APPENDIX E

Monitoring and Adaptive Management Framework

TABLE OF CONTENTS

Appendix E Monitoring and Adaptive Management Framework E-1
E.1 Introduction E-1
E.2 Adaptive Management Process E-1
E.3 Monitoring Framework E-2
E.3.1 Objective-Based Monitoring E-2
E.3.2 SCH Monitoring Plan Development E-3
E.3.3 Elements of Monitoring Plan E-4
E.4 Data Management and Assessment E-4
E.5 Decision-Making Process E-5
E.6 References E-5

TABLES

Table E-1 SCH Objective-Based Monitoring Framework E-3

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Appendix E

Monitoring and Adaptive Management Framework

E.1 Introduction

The two goals of the Salton Sea Species Conservation Habitat (SCH) Project are (1) to provide aquatic habitat to support fish and wildlife species dependent on the Salton Sea, and (2) to develop and refine information needed to successfully manage the SCH Project. The Project is intended to serve as a proof of concept for the long-term restoration envisioned for the Salton Sea. Therefore, the SCH Project is being developed consistent with the principles of adaptive management with the following objectives for its second goal:

1. Identify uncertainties in achieving the objectives of providing habitat and prey for piscivorous birds and minimizing impacts on species (e.g., selenium, disease);

2. Design science-based means to test alternatives and reduce uncertainty;

3. Develop and implement a monitoring plan that measures key indicators of SCH Project performance;

4. Develop a decision-making framework to evaluate data, adjust management, and refine operations and monitoring as needed to achieve Project goals; and

5. Provide proof of concept for future restoration to verify that the core ideas are functional and feasible prior to full scale restoration of the Salton Sea.

The purpose of this document is to present a monitoring and adaptive management framework to guide evaluation and improved management of the newly created habitat, as well as to inform future restoration. Because the SCH Project has not reached final design or construction, this document does not include the detailed protocols and site-specific sampling design necessary for actual implementation. A more detailed monitoring plan and decision-making process would be developed should the SCH Project be constructed.

E.2 Adaptive Management Process

Adaptive management is a process that promotes flexible decision-making that can be adjusted as new and improved information becomes available about outcomes of management actions and other events (Williams et. al 2007). Adaptive management provides the necessary flexibility and feedback to manage complex natural resources in the face of considerable uncertainty about the effectiveness of specific management actions. It is an iterative process with the following steps:

1. **Plan –** Define/redefine the problem, establish goals and objectives, develop restoration alternatives;

2. **Design –** Develop designs and operational scenarios for habitat ponds, develop monitoring framework;

3. **Implement –** Design, construct, and operate the SCH ponds;
4. **Monitor –** Conduct monitoring to detect change and determine status of resources;
5. **Evaluate –** Analyze, synthesize, and manage data; and
6. **Adapt and Learn –** Make any necessary adjustments to management, share information.

Because uncertainties remain about habitat function and biological responses at the ponds, the SCH Project is being designed with a range of operational scenarios (Appendix D, Project Operations) to evaluate the effectiveness of different management actions. A monitoring program would be implemented to collect data necessary to operate and evaluate the Project's success.

E.3 Monitoring Framework

E.3.1 Objective-Based Monitoring

Monitoring is a fundamental element of adaptive management because effective evaluation and management requires information about the status of target resources and their response to management activities. The information obtained would be used to measure Project effectiveness, to refine operation and management of the SCH ponds, to reduce uncertainties about key issues, and to inform subsequent stages of habitat restoration at the Salton Sea.

Monitoring can be defined as the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective (Elzinga et al. 1998). Inherent in defining monitoring as part of the adaptive management cycle are two key concepts (Elzinga et al. 1998). The first is that monitoring is driven by objectives. The objective describes the desired condition. Management is designed to meet the objective and monitoring is designed to determine if the objective is met. Objectives form the foundation of the entire monitoring project. The second concept is that monitoring is only initiated if opportunities for management change exist.

Monitoring efforts would be guided by the specific SCH Project objectives and desired outcomes. Table E-1 outlines the Project's objectives to meet its primary goal of providing aquatic habitat to support fish and wildlife species dependent on the Salton Sea. What is measured (indicator), how well it is measured, and how often it is measured are design features that would be defined by how an objective is articulated (Elzinga et al. 1998). The next step would be to define, quantitatively or qualitatively, the specific desired outcomes for each objective and to identify appropriate indicators for measurement. Monitoring should focus on the most informative, efficient, and cost-effective indicators and methods. Types of potential indicators include:

- Triggers for real-time pond operations – salinity, storage, residence time (inflow and outflow rates), depth;
- Performance measures – attributes of target species and their habitat, such as physical habitat conditions, water quality, and distribution, abundance and composition of aquatic invertebrates, fish and birds; and
- Threat indicators – contaminants of concern (selenium), mosquitoes, disease outbreaks.

Table E-1 SCH Objective-Based Monitoring Framework

Goal 1 - Provide aquatic habitat to support fish and wildlife species dependent on the Salton Sea	
Objectives	Examples of Potential Indicators
1. Provide appropriate foraging habitat for piscivorous birds	• Fish species, relative abundance, and size distribution
2. Develop habitats to support piscivorous birds	• Bird utilization (species, numbers) of islands and snags • Bird roosting and nesting activiity
3. Support a sustainable, productive aquatic community	• Fish species composition and abundance • Aquatic invertebrates • Phytoplankton
4. Provide suitable water quality to sustain productive fish community	• Salinity • Dissolved oxygen • Temperature • Water depth
5. Minimize adverse effects on desert pupfish	• Pupfish relative abundance and distribution in ponds • Pupfish connectivity from drains around the ponds
6. Minimize impacts from selenium	• Selenium concentrations in water and sediment • Selenium concentrations in invertebrates and fish • Egg selenium concentrations
7. Minimize impacts from disease or toxicity	• Bird die-offs - species, number, disease mechanism • Fish die-offs • Contaminant concentrations in bird eggs

E.3.2 SCH Monitoring Plan Development

A detailed monitoring plan would be developed once the final SCH Project design was approved. The actions identified in the monitoring plan would be based on the information needed to operate the Project facilities, to evaluate success and threats, and to help resolve remaining uncertainties, as well as available funding and monitoring requirements for compliance.

The SCH monitoring plan would be developed in coordination with broader efforts to plan for restoration of the Salton Sea ecosystem. The Salton Sea Ecosystem Monitoring and Assessment Plan (MAP) is being developed by the California Department of Water Resources (DWR), California Department of Fish and Game (DFG), Bureau of Reclamation, and United States Geological Survey (USGS in preparation). The MAP will provide a blueprint for quantitative evaluation of ecosystem restoration activities and will serve as a cornerstone for scientific studies that will help guide efforts to restore the Salton Sea. The SCH monitoring plan protocols would be consistent with the MAP.

Design and implementation of SCH monitoring would also be coordinated with ongoing and proposed survey and monitoring efforts at the Salton Sea to share and build on available data. This coordination would be especially valuable for evaluating SCH performance relative to other reference sites and for understanding regional patterns of physical and biological change. Examples of past and ongoing studies include biological surveys by DFG, monitoring at the Sonny Bono Salton Sea National Wildlife Refuge by the United States Fish and Wildlife Service, water quality monitoring by the Bureau of Reclamation, studies of water quality and biota in agricultural drains and rivers by USGS, bird surveys by the Natural History Museum of Los Angeles County, surveys for the Imperial Irrigation District's Habitat

Conservation Plan/Natural Community Conservation Plan, and studies of selenium and other contaminants by university researchers (University of California Riverside, San Diego State University, University of California Berkeley).

E.3.3 Elements of Monitoring Plan

The SCH monitoring plan would include several monitoring elements, modeled on the MAP framework. Each monitoring element would include a description of the purpose and justification for the monitoring activity, location(s), time period(s) and frequency of monitoring, protocol(s) for data collection, a description of the data to be collected and the anticipated use of the data, proposed quality assurance measures, reporting, and an overview of similar monitoring activities and opportunities for integration. The frequency of data collection and evaluation would be guided by the purpose of monitoring. For example, operational triggers such as water supply flow rates would be measured daily or weekly, while status of target resources would be monitored seasonally or annually. A detailed monitoring protocol would be developed prior to initiating monitoring activities in the field. This protocol would include a description of the measures that would be taken to ensure the quality of the data collected and how those measures would be implemented. The data quality assurance measures may include, but would not be limited to, procedures for calibrating or ensuring the accuracy of any instruments (e.g., GPS) employed in the field, procedures for recording and transferring electronic data, methods for ensuring proper operation of field equipment during surveys, and methods for avoiding double counting or insufficient coverage of survey areas.

Key monitoring elements would include the following:

- Physical Habitat – flow rate, depth, wetted area, islands, snags, submerged vegetation, and other habitat elements;
- Water Quality – salinity, temperature, dissolved oxygen, nutrients;
- Aquatic Biota – algae, plankton, invertebrates, fish community (species, distribution, abundance), desert pupfish;
- Birds – species, abundance and distribution, use of habitat features, breeding and nesting, sick or dead birds; and
- Contaminants – selenium concentrations in water, sediment, bird eggs, and other biota (invertebrates, fish).

E.4 Data Management and Assessment

Data collected, stored, or made accessible from the data management system would be available to the SCH Project team for the application of statistical and other analytical techniques. Data assessment would be used to foster the integration, consolidation, and review of data, updating of conceptual models, answering of key questions, reporting, and providing management recommendations. Consistent review and assessment of the data would be needed to assure that performance objectives are being met and that funding for data collection is effectively utilized. In addition to program-level data assessment and analysis, data assessment should take place at the individual monitoring activity level through regular evaluation and assessment of data collected over time. This individual monitoring would help ensure data quality and usefulness relative to meeting monitoring objectives.

Each year that surveys are conducted, an annual report would be generated that summarizes the data collected during that year and updates prior reports in a cumulative fashion. A synthesis report would be

prepared at the end of the 10-year proof-of-concept period with final recommendations for long-term SCH management.

Data, analyses, and publications developed from this monitoring plan would be organized, stored, and made publicly accessible through a common distributed data management system, in coordination with the broader Salton Sea MAP efforts. Common protocols would be developed and applied when possible, and all geospatial data would include full metadata and would be compliant with the Federal Geographic Data Committee (FGDC) standards. DFG would establish and maintain the data management system. The data collected as part of the Salton Sea restoration program would be stored in DFG's Biogeographic Information and Observation System (BIOS) map viewer and all documentation including metadata would be accessible to the public via metadata clearinghouses and DFG's document library.

E.5 Decision-Making Process

To track progress in meeting SCH Project objectives, the scientists and managers responsible for the Project would regularly synthesize and analyze the monitoring data and evaluate the status and trends in target resources through the use of monitoring data. An overall review would be conducted annually to evaluate Project performance. A decision-making framework would be established to provide recommendations to SCH managers for maintaining or adjusting operations.

The managers of the SCH Project, DFG and DWR, must have the capacity to change practices in response to what is learned over time. Governance for adaptive management should provide a decision-making structure that fosters communication between scientists and decision makers, and has clear lines of authority where timely decisions are made and implemented. Governance for implementing adaptive management must provide for the institutional capacity to interact, learn, and adapt. The decision-making structure would be developed in further detail with the monitoring plan prior to operation of the SCH ponds.

In accordance with the adaptive management framework, the assessment and analysis of data are anticipated to lead to periodic adjustments in management of the SCH ponds and updates in the operations and monitoring plans, especially during the 10-year initial implementation phase. The monitoring plan is envisioned to be a living document and would need to remain flexible to respond effectively to unanticipated events.

E.6 References

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and monitoring plant populations. U.S. Department of the Interior, Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO. BLM Technical Reference 1730-1. Available online at: http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf.

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