CALFED SCIENCE FELLOWS PROGRAM

In cooperation with the

California Sea Grant College Program

FELLOWSHIP APPLICATION COVER PAGE

APPLICANT TYPE ☐ Postdoctoral Researcher ☒ Ph.D. Graduate Student

PROJECT NUMBER

PROJECT TITLE Environmental Water: Developing Indicators and Identifying Opportunities

FINANCIAL SUMMARY

First Year CALFED Funds Requested:	$40,688
Total CALFED Funds Requested:	$114,063
Duration:	3 years
Proposed Start/Completion Dates:	January 2008/ December 2010

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Will animal subjects be used? ☐ Yes ☒ No

APPROVAL DATE: PROTOCOL #: PENDING:

Does this application involve any recombinant DNA technology or research? ☐ Yes ☒ No

Sara Hughes
UCSB, Doctoral Graduate Student
Science Fellows Application 2007

Proposed Research

Introduction

Securing and delivering environmental water flows to meet the fish recovery and water supply goals of the Environmental Water Account (EWA) are tasks that require identifying relevant ecological information and integrating this with an understanding of institutional and stakeholder needs and capabilities. According to the CALFED Science Fellows call for proposals, the Environmental Water needs include "managing projects in the Delta and upstream watershed…through both prescriptive standards and flexible, adaptive programs;" needs which can only be addressed by an interdisciplinary and integrative project. In this sense, having a clear understanding of the social and institutional context of developing and implementing the EWA program is just as important as determining such factors as biological responses to stream flow levels and timing. This project proposes to develop indicators of fisheries response to environmental allocation releases and to integrate these with current monitoring efforts, institutional capabilities, stakeholder needs and concerns, and future program development strategies. The results will provide both prescriptive standards and recommendations for flexible, adaptive programs able to meet the needs and goals of the diverse set of stakeholders and concerned parties associated with the EWA.

The World Conservation Union (IUCN) has identified environmental flows as critical for maintaining and restoring aquatic ecosystems and as a mechanism for minimizing political conflict around water resources (IUCN 2003). Environmental flows secured and administered by the EWA have the potential to provide critical resource needs for declining fish populations in the Delta region of California. The large scale water diversion and export schemes that have been developed in California have significantly altered the hydrology of the area, often to the detriment of local fish populations such as the delta smelt (*Hypomesus transpacificus*) (Nichols et al 1986). Increasing flows through the system at critical locations and at critical times could be a key to recovery of these species.

As the agencies involved in the EWA are well aware, reallocating water resources in the hydrologically and politically complex Delta region is not a straightforward task. A draft report prepared by the United States Geological Survey (USGS) for the Pelagic Organism Decline science program describes the Sacramento-San Joaquin Delta as "a complex network of over 700 miles of tidally influenced channels and sloughs. Over 20 million people depend on the Delta for drinking water; 4.5 million acres of cropland are irrigated with Delta water; and several native threatened or endangered fish species reside in or migrate through the Delta (Simi and Ruhl 2005)." As such, the way the Delta is managed is of critical importance to the people, economy, and ecosystems that depend on it. Recent newspaper articles in the region have highlighted water management issues, calling it Governor Schwarzenegger's "Holy War" (LA Times, April 28, 2007), highlighting upcoming impacts of climate change on storage (Contra Costa Times, April 29, 2007), and covering contentious court battles surrounding the California Endangered Species Act (The Record Gazette, April 24, 2007). It is clear that having well-defined, measurable, and communicable indicators of management actions taken within the Delta region is crucial.

The Review of the 2006 EWA by the EWA Technical Review Panel found that clear performance measures were lacking in the program, and suggested that demonstrating and measuring the impacts of the EWA are tasks that have yet to be completed satisfactorily. This project offers a unique and targeted approach to identifying key information needed to demonstrate EWA impacts and how this information can best be expanded and integrated into existing institutional arrangements as well as communicated to stakeholders.

Research Questions and Objectives

The questions we will address are specifically:

- Q1: What indicators of fish recovery could be developed that are ecologically meaningful and easily communicated?

- Q2: How could existing discretionary environmental water supplies be utilized to more effectively protect and recover at-risk fish species?

- Q3: Where are the institutional opportunities and obstacles to achieving these benefits?

In order to answer these questions, the following objectives will be met:

- O1: Integration of existing biological data (fish presence, condition and health) for the Delta with hydrologic monitoring and spatial information to develop four indicators to use for EWA project assessment and communication.

- O2: An analysis to determine the most effective way to use environmental water to provide the largest benefits to at-risk fish populations, including an analysis of the most important factors that should be considered in managing environmental water use.

- O3: An institutional assessment focusing on leverage points for project implementation and improvements.

These objectives were developed to allow for sequential analysis and integration when moving from one to the next: completing Objective 1 will allow us to begin on Objective 2, and completion of Objective 2 will allow us to complete Objective 3. Each objective corresponds to a year of research activity and funding (Figure 1).

Research Approach

In Objective 1 we propose to integrate existing fish presence, numbers, condition, and health information with hydrologic monitoring data in the Delta to develop four indicators with which to evaluate the EWA. We will then integrate spatial data for these characteristics to map their locations and changes as layers in a Geographic Information System (GIS). We will use EPA criteria for biological indicators; existing data from the US Fish and Wildlife Service and California Department of Fish and Game for fish presence, condition and health data; and USGS and DAYFLOW model hydrologic data.

In developing the biological indicator for fish, we follow the Environmental Protection Agency's guidelines for bioindicator development. According to the EPA, "an indicator is a numeric value derived from actual measurements of pressure, state or ambient condition over a specified geographic domain, whose trends over time represent

or draw attention to underlying trends in the condition of the environment. Key indicator criteria are:

- the indicator is useful
- the indicator is objective
- the indicator is transparent and reproducible
- the underlying data is characterized by sound collection methodologies, data management systems to protect its integrity, and quality assurance procedures
- data are available to describe changes or trends
- the data are comparable across time and space, and representative of the target population (EPA Biological Indicators of Watershed Health, 2006)."

As an example of the biological data compilation and expansion we propose, the United States Fish and Wildlife Service has begun to work toward developing fish condition and health indicators in the Delta. The methodology developed by Gartz (2005) in a draft report to the Pelagic Organism Decline science program could be adapted and expanded for incorporation in our indicator development. For measures of condition Gartz (2005) used:

- Fork Length (mm)
- Standard Length (mm)

For measures of health Gartz (2005) used:

- Presence/absence of external parasites
- Presence/absence of eroded fins
- Presence/absence of gill and internal parasites
- Presence/absence of skin lesions

These were described by Gartz for fish populations (delta smelt, inland silverside, and threadfin shad) for 2005 in both open channels and shallow water and were compared with previous studies from 1979-1983, 2001, and 2003. We propose to expand this assessment by incorporating additional data from other time periods and for other species, a task also recommended by Gartz in his report.

For the complimentary data set of timing and quantity of water flows in the Delta we will use monitoring data as well as specific information on EWA and (b)(2) releases. We will base the sources of monitoring data on the USGS draft report to the Pelagic Organism Decline science program summarizing Delta hydrology (Simi and Ruhl 2005). The sources include DAYFLOW model output, USGS Delta Flows Monitoring Network,

and operational summaries for the South Delta barriers and Delta Cross Channel gates, some of which are available from as far back as 1955. The data have been summarized by the USGS as "inflows," "outflows," and "barriers to flow" within the Delta. We will tailor these data to be complimentary to our fish condition and health information, and use EWA information to identify periods of intentional environmental water releases.

In order to identify key hydrologic components for maintaining fish populations in the Delta, we will integrate the EWA release data with USGS monitoring data to detect where and when the allocations are occurring. This will allow for a better understanding of how EWA releases operate within the complex hydrology of the Delta. If these are not detectable (as suggested by the 2006 technical review panel) we will still be able to categorize releases as being "inflows," "outflows," or, potentially, "barriers to flow" according to the USGS analysis. Identifying the spatial relationship of releases within the hydrologic system is a first step in understanding how they will affect key fish species. We will develop a Geographic Information System (GIS) database able to delineate hydrologic as well as biological characteristics of concern in the Delta. With such a system in place we will be able to demonstrate spatial and temporal relationships with analysis as well as visual represeantations. This may also allow us to address an additional question posed by the CALFED call for proposals: whether releases upstream or downstream (or North or South) of the Delta are more important for fish populations.

Once we have developed four indicators (2 for fish condition and health and 2 for location and timing of releases) we can track these over time and space to discover whether a relationship exists or, if not, what additional data will be necessary to identify in order to detect a relationship between fish populations and hydrology and develop such indicators. This will be completed by the end of Year 1.

Objective 2 is an application of the results of Objective 1 to identify gaps in data and potential management actions that will allow the indicators to be fully developed and operational. In Objective 2 we propose to conduct an analysis to determine the most effective way to use environmental water to provide the largest benefits to at-risk fish populations, including an analysis of the most important factors that should be considered in managing environmental water use. This directly addresses a Key Component of the

CALFED call for proposals. The results from completing Objective 1 will allow us to identify key indicators (or data that are lacking in order to do so) and therefore we will be able to target environmental water use recommendations toward these aims specifically. By taking such measures as including condition and health indicators, we will be able to provide the largest benefits from environmental water use.

However, there are additional measures that can be taken in order to achieve Objective 2. Promoting effectiveness and identifying important factors also includes an assessment of stakeholder acceptance and awareness and incorporating the wealth of knowledge that exists within agency specialists. We propose a second component of assessment that will use information from previous CALFED stakeholder consultations, relevant newspaper articles and reports, and interviews with agency specialists to ensure that the observations we make in regard to components of the analysis--such as "effectiveness" and "benefits"--are truly addressing the needs of the community and agencies as well as the fish populations.

Together with the assessment of the indicator development in Objective 1, this information will allow us to provide a suite of recommendations for better use of environmental water allocations that are biologically, hydrologically, and socially relevant. This will be completed by the end of Year 2.

Once we have identified potential options, we can complete our Objective 3, which is an institutional assessment focusing on leverage points for project implementation and improvements. This includes a comprehensive analysis of the institutional environment surrounding the EWA, such as the rights of various parties, the roles each play in determining successful implementation and allowing for change, and decision making procedures as related to the recommendations. This requires we collect data on policies and laws, political and social organizations, and relevant court cases as well as from interviews and focus groups. By including this component of the study, we ensure that when relevant and useful recommendations are developed in Objective 2, we are also able to evaluate how these relate to existing institutional structures, power dynamics, and levels of social awareness and acceptance. We will therefore be able to also develop predictions for likelihood of adoption as well as likely outcomes for the

different recommendations, providing critical information for implementing agencies that are often faced with difficult decisions.

As many agencies in California have discovered, water politics can be difficult to maneuver and a significant obstacle to project improvements. Our experience with social science data collection and analysis will allow us to contextualize our recommendations for the agencies and perhaps even allow for policy recommendations at higher levels.

Outputs and Benefits

Assessments of the EWA must be based on a systems-oriented approach such as ours in order to identify and realize the benefits the program can have for at-risk fish species (Figure 2). This will not only help to ensure a recovery of these populations, but will also benefit CALFED and EWA by integrating these recovery activities into the broader context of the water management institutional environment. CALFED focuses on a balanced approach to resource management. Our project also embraces this ideal, proposing to incorporate multiple sources of information and understanding and give these equal weights when determining ways to further the goals of the EWA. Research focused on water resources is often as tightly linked and complex as the hydrologic system itself. Our project recognizes these linkages and deliberately incorporates them into the research framework.

The specific products that can be expected to come from this project include:

- Four key indicators of EWA activities and actions needed to assess and improve them
- Hydrologically and biologically linked spatial analysis and maps of changes in the Delta region
- An assessment of stakeholder and agency specialists in relation to the past, current, and future provision of Environmental Water
- An institutional analysis of the potential for future alternative management activities, their likelihood, and outcomes

Environmental water allocations are a critical component to addressing the water management issues now and in the future. If these flows are to continue and become critical components of management strategies they must be clearly identifiable,

recognizable to stakeholders and specialists, and selected based on their biological, hydrological and social relevance. Our project synthesizes these sources of information in order to develop indices and recommendations that are not arbitrary but firmly planted within the EWA's goals of fish protection, water supply reliability. Institutional change is not easy to accomplish; incorporating all of these elements will be essential for the program's success.

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Figure 1: Timetable of activities and outputs for this project.

Year	Activities	Output
1	Data assimilation and integration	Four key indicators for impact of EWA; Spatial Analysis
2	Options assessment for achieving improvements in key indicators	Presentation of alternatives and important factors for assessing EWA
3	Institutional and stakeholder assessment of options	Identification of key leverage points and likely outcomes of alternatives

Figure 2: Conceptual diagram of this project