, reservoirs, diversions, canals, etc.
- Fish & Wildlife: fisheries, wildlife, birds, phytoplankton, zooplankton, benthos data from IEP, CDFG, USFWS, DWR, SFEI, CVPIA, EBMUD, USGS, CAMP, etc.
- Habitat: Extent and location such as given by the EcoAtlas project of SFEI or the riparian vegetation mapping and fluvial geomorphic surveys conducted by DWR for SB1086
- Land use: Changes through time; urban, suburban and rural development; agricultural development; land ownership changes on a broad scale -- public vs. private.
- Demographics: Population distributions and levels over time
- Historic disturbance: recent events and how they have shaped the current appearance of the landscape; e.g. fires, floods, hydraulic mining, railroad construction, etc.
- Levee profiles and cross section drawings
- Bathymetric studies
- Levee data: land surface elevation, subsidence rates, horizontal extent of peat and organic soils, ground water levels / elevations, peat and organic soil properties, sea level rise
- Site-specific and cumulative impacts to terrestrial and aquatic habitat, as well as terrestrial and aquatic species of concern, associated with levee improvements
- Water quality impacts associated with the dredging or deposition of material in the Delta waterways
- Site-specific and cumulative benefits derived through compensatory mitigation for impacts associated with levee improvements, including mitigation banking

## COORDINATION BETWEEN CALFED AND EXISTING PROGRAMS

Six principle areas of coordination need improvement between CALFED and existing programs to create a system that channels information effectively to decision-makers:

1. better organization of and access to information,
2. coordinating CALFED needs with existing programs,
3. regional focus and coordination of monitoring and research,
4. identify and filling gaps in data collection, assessment, quality assurance, management and reporting,
5. facilitating the process of converting data into condensed information usable by decision-makers, and
6. improving communication between scientists and decision-makers.

CMARP's role is not to interfere with what is already working well, but instead to provide a greater level of coordination and regional focus to the research and monitoring efforts currently occurring. Figure 5-2 illustrates how CMARP's role complements the existing projects by helping to integrate information at a regional level.

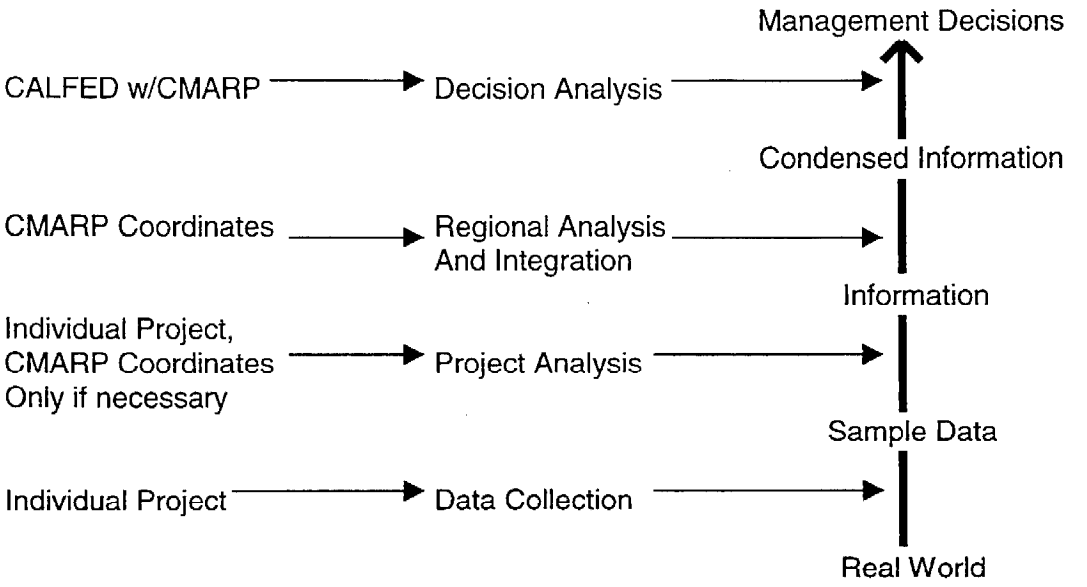



Figure 5-2. Providing Information to Managers and Decision-Makers.

Figure 5-3 provides a more detailed conceptual model illustrating 1) the steps involved in collecting the different types of information and integrating them for decision-makers, 2) the feedback loop between CALFED and CMARP, and 3) the feedback loop within CMARP as new research and monitoring needs are identified and acted upon.

**Data Management, Assessment and Reporting Guiding Principles**

Several guiding principles are identified to better facilitate the data management, assessment and reporting process:

1. coordinate closely with CALFED program managers and agencies in order to be responsive to their scientific information needs.
2. use existing monitoring programs to meet CALFED needs whenever possible.
3. focus on having any new analyses that are needed for CALFED be conducted by the researchers or agencies actually collecting the data, to the extent feasible. This may require additional funding by CALFED. If the original researchers are not able to do the additional analyses needed, then they may be conducted under the direction of CMARP science staff, in collaboration with the original researchers.
4. strongly encourage publication of research, monitoring, and project results in peer-reviewed literature.
5. make every effort to be an unencumbered channel of information flow between scientists and managers with strong effort made to avoid changes in purpose or content of reports and figures as they travel from scientists to managers. This will require close collaboration and feedback between CMARP and the researchers involved.
6. act as a communication bridge between scientists and managers -- working to get the information produced by scientists into the hands of managers in an understandable form, and working to help scientists better understand the needs of managers.

The areas needing improved coordination by CMARP include information gathering, quality assurance, indicator selection, analysis and integration, and reporting. These topics are subject headings in the rest of this chapter.

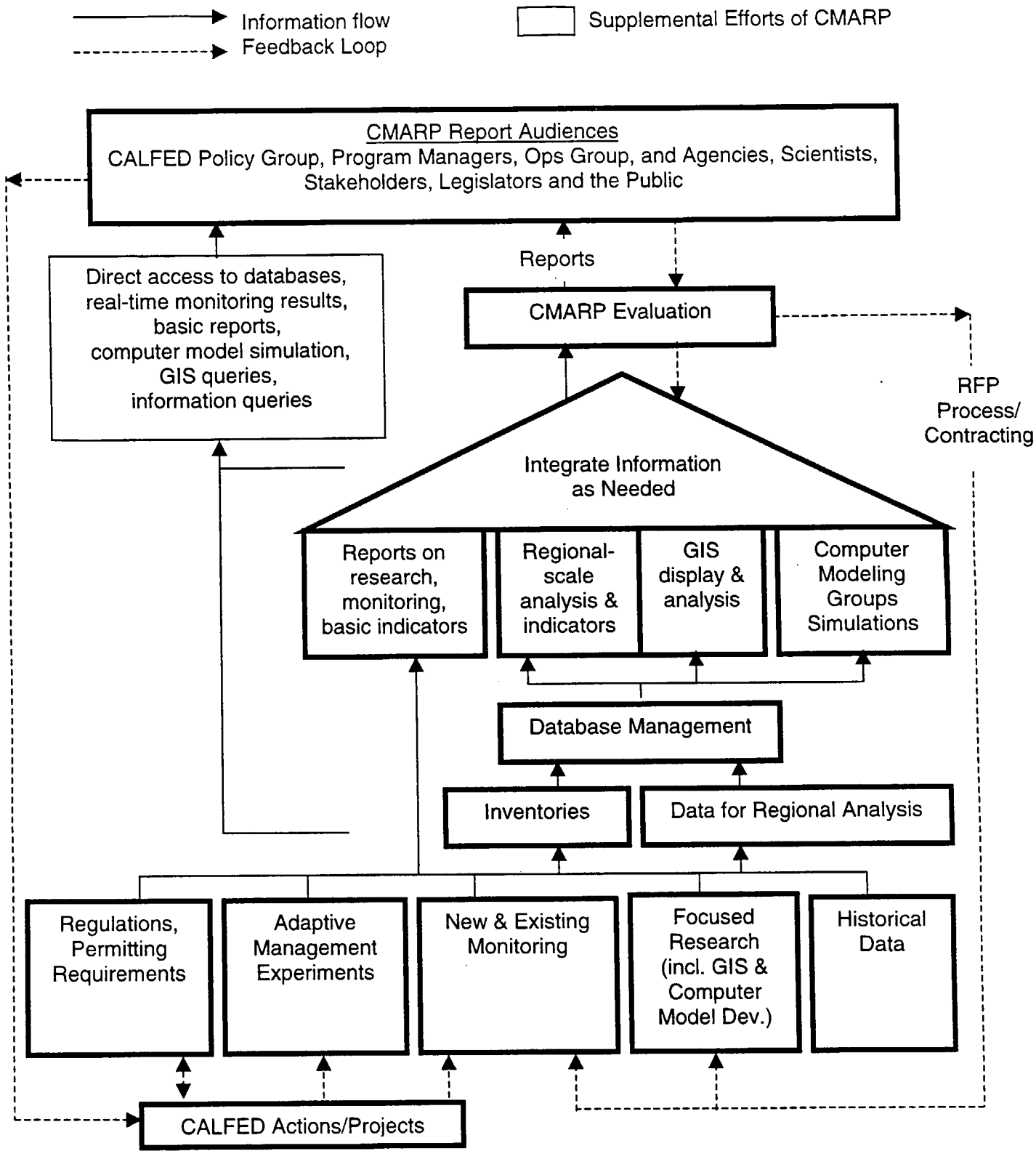



Figure 5-3. Conceptual Model of Information Flow and Feedback Loops between CMARP and CALFED.

## INFORMATION GATHERING AND ORGANIZATION

One of the principal needs in the CALFED Bay-Delta system is better organization of and access to the enormous amount of information available. A large number of monitoring, research, restoration, and watershed projects are already occurring. However, lack of communication among programs has historically been a problem, and few people are aware of the full range of information already available. The scope of CALFED requires efficient organization of the information available from a regional perspective.

Three types of support tools are recommended: metadatabases, an integrated relational database management system, and a system to track reports and information.

**Metadatabases and Inventories**
Metadatabases are used to inventory what information is available and where it is located. They contain information about data sets, such as the owner, content, quality, accessibility, etc, but do not contain the actual data themselves.

Several important sources of metadatabase information currently exist. The biggest sources include CERES (California Environmental Resources Evaluation System, http://ceres.ca.gov/), the Information Center for the Environment (ICE, http://ice.ucdavis.edu), San Francisco Estuary Institute (SFEI, http://www.sfei.org), and the Interagency Ecological Program (IEP, http://www.iep.water.ca.gov). Some of these metadatabases and databases include

- California Rivers Assessment (CARA)
- Natural Resources Projects inventory
  - Watershed Projects Inventory,
  - California Ecological Restoration Projects Inventory,
  - Noxious Weeds Database Project
- Geospatial Waterbody System
- Coastal Water Quality Monitoring Inventory
- California Watershed Information System
- California Ocean and Environmental Access Network (Cal-Ocean)
- California Wetlands Information System
- California Botanical Database (Cal-Flora)

The number of monitoring and research efforts being conducted in the CALFED Bay-Delta system is extremely large and there is no single existing metadatabase that links them all. To avoid duplication of effort, reduce the costs involved in providing information to CALFED, and improve coordination among agencies and researchers, CMARP is building a metadatabase of monitoring programs in the CALFED Bay-Delta system and associated watersheds (see Chapter 2). Over 600 monitoring programs have been identified. This metadatabase will allow CALFED to identify monitoring programs that it can coordinate with to meet its information needs. The current version of this metadatabase is being tested at the SFEI web site http://www.sfei.org/cmarpinv/.

CMARP will organize access to the existing metadatabases of GIS coverages (CERES, ICE, Army Corps of Engineers Comprehensive Review Study, etc.) and organize filling in gaps related to CALFED needs. Other metadatabases may become necessary in the future such as 1) larger research efforts related to CALFED's objectives, and 2) computer-modeling efforts related to CALFED's objectives, but these are currently of lower priority.

Additionally the development of a comprehensive list of scientists, agency staff, stakeholders, managers, etc. associated with CALFED into a queryable database is recommended. Also the Institutional Structure peer review process (see Chapter 6) also calls for the development of a list of experts who can be contacted by CMARP for peer review of reports, projects, etc.

These metadatabases and inventories will be accessible on the CMARP web page together with links to other web sites.

**CMARP Database Management**

Lack of coordination in data reporting, quality assurance, and database management among monitoring efforts can make it difficult to combine data across monitoring efforts and make regional information available quickly. For example, in previous years the reporting of spring-run chinook salmon monitoring required each data provider to fax or email the information to a central location where the data were re-entered. This process was time-consuming and error-prone.

In the past, one strategy attempted to solve these problems was to create a centralized database that combined data from multiple monitoring programs. Several problems were encountered because such efforts required data providers to turn over their data to a centralized database. This process was time consuming and data providers were understandably reluctant to lose control over their data. The process of making corrections to the centralized database was slow and tedious which resulted in the existence of multiple versions of the same data set– one set on the data provider's computer system and a second version in the centralized database. This scenario was unacceptable to most data providers.

Rapid advances in technology have made it possible to create a centralized, integrated database system allowing rapid gathering and dissemination of data to meet the needs of CALFED, agency staff and stakeholders, while still meeting the needs of data providers to maintain local control over their data, utilize low-effort in sharing their data, easily update and make changes to the data sets, and have only one version of a data set in existence.

The proposed solution is a Relational Database Management System (RDBMS). This system will allow individual data providers to manage their own data locally, while contributing to a larger comprehensive database. Each data provider will have control over its own data, which will be fully protected within the data management structure. Only the data provider will have permission to change its own data. Data will be uploaded with stringent QA/QC into a comprehensive database where it will be normalized, standardized with common units and labeling, and made available to users for reports and applications. Data providers will be immediately notified of problems. The database system will also allow geo-referencing. The intent of the CMARP database project is not to duplicate or replace the efforts of any entity involved, but to provide a comprehensive, integrated source of data for scientists and decision-makers.

Relational Database Management Systems and the World Wide Web are easily accessible technologies, and training is readily available. Most users are already using Internet browsers, such as Netscape Navigator/ Communicator or Internet Explorer. Once adapted to each data provider's system, the database provides an easy-to-use, customizable graphical user interface (GUI) that is easily learned. Exporting the data to the RDBMS can be accomplished with a simple export command or through an automated process that updates the RDBMS on a daily basis.

Use of the RDBMS will be driven by those areas where management has the greatest need for more efficient and coordinated reporting of regional information to facilitate decision-making.

A prototype of this system is currently being implemented for Spring Run Chinook salmon. A Bay/Delta and Tributaries (BDT) Relational Database Management System (RDBMS) is being developed by IEP, SRWP and CVPIA/CAMP in conjunction with California Urban Water Agencies (CUWA). Data providers manage their own

data locally, equipped with customized software that will dynamically update the centralized comprehensive server. Evaluations of this system will be based on actual use and feedback from data providers and users. The CMARP Data Management Work Group will formulate user surveys to gather information on the efficacy of the system directly from users. This will include groups using the system to supply information to GIS, data analysis software and other data-driven applications. Evaluating a working system will allow CMARP to effectively and realistically assess how well this type of system will address its needs.

By using the Bay/Delta and Tributaries Relational Database Management System as a prototype, CMARP can quickly and efficiently provide a data management tool that can be utilized by CMARP data providers, data users, agency staffs, and stakeholder groups. Such an integrated data management system will be a highly efficient means of compiling information quickly and encouraging a much wider use of the data by multiple agencies and stakeholders, such as CDFG, CUWA, SFEI, DWR, and IEP. This system will be an invaluable resource to CMARP.

A more detailed description of the proposed CMARP Relational Database Management System can be found in the CMARP Data Management Work Group Appendix *VII.H.*

**Reports and Information Tracking**
A large number of reports are already generated by existing programs. Some examples of these reports are included in Tables 5-1 and 5-2, at the end of this chapter. CMARP will coordinate with existing monitoring program managers to get copies of their reports and facilitate getting those reports into the hands of CALFED decision-makers as quickly as possible. To keep the large amount of material involved organized, it is recommended that a systematic process for tracking, organizing, and querying the information, reports, and data sets from CALFED-related research and monitoring programs be developed.

## CMARP QUALITY ASSURANCE

The quality of the information used by CMARP depends on two different levels of focus:

1. the quality of the data collection and analysis by the individual programs and
2. the integration of data from several monitoring programs for regional analysis efforts.

- Individual Programs – The quality of data collection and analysis by individual programs can be divided into three basic areas:
  a) the adequacy of the quality assurance/quality control plan of the individual monitoring program,
  b) the effectiveness and efficiency of the monitoring plan design in meeting its stated goals and objectives, and
  c) how closely CALFED's needs match the needs and objectives of the individual monitoring program. These issues will be resolved on a case-by-case basis.

- Regional Coordination– Integration of data from multiple monitoring programs for regional analysis efforts is limited by three basic problems:
  d) dissimilar units, basic error-checking, resolving outliers, etc.,
  e) differences in sampling methodology, detection limits, precision, laboratory protocols, equipment, experience of personnel, and nomenclature, and
  f) gaps in space, time and frequency among current monitoring efforts.

These six issues (a through f) are discussed further in the Data Assessment and Reporting Team Appendix *VII.I*

The level of quality assurance is highly variable among the various monitoring programs in the CALFED Bay-Delta solution area. Each program has QA/QC standards and laboratory methods suitable to its own needs and convenience. In general the level of QA/QC for water quality measures is much higher than that for ecosystem measures. However, even for water quality measures, the detection limits among laboratories can vary greatly causing some programs to report "Not detectable" for some pesticides whereas a research-grade laboratory could report the actual concentration. This lack of consistency in QA/QC standards makes it difficult to combine and compare data from multiple monitoring programs.

In addition, the level of communication between the data collectors and data analyzers can greatly affect the quality of the information. Often if this communication is poor, inaccurate assumptions are made about how the data are collected. Ease of communication with the original data collectors should be maintained. Data included in a CMARP database must have some "confidence level" assessment attached to them about the accuracy of the data.

The current level of regional coordination among programs is unclear at present. Some programs, such as the San Francisco Regional Bay Monitoring Program and the U.S. Geological Survey National Water Quality Assessment Program, provide regional assessments of water quality. The Interagency Ecological Program is an effort to provide regional coordination of ecological monitoring and research. Further efforts at regional coordination will build on these efforts already in place.

It is important to note that CALFED and CMARP can only request that existing monitoring programs share their data and/or make changes in their existing monitoring design. It is hoped that existing monitoring programs will be willing to assist CALFED in meeting its needs, in exchange for being part of a regionally coordinated monitoring effort, and having better exchange of information and communication among researchers, particularly if CALFED is able to pay any additional costs that are incurred. Obviously each program's own needs and objectives are expected to take precedence over CALFED needs.

A final issue, which will help assure quality of data collection and analysis used by CMARP, is external review, particularly external peer review of study proposals and progress, and publication of results in peer-reviewed literature. CMARP will place a strong emphasis on publication of results in peer-reviewed literature and will use this standard in all its activities. The process of external review and peer review is further discussed in Chapter 6.

## INDICATOR SELECTION

Using indicators is an important method of summarizing and reporting large amounts of information in a concise and effective format. The development and analysis of indicators for trends is anticipated to be a major function of CMARP in the future. Indicators are defined as

> *"direct or indirect measures of some valued component or quality of a defined system, used to assess and communicate the status and trends of that system's 'health'."* [from a lecture given by Jim Bernard of the Green Mountain Institute for Environmental Democracy at the "CMARP Integration Workshop", October 21, 1998, Bodega Bay, California]

Some examples of indicators relevant to CMARP include: 1) spatial extent and distribution of habitat patches, 2) dissolved oxygen in river water near Stockton, 3) number of delta levee miles or islands/tracts meeting the minimum

99 standard, 4) the amount and quality of recycled water produced by treatment plants, 5) collection of juvenile chinook salmon at certain sampling locations that indicate the start of the spring salmon migration to the ocean, and 6) the position of X2.

Although some indicators could be the same as the monitoring elements identified by the CMARP work teams, indicators generally summarize information derived from multiple sampling locations in a way that is more informative to managers. For example, the total number of salmon harvested/year would be calculated from the reports of commercial and recreational harvest in the ocean, Sacramento and San Joaquin rivers, and tributaries.

Several different efforts at identifying indicators have already been undertaken. 1) the CALFED Indicators Group has developed a set of over 150 landscape level and ecosystem level indicators for assessing the health of the ecosystem (ERP Ecological Indicators Group, 1998), 2) the Environmental Defense Fund (October 8, 1998) has developed a set of approximately 10-12 core ecosystem indicators, 3) some CMARP Work Teams, such as Delta Levees and the Water Use Efficiency, have identified programmatic indicators, and 4) some of the CALFED Programs themselves, such as the Ecosystem Restoration Program, have developed programmatic indicators to evaluate the success of CALFED actions during Stage I. The efforts of these different groups will be integrated and developed further into specific, practical indicators that are agreed upon by all groups involved.

## ANALYSIS AND INTEGRATION

A great deal of analysis is occurring at the level of individual projects. However, the areas where CMARP can provide the greatest assistance are the regional analysis and integration of research and monitoring results in the CALFED Bay-Delta solution area. These higher levels of integration involve the analysis of indicators, analysis of adaptive management experiments, and better coordination among GIS efforts.

### Analysis of Indicators

Much of the information needed to calculate CALFED indicators can be gleaned from existing agency reports and databases. Examples of such reports are shown in Tables 5-1 and 5-2, at the end of this chapter. Where such information is sufficient for CALFED purposes, the role of CMARP will be to facilitate the process of synthesizing and transmitting the information to decision-makers and to make the information generally available. Where the current analysis and reporting mechanisms are inadequate to meet CALFED needs, CMARP will focus on arranging for additional analysis and reporting, preferably by those researchers actually involved in collecting the information. However, CALFED should be willing to pay for these additional analyses to be conducted in a timely fashion. Unfortunately, when unpaid requests for analyses and reporting are made of busy researchers and agency staff, they receive low priority and serious time delays in reporting occur. Some specific types of analyses are anticipated.

Development of Baselines—To gain sufficient understanding of the Bay-Delta System upon which to make decisions and to evaluate the effect of CALFED actions once initiated during Stage I Implementation, it is important that baselines for indicators be developed as soon as possible using historical information and data collected before implementation actions begin.

Regional analysis across wide spatial and temporal scales—An important function of CMARP is the coordination of regional monitoring efforts among programs so that new analyses can be conducted across wide spatial and temporal scales. Regional

monitoring and analysis provides a broader, landscape-level picture than is achieved by looking at individual locally-targeted monitoring projects. Well-organized regional analysis can detect trends earlier with greater confidence since variation across space and time can be more accurately assessed. The data can also be used for evaluating correlations among different types of data (e.g., effects of nutrients, temperature and light on productivity) and for improving sampling methodology. Studies of this kind have already been used in IEP-related studies to refine the information needs of water quality, nutrient, and plankton sampling programs (i.e. what are the tradeoffs between the number of sites and the frequency of sampling in terms of being able to detect certain kinds of changes).

An example of how pulling together information on a regional scale is useful for decision-making is the process the CALFED Ops Group uses to anticipate salmon outmigration and reduce entrainment at the pumping facilities. This process is described briefly in Example A at the end of this chapter.

Develop correlations and hypotheses about cause-effect relationships—Various areas of uncertainty exist about the San Francisco Bay-Delta, such as how the ecosystem functions and reacts to change or how water transfers affect neighboring areas. Although a great deal of data are collected throughout the San Francisco Bay-Delta and its associated watershed, the agencies collecting these data sometimes do not have the time or the resources to analyze the data beyond the scope of their program's objectives. It is expected that some of these data can be combined and analyzed to identify possible cause-effect hypotheses, which can then be used as a foundation for prioritizing research needs. One function of CMARP will be to sort through the numerous uncertainties identified by the CMARP workteams, determine those addressable with existing information, and arrange for those analyses. An additional task is to continue monitoring currently established correlations for changes that can indicate shifts in the functioning of the system. Example B at the end of this chapter shows such a shift. In this example, mysid abundance is weakly correlated with the position of X2 until the late 1980's when clam density began to increase. In this case, the introduction of a new species changed the strength of existing correlations in the system.

**Adaptive Management Experiments**

The CALFED program is committed to a process of adaptive management, which will involve experiments. CMARP will work to facilitate communication between researchers and decision-makers to identify where adaptive management can be effectively applied and to design experiments that will yield as much information as possible without compromising other management issues or causing undue risk to species of concern. This will likely involve experiments that manipulate the system to better determine cause-effect relationships and pilot projects to test hypotheses of system functioning. CMARP will also facilitate analysis and reporting of these experiments by those researchers and agency staff most directly involved.

The Vernalis Adaptive Management Program (VAMP) and the CVPIA Delta Action 8 program provide examples of existing adaptive management experiments. The VAMP program investigates the relationship between juvenile salmon survival and flows and export rates in the San Joaquin River in April-May. The CVPIA Delta 8 program investigates the relationship between juvenile salmon survival in the Sacramento River under different export regimes in December-January.

**Geographic Information Systems (GIS)**

A comprehensive assessment of the GIS needs of CALFED and greater coordination

among GIS efforts is necessary in the CALFED Bay-Delta solution area. The creation of a GIS team is discussed in Chapter 7.

## REPORTING

An important tool in communications between researchers and decision-makers is an effective reporting system. An effective reporting process facilitates getting focused and understandable interpretations of the overwhelming amount of information currently being generated about the CALFED Bay-Delta system into the hands of decision-makers. This will involve compiling and evaluating the results from monitoring of indicators, research programs, regional monitoring analyses, real-time monitoring data, permitting and regulation requirements, GIS efforts, and computer modeling efforts and delivering it to decision-makers in a manner that is accessible, timely and understandable.

**Characteristics of reporting system**
CMARP's reporting role is to (1) make its information accessible to all interested CALFED participants, (2) facilitate the process of integrating and summarizing the information to the extent desired by decision-makers and the public, (3) sift through this information to find that information specifically requested by decision-makers and facilitate getting the information to them, (4) ensure presentation in a format that is clear and understandable to decision-makers, and (5) facilitate managers' understanding of the science involved and facilitate scientists' understanding of management needs.

CMARP will be building on current reporting efforts to meet the needs of CALFED program managers. Some examples of these reports are shown in Tables 5-1 and 5-2, at the end of this chapter. Table 5-2 provides a preliminary summary of web-page real-time monitoring reports.

The reporting system should be characterized by transparency, accessibility, objectivity, reliability, high quality and rapid reporting of results.

**Types and Frequency of Reports**
The types and frequency of reports will be determined by the needs of the public and of CALFED program managers. Each of the CALFED Programs is different in nature and purpose and has differing reporting needs. These needs will be more completely understood as the CALFED process moves forward. Reporting needs are expected to range greatly in frequency and content including annual reports, a science conference, real-time monitoring, monthly and quarterly reports, fact sheets, responses to information queries, and web page reporting. Listed below are the reporting recommendations for the future CMARP. The amount of staff resources available and the priorities dictated by CALFED and CMARP will determine whether each recommendation is implemented and the quantity of such activities. It is of critical importance that managers receive the information they need in time to assist decision-making.

General Annual Reports— The general annual report should be a joint effort between CALFED and CMARP and include contents reflecting the activities of each. This annual report would be directed primarily towards the public, stakeholders and legislative staff. The recommended content of the annual report includes: 1) summary of CALFED actions taken during the year, 2) status of indicators for valued system components and their influencing factors, 3) status of CALFED program goals and objectives, 4) highlights of what has been learned, both positive and negative, during the year, 5) highlights from research projects completed and underway, and 6) a fiscal summary. The recommended delivery date of the Annual Report is the third week of April (approximately the same time as the IEP spring newsletter currently comes out, which includes indicators that should also

be included in the Annual Report). The first annual report delivery date is recommended to be April 20, 2001. A trial annual report focusing on Category III Project results could be made in April 2000.

Annual Science Reports—An annual science report is recommended to report the proceedings of the Annual Science Conference and to summarize the monitoring and research results of the previous year. This report would be targeted to a more scientific and technical audience than the General Annual Report.

Annual Science Conference—An annual science conference is recommended to bring CALFED Program Managers, scientists, and agency staff together. Various research and monitoring efforts would be briefly reported and new issues raised. The Annual Science Conference is described further in Chapter 7.

Real-Time Monitoring Reporting—CMARP expects to use some real-time monitoring reporting. Real-time monitoring refers to the near-immediate reporting of data usually with a delay between collection and reporting ranging from a day to a few weeks depending on the type of data. Although such data typically are "raw" and often have not been reviewed for quality control, the information is useful for compliance monitoring and for early detection of changes and problems so program managers can respond quickly or initiate more focused monitoring or research.

In particular, the CALFED Ops Group already makes effective use of real-time monitoring, using data that relate stream-flow, turbidity, and the location of species of concern in the Delta to make decisions about pumping Delta exports. CMARP will not interfere with decision support systems that are already working well, but will attempt to facilitate the process of getting information to decision-makers, where needed, and to increase access of this information to other CALFED program managers.

The Water Quality Program anticipates needing monthly status reports, which will probably include a brief 3- to 4-page summary of the status of water quality indicators, and monitoring elements. Each of the CALFED water management programs (Storage, Conveyance, Water Transfers, Water Use Efficiency) will need regular access to information such as water flow-rates, height (stage), water quality and ground-water levels.

Because real-time monitoring can be expensive, CMARP will coordinate reporting of results from existing real-time monitoring efforts. Initiating new real-time monitoring efforts will be considered only after the considerations of purpose, expense, and diminished data-quality risk have been weighed.

Periodic Technical Meetings & Bulletin—Maintaining an atmosphere of open communication between science, management and stakeholders should help increase understanding and cooperation among the three groups and encourage proactive solution of problems. Frequent technical workshops or meetings are recommended, possibly on a quarterly basis, during which CALFED program managers, CMARP, scientists, managers, and stakeholders can meet for 1) updates on progress, 2) explanation of what the data reveal, and 3) discussion of new issues. A quarterly bulletin could be issued for the purpose of this workshop.

Fact Sheets – Development of fact sheets is another important reporting function. Fact sheets are 1-4 page summaries used to quickly and effectively explain important issues and increase public awareness. Some possible examples include descriptions of important non-indigenous species, descriptions of conceptual models of ecosystem functioning, and answers to frequently-asked questions.

Information Query Response—One important function of CMARP is to organize information so that it can be easily queried by managers, scientists, and other interested parties. In addition to having information on the web, CMARP will also respond directly to queries for information from program managers, scientists, agency staff, and stakeholders. Some queries will be simple requests for information; for example the Delta Levees Program will likely need to be able to query the status of delta-levee monitoring on a regular basis. Other requests for information will require some additional analysis and work, such as a request for information relating to a new invasive species (e.g., mitten crab collection at the south-delta pumps). CMARP's role will be to channel the request for this information, with funding, to those researchers and agency staff with the best ability to answer the question and to facilitate getting a timely response to decision-makers.

This process will be developed further as the specific needs of each of the CALFED programs become clear. As CMARP evolves, the ability to answer queries efficiently and quickly depends on the amount of staff time available and the amount of time and effort needed to create an accessible and frequently updated web page.

Web Page Reporting—CMARP will make intensive use of web-page technology to make information available quickly and effectively to all interested parties. It is anticipated that the CMARP web page will include (1) current status of public indicators, program manager level indicators, and additional monitoring elements of special interest to scientists, agencies and stakeholders; (2) access to metadatabase information compiled through the CALFED process; (3) access to the CMARP monitoring and research database; (4) copies of annual reports, quarterly and monthly status reports and journal articles related to CMARP; and (5) links to related web sites.

Creating and maintaining this web page will require planning and investment in staff and training from the beginning. In the long run, this investment will greatly reduce the amount of staff time spent answering queries for basic information and greatly increase access of information to all interested parties.

## CONCLUSIONS

In conclusion, by 1) providing better organization of and access to information, 2) coordinating CALFED needs with existing programs, 3) providing regional focus and coordination of monitoring and research, 4) identifying and filling gaps in data collection, assessment, quality assurance, management and reporting, 5) facilitating the process of converting data into condensed information usable by decision-makers, and 6) improving communication between scientists and decision-makers, CMARP will be providing a very needed service to CALFED itself, to CALFED agencies, and to the stakeholders.

## EXAMPLES AND TABLES

### Example A. An Example of the CALFED Operations Group Decision-Making Process

The CALFED Operations Group has developed a hierarchical consensus-driven process for quickly incorporating current environmental information into decisions regarding operations of the Central Valley Project (CVP) and the State Water Project (SWP). This process is depicted in Figure 5-5 and is summarized below. A more detailed description of the process is in the Data Assessment and Reporting Team Appendix *VII.I.*

To accomplish this process the CALFED Ops Group established the "No-Name Group" which keeps all involved agencies and interested parties informed about the

take of environmentally threatened or endangered listed species and other related issues that affect CVP/SWP operations. Sub-groups have been created which in turn analyze data and propose operation actions regarding specific issues such as winter-run chinook salmon, delta smelt, real-time fish monitoring, etc.

One such sub-group is called the Data Assessment Team (DAT) which consists of biologists from CALFED agencies and stakeholder group and CVP/SWP operators. This group compiles and interprets fishery-related data and disseminates the interpreted information to the CALFED Ops Group. DAT has been involved with evaluating spring-run Chinook salmon. DAT assesses data compiled from 13 sites for two indicators of the start of the spring run: either direct capture of Chinook salmon or abrupt changes in river flow or water clarity which are often associated with the beginning of the salmon run. When an indicator is found, DAT assesses the situation and makes recommendations within 24 hours for the adjustment of CVP/SWP operations. DAT then notifies the No-Name Group Chair, CVP/SWP Operators, and the co-chairs of the CALFED Ops Group.

Figure 5-4 shows a simple conceptual model relating water pumping in the south Delta, water supply reliability and health of the salmon. Figure 5-5 shows the decision process of the CALFED Ops Group. Figure 5-6 shows the relationship between salmon salvage, river flow rates, delta outflow rates and time of year.

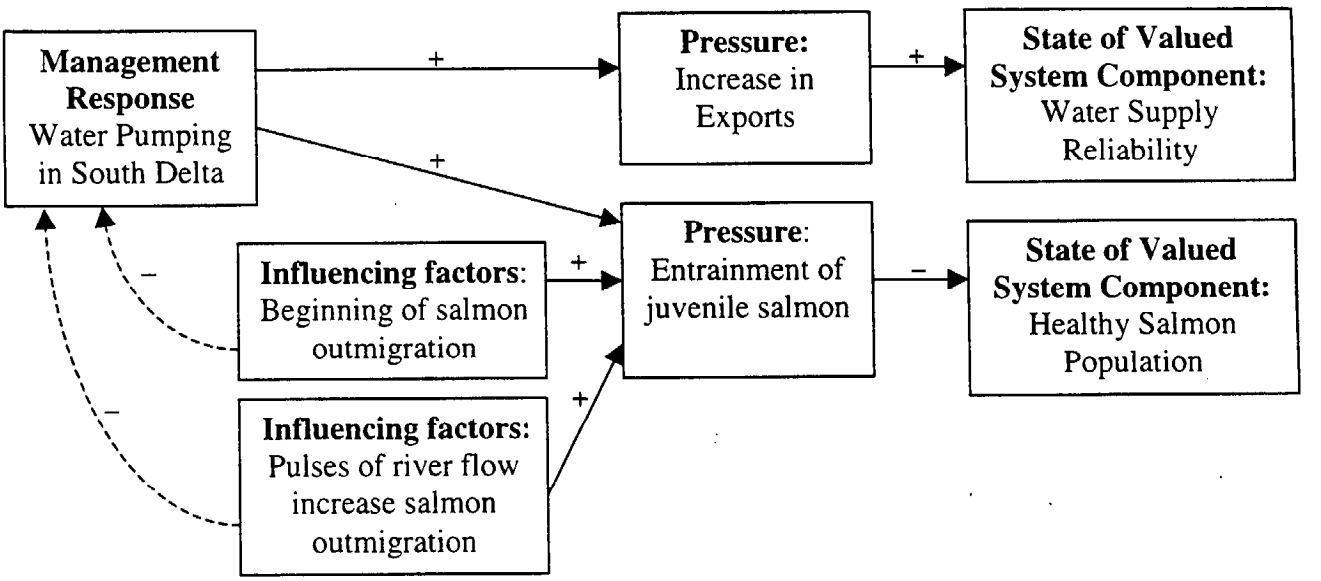



Figure 5-4. Relationship between management of water pumping in south Delta and corresponding effects on water supply reliability and the salmon population.

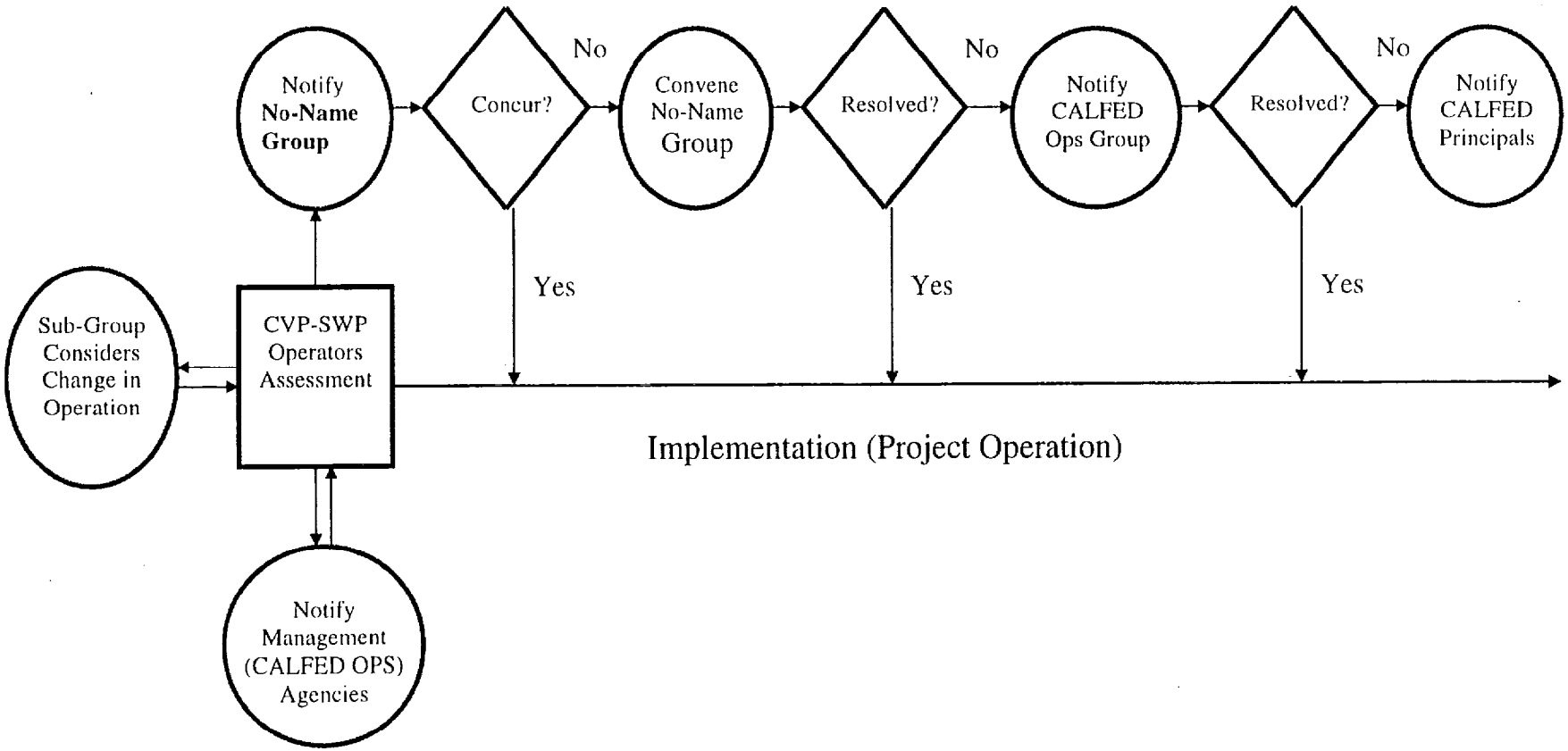
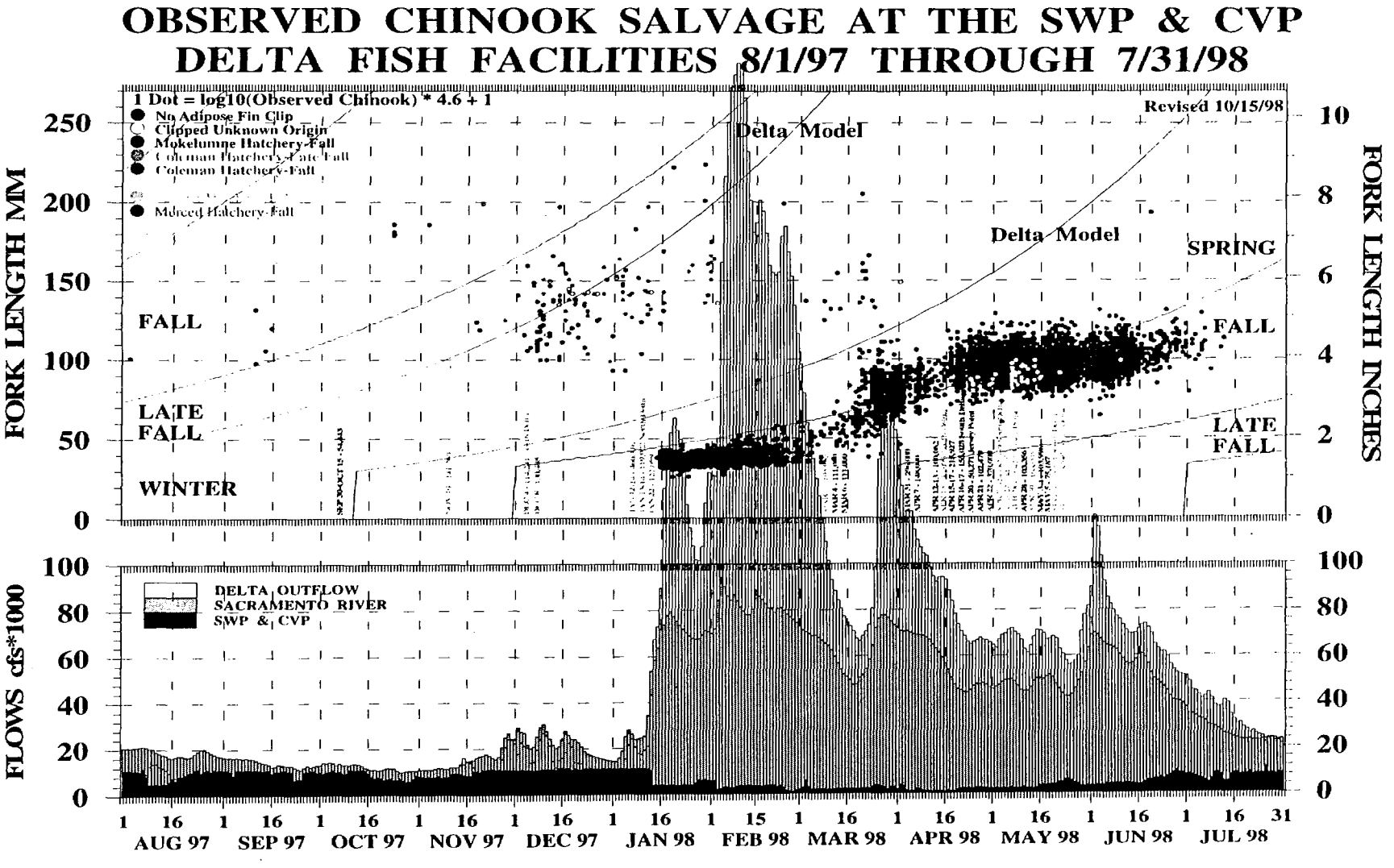



Figure 5-5. CALFED Ops Group Decision Process

**Figure 5-6.** Plot of Chinook salmon incidental take at the SWP & CVP Delta Fish Facilities from 8/1/97 through 7/31/98 created by Sheila Greene, Dept. of Water Resources. In addition to showing Chinook salmon salvage, the plot relates salmon salvage to flows and exports and shows the timing between hatchery releases and recapture at the facilities. The plot also shows the length criteria the hatchery fish fall in. For example late-fall chinook are released from Coleman hatchery from November to January. The plot shows how many of the recovered late-fall hatchery fish actually fall in the late-fall length criteria.



**Example B. Correlating Mysid abundance, X2 Position, and Clam density**

Developing correlations among different types of data are useful for discerning possible cause-effect relations, which can be further researched through an RFP process. In addition such correlations are important for discerning developing problems. For example, the following figure shows that mysids were weakly correlated with X2 position until the late 1980's when clam density began increasing. This emphasizes that the San Francisco Bay-Delta ecosystem is a constantly changing system. Coordination between managers and researchers is needed to rapidly identify such changing relationships and incorporate them into the decision-making process.

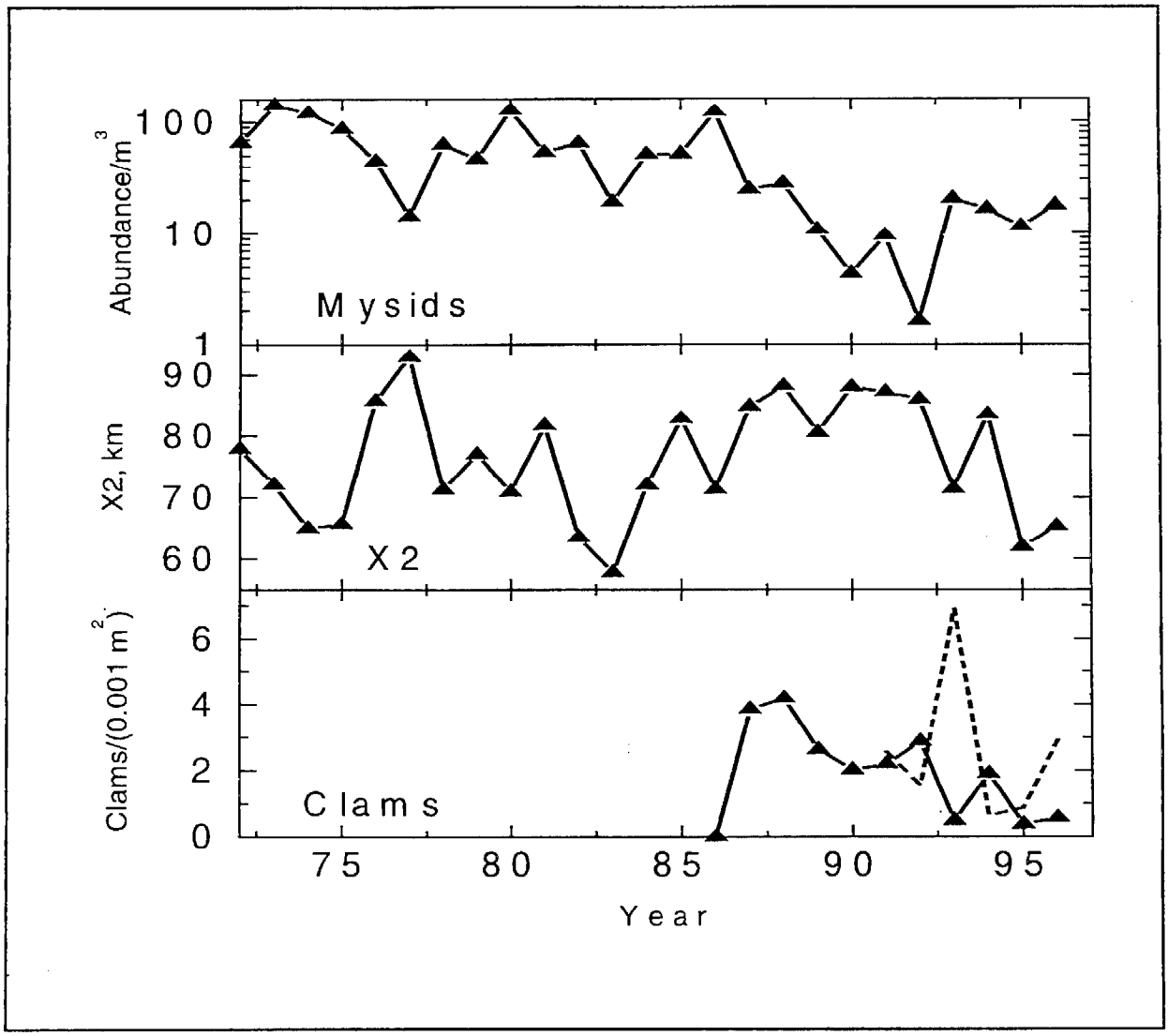



Figure 5-7.Time series for mysids (*Neomysis* and *Acanthomysis*) (top graph), X2 (middle graph), and clams (*Potamocorbula amurensis*) (bottom graph), annual means for sampling seasons for stations in Grizzly Bay (triangles) and San Pablo Bay (dashed line). Mysid abundance is weakly related to X2, but evidently affected by clams: the lowest abundances of mysids were post-clam, and even when flow increased after the drought in the 1980's-90's, mysid abundance failed to recover much beyond its previously lowest value.

Table 5-1. Examples of periodic and non-periodic reports from agencies and programs in the CALFED Bay-Delta solution area.

| Periodic Reports | | |
|---|---|---|
| **Program Acronym** | **General Report Title or Reference** | **Frequency** |
| CAMP | Comprehensive Assessment & Monitoring Program Annual Report | Annual |
| DWR | Cal. Dept. of Water Resources—Bulletin 120: Water Conditions in California | Annual |
| | Dept. of Water Resources-- Bulletin 160: California Water Plan | Every 5 yrs |
| | Dept. of Water Resources-- D1485 Annual Water Quality Report | Annual |
| | Dept. of Water Resources-- Reclamation Board General Manager's Report | Monthly |
| | Dept. of Water Resources-- Water Conservation News | Quarterly |
| IEP | Interagency Ecological Program (IEP) Annual Reports | Annual |
| | Interagency Ecological Program (IEP) Newsletter | Quarterly |
| PRBO | Point Reyes Bird Observatory--Flight Log: Newsletter of the California Partners in Flight—*http://www.prbo.org/PRBOJournals.html* | Biannual |
| | Point Reyes Bird Observatory--Observer Online *http://www.prbo.org/PRBOJournals.html* | Biannual |
| RMP | Regional Monitoring Program (RMP) Annual reports | Annual |
| | Regional Monitoring Program (RMP) Quarterly Newsletter | Quarterly |
| RWQCB | Regional Water Quality Control Board reports | |
| SCMP | Sacramento Coordinated Monitoring Program Annual Report | Annual |
| | Sacramento Coordinated Monitoring Program Summary Report | Every 2-3 yrs |
| SFEI | Grasslands Bypass Monitoring Program - monthly, quarterly, annual reports | monthly, quarterly, annual |
| SFEP | San Francisco Estuary Project "Estuary" Newsletter | bi-monthly |
| SWP /CVP | "Preliminary SWP and CVP Salvage Estimates" weekly report from the Fish Facilities Monitoring Unit, Bay-Delta & Special Water Projects Division, California Department of Fish & Game | weekly |
| USGS | U.S. Geological Survey-- Water Resource Data Annual Reports | Annual |
| | Sacramento River Watershed Program Annual Report | Annual |
| | Sacramento River Watershed Program Monitoring Plan | Every 2-3 yrs |

| Non-Periodic Reports | |
|---|---|
| **Program Acronym** | **General Report Title or Reference** |
| USACE | PL84-99Delta Specific Standard and PL84-99 Overview |
| CVAP | Central Valley Aquifer Project Reports |
| DWR | 1995 Inspection Report: Flood Control Project Maintenance Repair |
| | Dept. of Water Resources—Bulletin 118: Evaluation of Groundwater Resources |
| | Dept. of Water Resources—Bulletin 192-82: Delta Levees Investigation |
| IEP | Interagency Ecological Program Technical Report Series |
| FEAT | Final Report of the Governor's Flood Emergency Action Team: May 10, 1997 |
| NAWQA | National Water Quality Assessment Program- Sacramento River Basin & San Joaquin-Tulare Basin Reports |
| PRBO | Point Reyes Bird Observatory--Scientific Publication & Special Reports *http://www.prbo.org/Publ.html#Focus* |
| RASA | Regional Aquifer-System Analysis (RASA) Program Reports |
| RMP | Regional Monitoring Program (RMP) Technical Report Series |

| Program Acronym | *Non-Periodic Reports*—continued<br>General Report Title or Reference |
|---|---|
| SFEI | Biological Invasions Program Studies & Reports |
| SFEP | San Francisco Estuary Project Status & Trends Reports |
| SJVDP | San Joaquin Valley Drainage Program Reports |
| SWRCB | California Environmental Protection Agency – State Water Resources Control Board – Publications *http://www.swrcb.ca.gov/* |
| USGS | Historical work by Joe Poland on Land Subsidence, for example "Land Subsidence in San Joaquin Valley, California as of 1980", USGS Professional Paper 437i by Ireland, Poland and Riley, 1984. |
| | San Francisco Bay Estuary & Dixon Field Station studies |
| | "Land Subsidence Case Studies & Current Research", Association of Engineering Geologists Special Publication No. 8, 1998, 576 pages |

Table 5-2. Examples of real-time monitoring web-page reporting from agencies and programs in the CALFED Bay-Delta solution area.

| ***Real-Time Monitoring Web Page Reports*** | | |
|---|---|---|
| **Program Acronym** | **Web page name** | **Current Reports** |
| Audubon | Birdsource Bird Counts<br>*http://birdsource.cornell.edu/* | Audubon Christmas Bird Count |
| CDFG | California Dept. of Fish & Game—Central Valley Bay-Delta Branch—Fish Facilities Unit Monitoring & Operations Projects<br>*http://www.delta.dfg.ca.gov/* | Fish Salvage Monitoring; Striped Bass Monitoring; Spring Run Chinook Salmon; Delta Smelt |
| DWR | California Dept. of Water Resources California Cooperative Snow Surveys<br>*http://cdec.water.ca.gov/snow/* | Snowpack Status; Precipitation; Runoff; Reservoirs; Water Supply |
| | California Dept. of Water Resources California Data Exchange Center<br>*http://cdec.water.ca.gov/index.html* | Current River Conditions; Snowpack Status; River Stages/Flows; Reservoir Data/Reports; Weather Forecasts; Precipitation/Snow; River/Tide Forecasts; Water Supply; |
| | California Dept. of Water Resources Delta Environmental Compliance Section<br>*Http://wwwoco.water.ca.gov/cmplmon /Cmhome.html* | Delta Ops Summary; Water Quality Conditions; Hydrology Conditions; Bay-Delta Standards; Delta Smelt; Winter-Run Salmon |
| | California Dept. of Water Resources<br>*Http://wwwdwr.water.ca.gov/* | Surface Water; Ground Water; River Forecast; Reservoir Info |
| | California Dept. of Water Resources Municipal Water Quality Investigations<br>*Http://wwwdla.water.ca.gov/supply /sampling/mwq/main.htm* | Water Quality Conditions |
| | California Dept. of Water Resources State Water Project Analysis Office<br>*Http://wwwswpao.water.ca.gov/* | General Information |
| | California Dept. of Water Resources State Water Project Operational Reports<br>*http://wwwoco.water.ca.gov/subpages /opreports.menuo.html* | SWP Operations Data |

| Program Acronym | Web page name | Current Reports |
|---|---|---|
| DWR (cont.) | California Dept. of Water Resources State Water Project Water Quality Monitoring Program *http://wwwomhq.water.ca.gov/wq/astalist.htm* | Automated Water Quality Stations; Pathogen Monitoring Program; Pesticides, Herbicides & Other Organic Substances |
| IEP | Interagency Ecological Program Real-Time Monitoring *http://www2.delta.dfg.ca.gov/data/rtm98/* | Fish sampling |
| | Interagency Ecological Program *http://www.iep.ca.gov/data.html* | Time Series Database; Long-Term Monitoring Data; Historical Short-Term (Special) Studies; Estuary Data Viewer--Water Quality; IEP Comprehensive Database |
| SFEI | San Francisco Estuary Institute Regional Monitoring Program Data *http://www.sfei.org/rmp/data.htm* | Conventional Water Quality Parameters; Trace Elements; Trace Organics; Aquatic Bioassays; Sediment Bioassays; Sediment Quality Characteristics; Bivalve Condition & Survival |
| USACE | U.S. Army Corps of Engineers Water Control Data System *http://www.spk-wc.usace.army.mil/* | Midnight Reservoir Status; Monthly Reservoir Reports; Reservoir Storage, Inflow, Outflow; Hourly Time Series Reports; Release Change Notification; Average Reservoir Status; Weather & River Forecasts/Summaries |
| USBR | U. S. Bureau of Reclamation Central Valley Operations *http://www.mp.usbr.gov/cvo/index.html* | CVP Water Supply Report (DAMS); Sacramento River Temperature Report; Delta Accounting Reports; COA Report; Folsom Permissible Storage; Monthly Water Operations Forecast; Trinity River Flow Schedule; Delta Outflow |
| USFWS | USFWS Bird Monitoring *http://www.fws.gov/r9mbmo/statsurv /mntrtbl.html* | Bird Monitoring |
| | USFWS-SSJEFRO Chinook Salmon Monitoring Summary Report *http://www.delta.dfg.ca.gov/baydelta/monitoring /ychin.html* | Fall, late-fall, spring and winter run chinook salmon caught by gear type. Coded wire tag releases & recoveries |
| USGS | U.S. Geological Survey-- San Francisco Physical Oceanographic Real-Time System *http://sfports.wr.usgs.gov/sfports.html* | winds; currents; current profiles; forecasts |
| | U.S. Geological Survey--Water Resources of California Real-Time Data *http://wwwdcascr.wr.usgs.gov/sites/* | Streamflow Network |
| | U.S. Geological Survey-- Bird Monitoring in North America *http://www.im.nbs.gov/birds.html* | USGS Bird Monitoring in North America |
| | U.S. Geological Survey- Water Quality of San Francisco Bay-*http://sfbay.wr.usgs.gov /access/wqdata/* | Water Quality in San Francisco Bay |