The Consequences Of Operational Decisions On Water Quality: Reconciling Delta Smelt, Salmon, And Human Needs

submitted to Science Program 2006

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lead investigators:
Guerin, Marianne

Project Information And Executive Summary

The Consequences Of Operational Decisions On Water Quality: Reconciling Delta Smelt, Salmon, And Human Needs

This is proposal #0028 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Instructions

Please complete the Project Information and Executive Summary Form prior to proceeding to the other forms contained on this website and required to be completed as part of your PSP application submittal. Information provided on this form will automatically support subsequent forms to be completed as part of the Science PSP submission process. Information provided on this form will appear in the Contacts and Project Staff, Task and Budget Summary, and Conflict of Interest forms.

Proposal Title: **The Consequences of Operational Decisions on Water Quality: Reconciling Delta Smelt, Salmon, and Human Needs**

This field is limited to 255 characters. All proposal titles must be entered in title case. No abbreviations or acronyms will be accepted.

Applicant Information

Applicant Organization Name: **Contra Costa Water District**

Please provide the name of the organization submitting the application as follows: Davis, California University of; Fish and Game, California Department of; California Waterfowl Association, etc.

Applicant Organization Type:
local government or special district

eligibility

Below, please provide contact information for the representative of the applicant organization who is authorized to enter into a contractual agreement with the State of California and who has overall responsibility for the operation, management, and reporting requirements of the applicant organization. (This should be the same individual who signs the signature page.)

Salutation: **Mr.**
First Name: **Walter**
Last Name: **Bishop**
Street Address: **P.O. Box H2O**
City: **Concord**
State or Province: **CA**
Zip Code or Mailing Code: **94524**
Telephone: **925-688-8117**
E-mail Address: **dabriggs@ccwater.com**

Below, please provide contact information for the primary point of contact for the implementation of the proposal. This person should be the same individual who is serving as the project Lead Investigator/Project Director.

Salutation: **Dr.**
First Name: **Marianne**
Last Name: **Guerin**
Telephone: **925-688-8344**
E-mail Address: **mguerin@ccwater.com**

Proposal Information

Total Amount Requested: $116,927

The figure represented above is provided by the total amount requested on your completed Task and Budget Summary Form. The applicant must ensure the amount indicated above is correct and equal to the total amount requested in the budget document uploaded via the Budget and Justification Form for

this project.

Select one primary and up to three secondary topic areas that best apply to this proposal:

Habitat Availability and Response to Change (Primary)

Trends and Patterns of Populations and System Response to a Changing Environment

Environmental Water

Select up to five keywords to describe this project.
− ***agriculture***
− ***agricultural economics***
− ***agricultural engineering***
− ***agronomy***
− ***agro−ecology***
− ***benthic invertebrates***
− ***benthos***
− ***biochemistry***
− ***biological indicators***
− ***birds***
− ***channels and sloughs***
− ***climate change***
− ***conservation or agricultural easements***
− ***conservation program management***
− ***database management***
− ***ecotoxicology***
− ***economics***
− ***engineering***
− ***erosion control***
− ***environmental education***
− ***evapotranspiration***
− ***fish biology***
X delta smelt
X salmon and steelhead
− other species
− otoliths
− tagging
− ***fish management and facilities***
− ***flooded islands***
− ***floodplains and bypasses***
− ***forestry***
− ***genetics***
− ***geochemistry***
− ***geographic information systems (GIS)***
− ***geology***
− ***geomorphology***
− ***groundwater***
− ***human health***
− ***hydrodynamics***
− ***hydrology***
− ***insects***
− ***integrated pest management***
− ***integrated resource planning***
− ***invasive species / non−native species / exotic species***
− ***irrigation systems***
− ***land use laws and regulations***
− ***land use management***
− ***land use planning and policy***
− ***levees***
− ***mammals***
− ***microbiology / bacteriology***
− conceptual
− quantitative
− ***oceanography***

– ***performance measures***
– ***phytoplankton***
– ***plants***
– terrestrial
– aquatic
– wetland
– ***remote sensing / imaging***
– ***reptiles***
– ***reservoirs and lakes***
– ***restoration***
– ***riparian zone***
– ***rivers and streams***
– ***sediment***
– ***soil science***
– ***statistics***
– ***subsidence***
– ***sustainable agriculture***
– ***trophic dynamics and food webs***
X ***water operations (diversions, pumps, intakes, exports, barriers, gates, etc.)***
– ***water quality***
– other
X temperature
– contaminants
– nutrients, organic carbon, and oxygen depleting substances
X salinity
– sediment and turbidity
– ***water supply***
– ***watershed assessment***
– ***watershed management***
– ***wetlands***
– ***zooplankton***

Provide the geographic coordinates that best describe the center point of your project. (Note: If your project has more than one site, provide a center point that best captures the central location.)

Example:	Latitude:	38.575; must be between 30 and 45
	Longitude:	−121.488; must be between −120 and −130

Help for finding a geographic location.

Latitude: **38.104**
Longitude: **−121.534**

Provide the number miles radius from the center point provided above, to demonstrate the radius of the entire project.
20

Provide a description of the physical location of your project. Describe the area using information such as water bodies, river miles and road intersections.

Sacramento−San Joaquin Delta and watersheds

Successful applicants are responsible for complying with all applicable laws and regulations for their projects, including the National Environmental Policy Action (NEPA) and the California Environmental Quality Act (CEQA). Projects funded through this PSP that tier off the CALFED Programmatic EIS/EIR must incorporate applicable mitigation strategies described in the CALFED Programmatic Record of Decision to avoid or minimize the project's adverse environmental impacts. Applicants are encouraged to review the Programmatic EIS/EIR and incorporate the applicable mitigation strategies from Appendix A of these documents for their projects.

If you anticipate your project will require compliance of this nature (ie applications for permits, other environmental documentation), provide below a list of these items, as well as the status of those applications or processes, if applicable. If you believe your project will not require these regulatory actions, please provide one or two lines of text outlining why your proposed project will not be subject to these processes. Further guidance is available in The Guide to Regulatory Compliance for Implementing CALFED Activities.

All of the analyses are numerical and activites for this project are confined to the office.

Is this proposal an application for next phase funding of an ongoing project funded by CALFED Science Program?
X No. **–** Yes.

If yes, identify the ongoing project:

Project Title:
CALFED Contract Management Organization:
Amount Funded:
Date Awarded:
Lead Organization:
Project Number:

Have primary staff and/or subcontractors of the project team (those persons listed on the Contacts and Project Staff form) received funding from CALFED for a project *not* listed above?
– No. **X** Yes.

If yes, list the projects below: (only list up to the five most recent projects)

Project Title: **Canal Replacement Project**
CALFED Contract Management Organization: **Department of Water Resources**
Amount Funded: **7,313,716.00**
Date Awarded: **10/15/04**
Lead Organization: **Contra Costa Water District**
Project Number: **4600003804**

Project Title: **Rock Slough and Old River Water Quality Management Projects**
CALFED Contract Management Organization: **Department of Water Resources**
Amount Funded: **2,009,950.00**
Date Awarded: **3/15/02**
Lead Organization: **Contra Costa Water District**
Project Number: **4600002846**

Project Title: **Rock Slough and Old River Water Quality Management Projects**
CALFED Contract Management Organization: **Department of Water Resources**
Amount Funded: **2,855,000.00**
Date Awarded: **3/1/04**
Lead Organization: **Contra Costa Water District**
Project Number: **4600003591**

Project Title: **Reducing Non-Point DOC and Nitrogen Exports from Rice Fields – Pilot Study**
CALFED Contract Management Organization: **State Water Resources Control Board**
Amount Funded: **869,715.00**
Date Awarded: **1/1/04**
Lead Organization: **Contra Costa Water District**
Project Number: **03-165-555-0**

Project Title: **The Water You Play In Is the Water You Drink**
CALFED Contract Management Organization: **State Water Resources Control Board**
Amount Funded: **985,000.00**
Date Awarded: **September 2002**
Lead Organization: **Contra Costa County**
Project Number: **03-083-555-0**

Has the Lead Investigator, the applicant organization, or other primary staff or subcontractors of your project team ever submitted a proposal for this effort or a similar effort to any CALFED PSP?
X No. **–** Yes.

If yes, list the submission below: (only list up to the five most recent projects)

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:

Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Project Title:
CALFED Program:
Date of PSP:

Note: Additional information on this or prior applications submitted −− or proposals funded −− may be required of applicants.

List people you feel are qualified to serve as scientific and/or technical reviewers for this proposal and are not associated with your organization or CALFED.

Full Name	Organization	Telephone	E−Mail	Expertise
Peter Vorster	San Francisco Bay Institute	510−444−5755	vorster@bay.org	hydrodynamics
Wim Kimmerer	San Francisco State University	415−435−7143	kimmerer@sfsu.edu	fish biology
Paul H. Hutton	Metropolitan Water District of Southern California	916−650−2620	phutton@mwdh2o.com	modeling, quantitative
B.J. Miller	Miller Consulting Engineers	510−644−1811	bj_miller@sbcglobal.net	water operations (diversions, pumps, intakes, exports, barriers, gates, etc.)

Provide additional comments, information, etc. here:

Executive Summary

Provide a brief but complete summary description of the proposed project; its geographic location; project objective; project type, approach to implement the proposal; expected outcomes; and adaptive management approach and relationship to the Science Program goals. The Executive Summary should be a concise, informative, stand−alone description of the proposed project and be no longer than one page in length. Please note, this information will be made public on our website shortly after the closing date of this PSP.

The CALFED Bay−Delta Authority (CBDA) has been charged with a daunting task – assuring a safe and stable supply of water to meet the needs of municipal, recreational, industrial and agricultural users, while at the same time safeguarding the ecosystems supporting the native species of the San Francisco Bay, the Sacramento−San Joaquin Delta, and the supporting watersheds. This task is complicated by the responsibility to protect certain species, such as delta smelt and several species of Chinook salmon, under the Federal and California Endangered Species Acts (ESA and CESA, respectively). The requirements mandated by these acts have placed rigid constraints on the allocation of California's limited water supply, as well as a severe demand on the financial resources available for environmental protection. In the last two years, summer and fall delta smelt population indices have reached historic lows – delta smelt were listed as a threatened species under the ESA in 1993. Concurrently, winter−run Chinook salmon on the Sacramento River, which were listed as an ESA endangered species in 1990, have seen resurgence in their numbers. Are these observations related? This proposal is motivated by the following:

Hypothesis: The changes in upstream reservoir operations − including temperature control in the upper Sacramento River in the summer, spring operations on the San Joaquin River, shifts in export timing, and other upstream uses − have changed seasonal salinity patterns in the Delta that have contributed to the decline of the Delta smelt.

Although there are clearly many factors that combine to influence the survival of each of these species, we focus in this proposal on two main factors – seasonal salinity changes in the Delta plus changes in reservoir operations for temperature and flow control – which we suspect may, in combination with Delta Cross Channel and Head of Old River Barrier operations, be related to the decline of the delta smelt. Salinity is the key environmental feature defining the fundamental 'ecological niche' for delta smelt, and temperature is one of two main factors key to preventing the extinction of winter-run Chinook salmon. As these are factors over which we can exert considerable operational control, the results of this study have practical significance as well.

The goals of this project are: to assess the consequences of actions taken to protect threatened or endangered Chinook salmon species relative to other upstream and in-Delta water management actions that have changed seasonal salinity in the Delta, thus reducing the ability of delta smelt to survive as a species; and, to investigate with modeling scenarios the potential to ameliorate this trade-off with specific operational actions. The project scope includes historical data analysis, water quality and temperature modeling, salmon population modeling, and statistical analyses relating delta smelt population indices to Delta water quality and flow. These investigations will assess the extent to which changes in reservoir and barrier operations and in the timing of exports have contributed to the loss of 'environmental quality' in delta smelt habitat, and if changes in these actions can mitigate for the degradation of delta smelt habitat, particularly fall salinity, without harming Chinook salmon species. The results of this proposal are relevant to one of the most pressing environmental issues currently facing CALFED – the Pelagic Organism Decline and the continued survival of the delta smelt. The proposal integrates water supply and management decisions with the need to maintain or improve ecosystem quality for two ESA species – delta smelt and winter-run Chinook salmon.

Contacts And Project Staff

This is proposal #0028 for the Science Program 2006 solicitation.

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INSTRUCTIONS

Use this form to provide titles, affiliations, qualifications, and descrptions of roles of the primary and secondary project staff. Include any consultants, subcontractors and/or vendors. The Lead Investigator or Project Director, as identified in the Project Information and Executive Summary Form, is required to upload a PDF version of their resume. To complete the qualification field of this form, please provide a bulleted list of relevant project/field experience and any publications/reports that support your participation in the proposed project.

Information provided on this form will automatically support subsequent forms to be completed as part of the Science Program PSP submission process. Please note tht information you enter in this form will appear in the Task and Budget Summary and Conflict of Interest forms.

Information on subcontractor services must be provided even if the specific service provider has not yet been selected. If the specific subcontractor has not been identified or selected, please list TBD (to be determined) in the last name field and the anticipated service type in the title field (example: Fish Biologist).

Please provide this information before continuing to the Tasks and Deliverables Form.

Applicant

Contra Costa Water District
Mr. Walter Bishop
P.O. Box H2O
Concord CA 94524
925−688−8117
dabriggs@ccwater.com

Lead Investigator/Project Director

Salutation: **Dr.**
Last Name: **Guerin**
First Name: **Marianne**
Title: **Associate Water Resources Specialist**
Organization: **Contra Costa Water District**
Responsibilities: **Development of written deliverables, tracking documentation of tasks, including semi−yearly reports**
Resume:

You have already uploaded a PDF file for this question. Review the file to verify that appears correctly.

Mailing Address: **P.O. Box H2O**
City: **Concord**
State: **CA**
Zip: **94524−2099**
Telephone: **925−688−8344**
E−Mail: **mguerin@ccwater.com**

All Other Personnel

Salutation: **Dr.**
Last Name: **Briggs**
First Name: **David**
Title: **Water Resources Manager**
Organization: **Contra Costa Water District**

Position:
primary staff
Responsibilities: **Project management and coordination, technical oversight and review**
Qualifications:

David A. Briggs, Ph.D., P.E.

Education Ph.D. in Mechanical Engineering, Stanford University, 1996 Dissertation focus: applied mathematics, fluid mechanics

M.S. in Mechanical Engineering, Stanford University, 1992

B.S. in Mechanical Engineering (with honors), University of California, Davis, 1990

Professional Experience

8/06 – present Contra Costa Water District, Water Resources Manager. Responsible for ensuring quality and quantity of District's water supplies, protecting District's water rights, providing technical assistance to District's water resources capital projects, engaging stakeholders in the Delta, and negotiating supply contracts.

11/03 – 8/06 Contra Costa Water District, Special Projects Manager. Project Manager for CALFED-funded projects related to drinking water quality improvement including source control/watershed management, water treatment research, and facilities planning (storage/conveyance). Lead on operations technical studies for the CALFED Los Vaqueros Reservoir Expansion Studies.

5/01 – 11/03 Contra Costa Water District, Principal Engineer. Project Manager for CALFED-funded projects related to drinking water quality improvement including source control/watershed management, water treatment research, and facilities planning (storage/conveyance).

11/95 – 5/01 Contra Costa Water District, Associate and Senior Water Resources Specialist. Previous responsibilities: management of complex water resources projects relating to CALFED, technical assistance in stakeholder forums with implementation of Central Valley Project Improvement Act and other laws/policies (e.g., Endangered Species Act, water service contracts and allocation of water supplies); negotiation of CCWD contracts for federal water supply and water transfers involving federal facilities; communication with CCWD Board of Directors; service as an expert witness before the State Water Resources Control Board; preparation of testimony for various hearings; preparation of environmental documentation (e.g., NEPA); staff supervision; and budget preparation.

5/00-9/00 CALFED Bay-Delta Program Ecosystem Restoration. Chaired review panel for research proposals for the CALFED Ecosystem Restoration Program.

10/99-pres. Univ. Calif. Berkeley Extension, Instructor. Developed and taught a course related to water resources science and management of the Bay-Delta.

8/95-1/96 San Jose State University, Engineering instructor. Thermodynamics instructor for 40 undergraduate students.

Honors • Tau Beta Pi, Engineering Honor Society • Graduation from University of California (Davis) with honors • Guest Student at Woods Hole Oceanographic Institution, 1993 and 1994

Memberships American Academy of Environmental Engineers, Associate Member UC Water Resources Center Advisory Council

Registration Professional Civil Engineer Registration: California 57143

Peer Review Publications

Campbell, J. E., Briggs, D.A., Denton, R.A, &Gartrell, G. 2002 Water quality operation with a blending reservoir and variable sources, J. Water Resour. Plng. Mgmt., ASCE, Volume 128, Issue 4.

Briggs, D. A., Ferziger, J. H., Koseff, J. R., &Monismith, S. G. 1998 Turbulent Mixing in a Shear-Free Stably Stratified Two-Layer Fluid, Journal of Fluid Mechanics, 354, 175-208.

Briggs, D. A., Ferziger, J. H., Koseff, J. R., &Monismith, S. G. 1996 Entrainment in a Shear-Free

Turbulent Mixing Layer, Journal of Fluid Mechanics, 310, 215–241.

Itsweire, E. C., Koseff, J. R., Briggs, D. A. &Ferziger, J. H. 1992 Turbulence in stratified shear flows: Implications for interpreting shear–induced mixing in the ocean. J. Physical Oceanography, Vol 23, No. 7, pp. 1508 – 22

Other Publications

Denton, R. A. &Briggs, D. A. Incorporating a new salinity–outflow algorithm into an operations model for the Central Valley, Proceedings of the 27th Congress of the International Association for Hydraulic Research, Theme B, Volume 1, 1997, 611–616

Ferziger, J. H., Koseff, J. R., Monismith, S. G., Briggs, D. A. &Garg, R. P. Mixing in inland waters and near–coastal regions, Gather–Scatter Magazine, San Diego Supercomputer Center, July 1995.

Briggs, D. A., Ferziger, J. H., Koseff, J. R. &Monismith, S. G. Entrainment in a turbulent mixing layer. AGARD Conference Proceedings, Application of Direct and Large Eddy Simulation to Transition and Turbulence, Crete, Greece, April 18–21, 1994.

Ivey, G. N., Koseff, J. R., Briggs, D. A., Ferziger, J. H. Mixing in a stratified shear flow: energetics and sampling. Annual Research Briefs, Center for Turbulence Research, Stanford University. 1992: 334–341.

List relevant project/field experience and publications/reports.

Salutation: **Dr.**
Last Name: **Deas**
First Name: **Mike**
Title: **Principal Engineer**
Organization: **Watercourse Engineering, Inc.**
Position:
subcontractor
Responsibilities: **Temperature modeling and analysis**
Qualifications:

Michael L. Deas Watercourse Engineering, Inc. 133 D Street, Suite F Davis, CA 95616 530–750–3072 mike.deas@watercourseinc.com

QUALIFICATIONS Michael Deas has over 15 years of problem–solving experience. Dr. Deas analyzes surface water systems, quantifies physical, chemical, and biological processes in aquatic systems as they affect water quality, and evaluates surface water quality for environmental, industrial, and municipal supplies. He is a recognized expert on water quality issues in Northern California and Central Valley systems.

Michael Deas: • Conducts surface flow, temperature, and quality assessments. • Develops conceptual models, identifying the interactions between/among aquatic systems, inputs and outputs, as well as processes taking place within the systems themselves. • Develops and applies analytical tools as well as complex numerical models to evaluate flow and the fate and transport of physical and chemical constituents in aquatic systems. • Provides technical presentations, both orally and in writing, for diverse audiences.

EDUCATION Doctor of Philosophy, Civil Engineering (2000), University of California, Davis. Major: Environmental Fluid Mechanics. Minor: Water Resources Management. Dissertation: Application of numerical models in ecological assessment

Master of Science (1989), University of California, Davis. Major: Water Resources Management. Master's Thesis: A finite element model of groundwater flow on shallow layer and perched aquifers

Bachelor of Science (1986), University of California, Davis. Major: Civil Engineering

PROFESSIONAL EXPERIENCE

Principal, Watercourse Engineering, Inc. 2000 – Present Provided professional engineering services for

water quantity and quality issues associated with river and reservoir systems. Typical tasks include system definition, monitoring (including development and implementation of Quality Assurance Project Plans), numerical model construction and/or application, and analysis of system response to alternative management conditions. Projects include − Basin−scale flow and water quality modeling for river and reservoir reaches in the Klamath River basin (PacifiCorp) − Physical characterization of spatial and temporal variability of flow and temperature within thermal refugia for over−summering anadromous fishes on the Klamath River (U.S. Bureau of Reclamation in cooperation with the Karuk and Yurok Tribes) − Reservoir water quality management planning (City and County of San Francisco/MSC) − Wastewater/recycled water reuse and management modeling (City of Santa Rosa/MSC) − Water quality modeling training program (State Water Resources Control Board) − Recreation of historic flow and water temperature conditions on the Upper Sacramento River: 1970 to 2001 (United States Geological Survey) − Shasta River flow and temperature modeling for anadromous fish restoration (United States Fish and Wildlife Service and California Department of Fish and Game) − Water quality model application to assess eutrophication potential within the Crystal Springs Reservoir complex (City of San Francisco for Merritt Smith Consulting) − Central Valley water temperature modeling review (Bay Delta Modeling Forum) − Klamath River water quality monitoring and modeling for anadromous fish restoration (U.S. Bureau of Reclamation)

Senior Engineer, Earth Science Associates, 1992−93. Designed, constructed, tested, and applied a monthly operations model of the Los Angeles Department of Water and Power Mono Basin Owens Valley Aqueduct System (Los Angeles Aqueduct Simulation Model). Implemented a long−term computer model maintenance program. Performed water supply analysis for various clients.

Consulting Engineer, Los Angeles Department of Water and Power − 1991, 1993. Co−managed Mono Basin Owens Valley computer modeling project. Formulated and implemented system operation model for Los Angeles' eastern Sierra Nevada water gathering facilities. Participated in a UCLA−Mono Basin public policy program mediation effort, and served on technical advisory committees for the State Water Resources Control Board (State Board) water rights re−issuance hearings for Los Angeles. Testified before the State Board concerning predictive computer models for the Mono Basin and Owens River Basin.

Assistant Engineer, Aqueduct Division, Los Angeles Department of Water and Power, 1989−90. Revamped and expanded the Mono Basin computer model from a spreadsheet to a FORTRAN program capable of assessing a wide range of scenarios. Conducted various studies examining the impact of alternative operations and hydrologic conditions on Mono Lake surface elevations and water supply to Los Angeles. Reviewed water rights issues and made recommendations to legal staff.

Civil Engineer, Hydrologic Engineering Center, U.S. Army Corps of Engineers, 1987. Researched and formulated a report on the Corps responsiveness to the 1986 drought in the southeastern United States. The report, titled "Lessons Learned from the 1986 Drought" compiled information learned from the drought and presented specific recommendations for drought contingency planning.

RESEARCH EXPERIENCE Project Manager, Klamath River water temperature and water quality modeling project. University of California, Davis. (United States Fish and Wildlife), 6/95 – 12/99. Application of hydrodynamic and water quality models to analyze water quality control alternatives designed to improve anadromous fisheries in the Klamath River downstream of Iron Gate Dam. Simulated dissolved oxygen, temperature, nutrients, and algal dynamics.

Project Manager, Shasta River Flow and Temperature Modeling Project. University of California, Davis. (California State Water Resources Control Board, 205(j) Clean Water Act Grant Program, 3/95 – 6/98. Project included modeling flow and water temperature on the Shasta River for anadromous fish restoration efforts. Subtasks included hydrology, meteorology, water temperature data inventory and woody riparian vegetation inventory. Designed and implemented temperature monitoring program.

Project Manager, Sacramento River Temperature Modeling Project. University of California, Davis. (California State Water Resources Control Board, 205(j) Clean Water Act Grant Program, 3/95 − 3/97. Managed a team of engineers to implement and apply computer models to analyze the potential for temperature control in reaches critical for salmon reproduction downstream of Central Valley Project (CVP) reservoirs. Applied numerical flow and temperature models to Lake Shasta and Trinity Lake, Keswick Reservoir, and the Sacramento and Feather Rivers.

Research Engineer, Putah Creek Coarse Sediment Evaluation below Monticello Dam (University of California, Davis Public Service Research Program), 6/95−8/96 Designed and completed field monitoring program to examine morphological changes to Putah Creek. Field work and associated research revealed that direct effects of Monticello Dam include creek aggradation due to tributary sediment contributions, as well as tributary down−cutting due to reduced post−project stream levels.

Project Manager, Willits Bypass Floodplain Study. University of California, Davis. (California Department of Transportation), 4/94 − 6/95. Applied a two−dimensional finite element hydrodynamic model to an inundated floodplain with coalescing streams in Little Lake Valley near Willits, California. Verified and applied model for 100−year flood event to examined impacts of alternative freeway alignments on floodplain dynamics.

TEACHING EXPERIENCE

Associate Instructor, Department of Civil and Environmental Engineering, University of California, Davis, Spring 1999, Spring 2001.

Environmental Quality Modeling (Civil and Environmental Engineering 244) – Instructor for graduate course addressing mathematical modeling of environmental water quality. Subject matter focused on structure, capabilities/limitations, sensitivity and reliability of water quality models as analytical tools.

Associate Instructor, Department of Civil and Environmental Engineering, University of California, Davis, Fall 1997. Unsteady Flow in Surface Waters (Civil and Environmental Engineering 277) – Instructor for graduate course covering topics of unsteady flow. Subjects included long waves in surface flow, St. Venant equations, method of characteristics, explicit and implicit finite difference methods, stability of numerical schemes, and flood routing techniques.

Teaching Assistant, University of California, Davis, 1986−88, 1993, 1996. Duties included preparing lectures, designing homework assignments, administering and grading tests, evaluating student performance, and assigning grades. Classes include: Engineering 3: Introduction to Engineering (lab) Engineering 35: Statics (discussion) Civil and Environmental Engineering 10: Introduction to Surveying (lab) Civil and Environmental Engineering 141L: Hydraulics (lab) Civil and Environmental Engineering 145: Design of Open Channel Structures (class) Civil and Environmental Engineering 152: Civil Engineering Planning (class) Civil and Environmental Engineering 271: Water Resources Planning Lab (class)

PROFESSIONAL ACTIVITIES

Peer Review of the California Department of Fish and Game San Joaquin River Salmon Population Model (2006) (California Bay Delta Authority)

Independent Science Review Team – Temperature Effects on Salmonids in the Lower Clackamas River, Oregon (2006) (sponsored by Portland Gas and Electric)

Technical Peer Review Panel to assess Review of the Biological Opinion of the Long−Term Central Valley Project and State Water Project Operations Criteria and Plan (2005) (CALFED)

Chairman: Peer Review Panel for setting temperature objectives for anadromous fish in the Stanislaus River (2003−present) (CALFED)

Levee Risk Assessment Team (CALFED) (2004)

California Water and Environmental Modeling Forum Steering Committee member (2002−present)

Nathaniel Bingham Memorial Award, U.S. Fish and Wildlife (2001)

Causative Factors Analysis ad hoc committee: Shasta River anadromous fisheries restoration (1999)

Water Quality Modeling Panel (1998), Klamath River Technical Working Group Mono Lake Technical Advisory Group (1992−93), State Water Resources Control Board

Mono Lake Public Policy Program (1991); City of Los Angeles, UCLA.

Peer Reviewer for Processional Journals (ongoing) − Water Resources Research − American Society of Civil Engineers: Journal of Water Resources Planning and Management

PROFESSIONAL SOCIETIES, AFFILIATIONS, AND LICENSES:

Sigma Chi – Member American Society of Civil Engineers American Water Resources Association American Geophysical Union Registered Professional Civil Engineer, State of California (1990)

List relevant project/field experience and publications/reports.

Salutation: **Dr.**
Last Name: **Denton**
First Name: **Richard**
Title: **Water Resources Consultant**
Organization: **Richard Denton, Consultant**
Position:
subcontractor
Responsibilities: **Define and document the influences and alterations on Delta salinity patterns due to various natural, mandated or adpative management flows.**
Qualifications:

Resume

Richard A. Denton, Ph.D., P.E. 6667 Banning Drive Oakland, CA 94611 Tel: (510) 339−0161 Email: rdenton@ccwater.com

Present Position (as of August 14, 2006) Water Resources Consultant 6667 Banning Drive Oakland, CA 94611

Education B.E. (Civil) with First Class Honors, 1972, University of Canterbury, New Zealand Ph.D. in Civil Engineering, 1978, University of Canterbury, New Zealand

Professional Registration Registered Civil Engineer C47212, California

Employment History

Contra Costa Water District 1331 Concord Avenue P.O. Box H2O Concord, CA 94524−2099 1995 − 2006: Water Resources Manager 1995: Principal Engineer 1994 − 1995: Senior Water Resources Specialist 1992 − 1994: Senior Engineer 1989 − 1992: Water Resources Specialist

Managed CCWD's Water Resources Group. Represented CCWD, California Urban Water Agencies, and Ag/Urban coalition in State Water Resources Control Board, CALFED Bay−Delta program and CVP Improvement Act proceedings related to the San Francisco Bay Delta. Analyzed and modeled Central Valley operations and flow and salinity regimes in Sacramento−San Joaquin Delta. Modeled the operation of CCWD's Los Vaqueros Reservoir (completed in 1998) and proposed Bay−Delta projects. Participated in development and review of CEQA/NEPA and water right documents. Chair of CALFED Operations and Fish Forum. Served on the CALFED Bay−Delta Advisory Committee water supply subcommittee and the Association of California Water Agencies water quality committee.

University of California at Berkeley 1982 − 1989: Assistant Professor in Civil Engineering, Carried out research in stratified flow, surface water hydrology, hydraulic engineering and mixing processes in rivers, reservoirs and estuaries. Taught graduate and undergraduate courses and supervised graduate research. Director of hydraulic and coastal engineering research laboratory.

University of Karlsruhe, West Germany 1978 − 1981: Research Engineer, Sonderforschungsbereich 80, Postdoctoral research on stratified flow in reservoirs.

New Zealand Oceanographic Institute, Wellington, New Zealand 1978: Physical Oceanographer,

Analysis of tidal currents in fjords. Participated in marine biology cruise to the N.E. coast of Australia.

Professional Societies and Committees Member, American Society of Civil Engineers Member, International Association of Hydraulic Research Convener, California Bay−Delta Modeling Forum, 1998 Chair, CALFED Operations and Fish Forum (August 2001 – August 2006) Member, Friends of Water Resources Center Archives Board, UC Berkeley, CA

Previous Committees and Advisory Groups Member, Local Organizing Committee for 27th Congress of the International Association for Hydraulic Research, San Francisco, August 1997 Member, ASCE Hydraulics Division Task Committee on Density Currents and Their Applications in Hydraulic Engineering. Member, Technical Program Committee for the 1993 ASCE Hydraulic Division Conference. Member, San Francisco

Estuary Project (SFEP) Technical Advisory Committee. Member, SFEP Technical Advisory Committee Workgroup on (Biological and Pollutant) Monitoring.

Awards 1995 Hugo B. Fischer Award, Bay–Delta Modeling Forum (Joint winner with Alan Jassby)

Publications 13 papers in refereed journals, 10 papers in conference proceedings and 6 research reports. The following is a selection of these publications.

"Turbulent convection between two horizontal plates." (with I.R. Wood) International Journal of Heat and Mass Transfer, Vol. 22, pp. 1339–1346, 1979.

"Penetrative convection at low Péclet number." (with Ian R. Wood) Journal of Fluid Mechanics, Vol. 113, pp. 1–21, 1981

"Currents in Suisun Bay." California State Water Resources Control Board, Publication No. 85–3wr, 1985.

"Currents in San Pablo Bay." California State Water Resources Control Board, Publication No. 85–4wr, 1985.

"Hydraulic control over the sill in Observatory Inlet." (with David M. Farmer) Journal of Geophysical Research – Oceans, Vol. 90, No. C5, pp. 9051–9068, 1985.

"Currents in Central San Francisco Bay." California State Water Resources Control Board, Publication No. 86–6wr, 1986.

"Currents in San Francisco Bay – Final Report." (with James R. Hunt) California State Water Resources Control Board, Publication No. 86–7wr, 1986.

"Locating and identifying hydraulic controls for layered flow through an obstruction." Journal of Hydraulic Research, IAHR, Vol. 23, No. 3, pp. 281–229, 1987.

"Energy curves for multi layer flow through obstructions." Journal of Hydraulic Research, IAHR, Vol. 27, No. 5, pp. 617–635, 1989.

"Classification of unidirectional three layer flow over a hump." Journal of Hydraulic Research, IAHR, Vol. 28, No. 2, pp. 215 233, 1990.

"Analytical asymptotic solutions for longitudinal dispersion with dead zones." Journal of Hydraulic Research, IAHR, Vol. 28, No. 3, pp. 309 329, 1990.

"Hydraulic control of multi layered exchange flow through obstructions." In Chapter 3, Stratified Flows, Edited by E.J. List and G.H. Jirka, Published by American Society of Civil Engineers, New York, 1990, pp. 123 132, 1990.

"Accounting for density front energy losses." (Discussion). Journal of Hydraulic Engineering, ASCE, Vol. 116, pp. 270––275, 1990.

"Seasonal influences on the sediment transport characteristics of the Sacramento River, California." (with Peter Goodwin) Technical Note 530, Proceedings of the Institution of Civil Engineers, Great Britain, Part 2, Vol. 91, March 1991, pp. 163–172, 1991.

Closure on Discussion of "Accounting for density front energy losses," by R.A. Denton (1989). Discussion by Wright, Kim and Bühler. Closure appeared in Journal of Hydraulic Engineering, ASCE, Vol. 117, No. 9, pp. 1224–1225, 1991.

"Density currents entering lakes and reservoirs." (with V. Alavian, G.H. Jirka, M.C. Johnson, and H.G. Stefan) Journal of Hydraulic Engineering, ASCE, Vol. 118, No. 11, November 1992, pp. 1464–1489.

"Accounting for Antecedent Conditions in Seawater Intrusion Modeling – Applications for the San Francisco Bay–Delta." Hydraulic Engineering 93, Volume 1, pp. 448–453, Proceedings of ASCE National Conference on Hydraulic Engineering, San Francisco, July 1993.

"Modeling the operation of a water quality reservoir and its effect on the Sacramento–San Joaquin Delta." (with G. Gartrell, and A.W. Nelson) Hydraulic Engineering 93, Volume 1, pp. 623 628, Proceedings of the ASCE 1993 National Conference on Hydraulic Engineering, San Francisco, July 25–30.

"Predicting Water Quality at Municipal Water Intakes – Part 1: Application to the Contra Costa Canal Intake." Hydraulic Engineering 93, Volume 1, pp. 809–814, Proceedings of ASCE National Conference on Hydraulic Engineering, San Francisco, July 1993.

Discussion of "Distribution of suspended sediment over wave–generated ripples." (with Gib Bogle) Journal of Waterways, Port, Coastal and Ocean Engineering, ASCE, pp. 152–153, March/April 1995.

"Understanding the Delta – An engineering perspective." Invited lecture, California Colloquium on Water, University of California at Berkeley, April 10, 2001

"Water Quality Optimization with a Blending Reservoir and Variable Sources" by Elliott Campbell, David Briggs, Richard Denton and Greg Gartrell. Journal of Water Resources Planning and Management, Volume 128, No. 4, pp. 288–302, July/August 2002

List relevant project/field experience and publications/reports.

Salutation: **Dr.**
Last Name: **Gartrell**
First Name: **Greg**
Title: **Assistant General Manager**
Organization: **Contra Costa Water District**
Position:
primary staff
Responsibilities: **Concept development and synthesis**
Qualifications:

Gregory Gartrell, Ph.D., P.E. Assistant General Manager for Planning and Delta Projects Contra Costa Water District P.O. Box H20 Concord, CA 94524 925–688 8100 (Fax: 925 688 8303)

Employment History: 1988 – present, Contra Costa Water District. Assistant General Manager 2001–present Director of Planning 1995–2001 Principal Engineer 1993–1995 Division Engineer 1988–1992 1985 – 1988, Vice President and Senior Engineer, Flow Science Inc. 1983 – 1984, Engineer, HYDRATEC, Paris, France 1982 – 1983, National Hydraulics Laboratory, Electricité de France, Chatou, France 1979 – 1982, Chaim Weizmann Research Fellow, California Institute of Technology

Education: B.S. with Honor, 1973 California Institute of Technology, Pasadena, CA M.S., Environmental Engineering Science, 1974 California Institute of Technology Ph.D., Environmental Engineering Science, 1979 California Institute of Technology Water and Wastewater Leadership Center, 2003 Kenan–Flagler Business School, University of North Carolina Awards Association of California Water Agencies' Excellence in Water Leadership Award, 1997 Hugo B. Fischer Award, 1997 for model development of the Bay–Delta system Lorenz G. Straub Award for doctoral thesis on density–stratified flows, 1980 Elected to Sigma Xi, 1976; Tau Beta Pi, 1972

Memberships, Affiliations: Member, California Bay–Delta Public Advisory Committee [BDPAC] (2001–present) Chair, BDPAC Drinking Water Subcommittee (2001–present) Co–Chair, CALFED Ecosystem Roundtable (1996–2001) Chair, Operations and Fish Forum, CALFED Operations Group (1995–2001) Chair, California Urban Water Agencies/Agriculture Caucus (CUWA/Ag) Technical Committee on Bay–Delta Standards for Bay–Delta Accord (1994) Member, Bay–Delta Accord Ecosystem Restoration (Category III) Steering Committee 1994–96 Member, Water Quality Technical Advisory Committee to the Governor's Bay–Delta Oversight Council, 1993–94 Convener, Bay–Delta Modeling Forum 1994, Past–Convener 1995 Member, San Francisco Estuary Project Technical Advisory Committee Chair, State Water Resources Control Board Bay–Delta M Water Quality Workgroup, 1989–90

Professional Affiliations and Registrations Registered Civil Engineer # C33021, State of California Member, American Society of Civil Engineers (ASCE) Member, American Water Works Association (AWWA)

Professional Experience: Current Activities: As Assistant General Manager, Dr. Gartrell manages Contra Costa Water District's Planning Department and Delta Projects, including: 1) CALFED's Los Vaqueros Expansion Studies, a $30 million, four year feasibility study on expansion of the existing 100,000 acre–foot reservoir to 500,000 acre–feet; 2) CCWD's Alternative Intake Project, a $96 million pipeline and intake relocation to improve water quality, 3) CALFED's $15 million Veale and Byron Tract Drainage water quality projects to remove the impacts of local agricultural drainage on CCWD's water quality; 3) CCWD's Future Water Supply Implementation (a fifty year strategic plan for improving the water supply

reliability of CCWD), including an increased conservation program, water transfers and renewal of CCWD's Central Valley Project Contract for 195,000 acre−feet of water annually; 4) CCWD's 10−year, $400 million Capital Improvement Program; 5) CCWD's Water Resources group involved in all Bay−Delta and CALFED activities; 6) CCWD's planning efforts for renewal, replacement and addition to its facilities and infrastructure, including 70 miles of major water conveyance facilities and a treated water infrastructure that includes two treatment plants and over 700 miles of water mains serving a population of over 250,000.

CALFED: Dr. Gartrell was appointed by the Secretary of the Interior and the Governor of California to the Bay−Delta Public Advisory Committee at its formation in 2001, and was appointed co−chair of its Drinking Water Subcommittee. Dr. Gartrell was Co−chair of the CALFED Ecosystem Roundtable, an oversight and advisory committee that recommended funding for over $300 million in Sacramento−San Joaquin River Delta ecosystem restoration projects.

Bay−Delta Accord: Dr. Gartrell was in leadership roles in the negotiation and implementation of the 1994 Bay−Delta Accord. He chaired the CUWA/Ag technical team that developed the proposal that formed the basis for the Accord. He helped negotiate and develop consensus on the Accord and was among the Accord signatories. Dr. Gartrell helped lead implementation of the Bay−Delta Accord as Chair of the Operations and Fish Forum (charged with implementing the operations of the State Water Project and the Federal Central Valley Project to protect fisheries) and as a representative of Urban/Ag Stakeholders on the CALFED Operations Coordination Group, which is charged with implementing the Accord. He received the 1997 Association of California Water Agencies' Excellence in Water Leadership Award for his work in developing, negotiating and implementing the Accord.

Los Vaqueros Project: Dr. Gartrell led the development of technical and environmental documentation on project operations and Delta modeling necessary for the water rights and environmental permits of the $450 million Los Vaqueros Project, the first reservoir permitted in California's Central Valley water system in over 15 years. Dr. Gartrell worked with U.S. Fish and Wildlife Service staff to obtain non−jeopardy biological opinions for the Project, and with State agencies to obtain the Project's water rights.

Multi−Purpose Pipeline: Dr. Gartrell led this $100 million, 20−mile pipeline project through pre−design and environmental permitting. Dr. Gartrell worked with U.S. Fish and Wildlife Service staff to obtain Endangered Species Act permits that included a non−jeopardy biological opinion for the pipeline and for the District's Future Water Supply Implementation and piloted the EIR/EIS through all stages to final approval.

Areas of Expertise: In addition to his management skills, Dr. Gartrell has technical expertise in the areas of hydraulics and water resources, and water and wastewater treatment. He received the Hugo B. Fischer Award for development of models of the Bay−Delta system and the Lorenz G. Straub Award (an annual international hydraulics and water resources award) for his doctoral thesis on density stratified flows. Publications Gartrell, G. and S.K. Friedlander, 1975, "Relating Particulate Pollution to sources: The 1972 California Aerosol Characterization Study," Atmospheric Environment, Vol. 9, pp. 279 299.

Gartrell, G., 1978, "A Signal Processor for a Laser Doppler Velocimeter," W.M. Keck Laboratory of Hydraulics and Water Resources, Technical Memorandum 78 5, California Institute of Technology.

Gartrell, G., 1979, "Studies on the Mixing in a Density Stratified Shear Flow," Ph.D. Thesis, available as Report No. KH R 39, W.M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology.

Gartrell, G., 1980, "Vertical Flux Measurements in a Density Stratified Shear Flow," IAHR, Second International Symposium on Stratified Flows, Trondheim, Norway.

Gartrell, G., S.L. Heisler and S.K. Friedlander, 1980, "Relating Particulate Properties to Sources: The Results of the California Aerosol Characterization Experiment," pp. 665 714 in The Character and Origins of Smog Aerosols, Advances in Environmental Science and Technology, Vol. 9, G.M. Hidy et al. ed., John Wiley &Sons, N.Y.

Gartrell, G. and E.J. List, 1990, "Chapter 9: Stresses on Well Casing and Screen", in The Handbook of Ground Water Development, The Roscoe Moss Company (ed.), John Wiley &Sons, New York.

List, E.J., G. Gartrell and C.D. Winant, 1990, "Diffusion and Dispersion in Coastal Waters", Journal of Hydraulic Engineering, ASCE, Vol 116, No. 10, October 1990, pp 1158−1179

Burt, C.M., and Gartrell, G., 1991, "Canal Models and You", ASCE Task Committee on Irrigation Canal System Hydraulic Modeling, presented at the ASCE National Conference on Irrigation and Drainage Engineering, Honolulu, HI, July 22–26, 1991.

Gartrell, G., 1993, "Quantification of Uncertainties in Water Quality Models with Application to the Sacramento–San Joaquin Delta", ASCE National Conference on Hydraulic Engineering, San Francisco, July, 1993.

Gartrell, G., 1993, "Predicting Water Quality at Municipal Intakes –Part 2: Application to the Southern Sacramento–San Joaquin Delta", ASCE National Conference on Hydraulic Engineering, San Francisco, July, 1993.

Denton, R. A., Gartrell, G., &Nelson, A. W., 1993, "Modeling the Operation of a Water Quality Reservoir and its Effect on the Sacramento–San Joaquin Delta", ASCE National Conference on Hydraulic Engineering, San Francisco, July, 1993.

Campbell, J. E., Briggs, D.A., Denton, R.A, &Gartrell, G. 2002 "Water quality operation with a blending reservoir and variable sources", J. Water Resour. Plng. Mgmt., ASCE, Volume 128, Issue 4.

List relevant project/field experience and publications/reports.

Salutation: **Mr.**
Last Name: **Cramer**
First Name: **Steve**
Title: **President and Principal Scientist**
Organization: **Cramer Fish Sciences**
Position:
subcontractor
Responsibilities: **Biological support, advisor on fisheries biology and trawl gear efficiencies**
Qualifications:

Steve Cramer President &Principal Scientist, Cramer Fish Sciences Corporate office: 600 NW Fariss Road, Gresham, OR 97030, Office Phone: 503–491–9577

Education 1972, B.S. in Fisheries Science, Oregon State University. 1974, M.S. in Fisheries Science, Oregon State University. Minor: Statistics.

Employment History Fisheries Consultant, Cramer Fish Sciences, 1987–Present. Research Program Leader, ODFW, 1977–1987. Research Project Leader, ODFW, 1974–1977.

Expertise &Qualifications Population Status. Mr. Cramer has supervised assembly and analysis of data on anadromous salmonid throughout the west coast to identify Evolutionary Significant Units and assess their risk of extinction. Mr. Cramer has been the lead author on over a dozen major reports supplied to NOAA Fisheries for ESA status review of coho, Chinook, and steelhead populations.

Population Modeling. Mr. Cramer has led numerous efforts to model salmon and steelhead populations, both to predict future outcomes, and to synthesize existing knowledge of population dynamics. He has developed an Integrated Modeling Framework for key fish species in the California Central Valley

Fish–Habitat Relationships. Mr. Cramer has designed and led several innovative projects have relating fish carrying capacity and survival to habitat features. He hs guided studies to analyze existing data on smolt production and habitat features, and led the experimental design and analysis of data from snorkel and habitat surveys in to determine the relationships of salmonid rearing densities to habitat features.

Project Experience

Selected Biological Assessments Viability of Oregon Coastal Coho: Comments on Oregon's 2005 Assessment. 2005. Prepared for Oregon Forest Industries Council and Douglas County. Viability of the Middle Columbia Steelhead ESU. 2005. Prepared for Yakima Basin Joint Board.

Simulation of human effects on bull trout population dynamics. Washington. 2005. Report prepared for Yakima Joint Board.

A review of abundance trends, hatchery and wild fish interactions, and habitat features for the Middle Columbia steelhead ESU. 2003. Prepared for Mid Columbia Stakeholders.

Derivation of viable population targets (de−listing goals) for ESA−listed salmonids. Prepared for Discovery Institute. 2003.

Estimation of production potential for anadromous salmonids above Keechelus Dam in the Yakima basin. 2002. Prepared for Yakima Basin Joint Board.

Spawning success of hatchery spring Chinook salmon outplanted as adults in the Clearwater River Basin, Idaho, 2001. 2002. Prepared for Bonneville Power Administration.

Impacts of hatchery rainbow trout on naturally produced spring Chinook salmon and winter steelhead in the upper Willamette River basin. 2001. Prepared for U.S. Army Corp of Engineers.

Outmigrant Trapping of Juvenile Salmonids in the Lower Stanislaus River Caswell State Park Site 1999. 2000. Prepared for U.S. Fish and Wildlife Service.

Status of Chinook salmon and their habitat in Puget Sound. 1999. Prepared for Coalition of Puget Sound Businesses.

Synthesis and analysis of the Lower Columbia River Steelhead Initiative. 1997. Submitted to the National Marine Fisheries Service.

Evaluation of delisting criteria and rebuilding schedules for Snake River Spring/Summer Chinook, fall Chinook, and sockeye salmon. Recovery issues for Threatened and endangered Snake River salmon, Technical Report 10 of 11. 1993. Bonneville Power Administration.

Population Modeling

Integrated modeling framework (IMF) user’s guide. Understanding and running the winter−run Chinook salmon IMF Model (Version 1.2). 2004. Prepared for California Urban Water Agencies.

Population dynamics, habitat capacity, and a life history simulation model for steelhead in the Deschutes River, Oregon. 2002. Prepared for Portland General Electric.

Evaluation and modeling of steelhead capacity, population dynamics, and reintroduction potential above impoundments in the upper Deschutes River, Oregon. 2002. Prepared for Portland General Electric.

Evaluation of a habitat based steelhead parr capacity model using Trout Creek, Oregon smolt production estimates. 2002. Prepared for Portland General Electric.

The Relationship of Stream Habitat Features to Potential for Production of Four Salmonid Species. 2001. Prepared for Oregon Building Industry Association.

Conceptual framework for an integrated life cycle model of spring−run Chinook salmon in Butte Creek. 2004. Prepared for California Urban Water Agencies.

Selected Hydro Assessments Biological Assessment, Potential Impacts from the Tieton Hydroelectric Project on ESA Listed Bull Trout and Steelhead in the Yakima Basin. 2002. Prepared for Tieton Hydropower, L.L.C.

Indirect effects of water export on juvenile salmon in the Sacramento−San Joaquin Delta: A conceptual foundation. 2002. Prepared for Metropolitan Water District of Southern California.

Monitoring of Juvenile Fish Passage at Savage Rapids Dam, 1999. 2001. Prepared for Grants Pass Irrigation District.

Effects of Pulse Flows on Juvenile Chinook Migration in the Stanislaus River. 2000.

Seasonal changes during 1996 in survival of yearling Chinook smolts through the Snake River as estimated from detections of PIT Tags. 1996. Report prepared for Direct Service Industries.

Harvest &Hatcheries Review of the Coded Wire Marking Program for Columbia Basin Hatchery Salmon and Steelhead, Phase I. 2004. Prepared for Bonneville Power Administration. Hood River Production Program

Review 1991–2001. 2003. Prepared for Bonneville Power Administration.

Evaluation of contribution to catch and escapement by spring Chinook, fall Chinook, and coho produced at Cowlitz Salmon Hatchery. 2002. Prepared for Tacoma Public Utilities.

Estimation of total catch and spawning escapement from fall Chinook salmon produced at central Valley Hatcheries, 1967–1996. 2002. Prepared for U.S. Fish &Wildlife Service.

Effect of harvest rates on spawning escapement of fall Chinook salmon in the San Joaquin basin. 2001.

Contribution rate benchmarks for future runs of spring Chinook, fall Chinook, and coho produced at Cowlitz Salmon Hatchery. 2000. Prepared for Tacoma Public Utilities.

Estimation of probable harvest rates on Cowlitz River fall Chinook salmon during the 1940's and 1950's. 1998. Prepared for Harza Engineering Company.

Comparative contribution to catch and escapement of fall Chinook fingerlings from Cowlitz Hatchery to that of wild fish from the Lewis River. 1997. Report Prepared for Tacoma Public Utilities, Tacoma, WA

Contribution to catch and spawning escapement of salmon produced at Cowlitz Salmon Hatchery and steelhead at Cowlitz Trout Hatchery. 1996. Report submitted to Harza NW.

Quantification of the probable effects of alternative in–river harvest regulations on recovery of Snake River fall Chinook salmon. 1996. Report submitted to Bonneville Power Administration, Portland, Oregon, 107 pp.

Monitoring and evaluation plan for the Nez Perce Tribal Hatchery: Phase 1 Action Plan. 2000. Prepared for Nez Perce Tribe.

Scientific Publications

In prep. Use of stream habitat surveys to predict rearing capacity for juvenile steelhead (Oncorhynchus mykiss) . Submitted to Am. Fish. Soc. Books, Pacific Salmon Environment and Life History Models: Advancing Science for Sustainable Salmon in the Future. (Cramer, S.P. and N. K. Ackerman)

In prep. Potential production of salmonids in streams is predictable from habitat features. Submitted to Am. Fish. Soc. Books, Pacific Salmon Environment and Life History Models: Advancing Science for Sustainable Salmon in the Future. (Cramer, S.P. and N. K. Ackerman)

1999. The effect of environmentally–driven variation in recruitment on sustainable yield from salmon populations. In E.E. Knutsen, C.R. Steward, D.D. McDonald, J. E. Williams, and D.W. Reiser editors, Sustainable Fisheries Management: Pacific Salmon. Lewis Publishers, New York. (Cramer, S.P.)

1997. Use of managed pulses in flow to stimulate outmigration of juvenile salmon. Proceedings of the 27th Congress of the International Association for Hydraulic Research, volume 1. American Society of Civil Engineers, New York, New York, pp. 563–568. (Cramer, S.P.)

1975. Heritable resistance to gas bubble disease in fall chinook salmon, Oncorhynchus tshawytscha. Fishery Bulletin 73(4):934 938. (Cramer, S.P., and J.D. McIntyre)

1979. Parameter selection and sample sizes in studies of anadromous salmonids. Information Report Series, Fisheries No. 80 1, Oregon Department of Fish and Wildlife, Corvallis, 25p. (Lichatowich, J. and S. Cramer)

1984. An evaluation of recycling hatchery spring chinook salmon through the sport fishery in the upper Rogue River. Information Report Series No. 84 10, Oregon Department of Fish and Wildlife, Corvallis, 18p. (Evenson, M.D., and S.P. Cramer) 1978. Factors influencing the rate of downstream migration of juvenile chinook salmon in the Rogue River, p. 43–48. In: B.C. Shepherd and R.M.J. Ginetz (rapps.). Proceedings of the 1977 Northeast Pacific Chinook and Coho Salmon Workshop. Fish. Mar. Serv. (Can.) Tech. Rep. 759:164p. (Cramer, S.P., and J.A. Lichatowich)

List relevant project/field experience and publications/reports.

Salutation:
Last Name: **TBD**
First Name: **No. 1**
Title: **Technical Staff #1**
Organization:
Position:
subcontractor
Responsibilities: **Data entry and database support**
Qualifications:
List relevant project/field experience and publications/reports.

Salutation:
Last Name: **TBD**
First Name: **Bio**
Title: **Statistician**
Organization:
Position:
subcontractor
Responsibilities: **Define statistically valid delta smelt capture regions for fall and summer population surveys, and relate regions to salinity, temperature and turbidity**
Qualifications:
List relevant project/field experience and publications/reports.

Salutation:
Last Name: **TBD**
First Name: **No. 2**
Title: **Technical Staff #2**
Organization:
Position:
subcontractor
Responsibilities: **Modeling support**
Qualifications:
List relevant project/field experience and publications/reports.

Salutation:
Last Name: **TBD**
First Name: **No. 3**
Title: **Technical Staff #3**
Organization:
Position:
subcontractor
Responsibilities: **GIS database and mapping support**
Qualifications:
List relevant project/field experience and publications/reports.

Salutation: **Mrs.**
Last Name: **Brun**
First Name: **Desiree**
Title: **Grant Specialist**
Organization: **Contra Costa Water District**
Position:
secondary staff
Responsibilities: **Coordinate tasks, budget and reports**
Qualifications:
List relevant project/field experience and publications/reports.

Salutation: **Mr.**
Last Name: **Pyper**
First Name: **Brian**
Title: **Senior Consultant and Biometrician**

Organization: **Cramer Fish Sciences**
Position:
subcontractor
Responsibilities: **Biological and statistical support**
Qualifications:

Brian Pyper Senior Consultant &Biometrician, Cramer Fish Sciences Corporate office: 600 NW Fariss Road, Gresham, OR 97030, Office Phone: 503−491−9577

Education Ph.D. candidate, Fisheries Management, University of Alaska Fairbanks. 2001 – Present M.S. Natural Resource Management, Simon Fraser University. 1996 B.S. Ecology, University of British Columbia. 1991

Employment History Senior Consultant &Biometrician, Cramer Fish Sciences (formerly S.P. Cramer &Associates), 2004 – Present. Research Assistant for Dr. Randall Peterman, Simon Fraser University, Burnaby, B.C, 1996−2001. Statistical Consultant for the Department of Fisheries and Oceans (DFO), Vancouver, B.C, 1995–1997. Research Assistant, ESSA Technologies Ltd., Vancouver, B.C, 1995.

Expertise &Qualifications Quantitative Population Analysis. Brian has extensive experience with quantitative evaluations of fish population dynamics, status, and viability. He has conducted numerous large−scale empirical analyses of spatial and temporal variation in survival, growth, and age of salmon, sturgeon and burbot populations. Brian has broad experience in developing and applying analytical tools to empirical data, including mark−recapture analysis, analysis of PIT and CWT data, multivariate statistics, time−series analysis, Bayesian statistics, and experimental design.

Modeling and Risk Assessment. Brian has considerable experience formulating, applying and evaluating simulation models of population dynamics. He has developed models for a variety of purposes, including models for stock−assessment or analytical procedures, and evaluations of alterative experimental designs and monitoring programs.

Project Experience Factors influencing catch rates of juvenile Chinook salmon by rotary screw traps in the Stanislaus River, California. 2006. Prepared for Tri−Dam Project and U.S. Fish and Wildlife Service.

Evaluation of salmonid survival resulting from flow alterations to the Lower Yakima River. 2005. Prepared for Kennewick Irrigation District and United States Bureau of Reclamation.

Conceptual Framework for an Integrated Life Cycle Model of Spring−Run Chinook Salmon in the Sacramento River Valley. 2005. Prepared for California Urban Water Agencies and State Water Contractors.

Viability of the Middle Columbia Steelhead ESU. 2005. Prepared for Yakima Basin Joint Board.

Population dynamics and extinction risks of Kootenai River burbot. 2004. Prepared for Kootenai Tribe of Idaho and Idaho Department of Fish and Game.

Viability of coho salmon populations on the Oregon and Northern California coasts. 2004. Update. Prepared for Douglas County. Cramer, Ackerman, Brauner Lando, and Pyper.

Scientific Publications 2005. Across species comparisons of spatial scales of environmental effects on survival rates of Northeast Pacific salmon. Trans. Amer. Fish. Soc. 134:86−104. Pyper, B.J., Mueter, F.J., and Peterman, R.M.

2005. Relationships between coastal ocean conditions and survival rates of Northeast Pacific salmon at multiple lags. Trans. Amer. Fish. Soc. 134:105−119. Mueter, F.J., Pyper, B.J., and Peterman, R.M.

2003. Use of the Kalman filter to reconstruct historical trends in productivity of Bristol Bay sockeye salmon (Oncorhynchus nerka). Can. J. Fish. Aquat. Sci. 60: 809−824. Peterman, R.M., Pyper, B.J., and MacGregor, B.W.

2002. Spatial covariation in survival rates of Northeast Pacific chum salmon. Trans. Amer. Fish. Soc. 131: 343−363. [finalist for Best Paper, 2002 volume] Pyper, B.J., Mueter, F.J., Peterman, R.M., Blackbourn, D.J., and Wood, C.C.

2002. A decision−analysis framework for comparing experimental designs of projects to enhance Pacific salmon. N. Amer. J. Fish. Man. 22: 509−527. MacGregor, B.W., Peterman, R.M., Pyper, B.J., and Bradford,

M.J.

2002. Opposite effects of ocean temperature on survival rates of 120 stocks of three species of Pacific salmon (Oncorhynchus spp.) in northern and southern areas. Can. J. Fish. Aquat. Sci. 59: 456–463. Mueter, F.J., Peterman, R.M., and Pyper, B.J.

2001. Spatial covariation in survival rates of Northeast Pacific pink salmon (Oncorhynchus gorbuscha). Can. J. Fish. Aquat. Sci. 58: 1501–1515. Pyper, B.J., Mueter, F.J., Peterman, R.M., Blackbourn, D.J., and Wood, C.C.

2000. Biological responses of sockeye salmon to the fertilization of Chilko Lake, a large lake in the interior of British Columbia. N. Amer. J. Fish. Man. 20: 661–701. Bradford, M.J, Pyper, B.J., and Shortreed, K.S.

2000. Comparison of parameter estimation methods for detecting climate–induced changes in productivity of Pacific salmon (Oncorhynchus spp.). Can. J. Fish. Aquat. Sci. 57: 181–191. Peterman, R.M., Pyper, B.J., and Grout, J.A.

2000. Review of the Coho and Chinook salmon sections of the "Agreement Under the Pacific Salmon Treaty" between Canada and the United States, dated 30 June 1999. Pacific Fisheries Resource Conservation Council. Background Paper No. 2000/2. 35 pp. Peterman, R.M., and Pyper, B.J.

1999. Relationship among adult body length, abundance, and ocean temperature for British Columbia and Alaska sockeye salmon (Oncorhynchus nerka), 1967–1997. Can. J. Fish. Aquat. Sci. 56: 1716–1720. Pyper, B.J., and Peterman, R.M.

1999. Patterns of covariation in length and age at maturity of British Columbia and Alaska sockeye salmon (Oncorhynchus nerka) stocks. Can. J. Fish. Aquat. Sci. 56: 1046–1057. Pyper, B.J., Peterman, R.M., Lapointe, M.F., and Walters, C.J.

1998. Patterns of covariation in survival rates of British Columbian and Alaskan sockeye salmon (Oncorhynchus nerka) stocks. Can. J. Fish. Aquat. Sci. 55: 2503–2517. Peterman, R.M., Pyper, B.J., Lapointe, M.F., Adkison, M.D., and Walters, C.J.

1998. Comparison of methods to account for autocorrelation in correlation analyses of fish data. Can. J. Fish. Aquat. Sci. 55: 2127–2140. Pyper, B.J., and Peterman, R.M.

1998. Implications of a Bayesian approach for simulating salmon population dynamics. In Funk F., et al. (eds.), Fishery stock assessment models, Alaska Sea Grant College Program Report No. AK–SG–98–01, University of Alaska Fairbanks. pp. 873–888. Hill, R.A., and Pyper, B.J.

1998. Experimental design and monitoring of projects to restore and enhance Pacific salmon habitat. Report for Habitat and Enhancement Branch, Dep. of Fisheries and Oceans, Vancouver, B.C. 27 pp. Pyper, B.J., and R.M. Peterman.

1997. Patterns of covariation in components of recruitment among sockeye salmon stocks in British Columbia and Alaska. In Emmett, R.L. and M.H. Schiewe (eds.), Estuarine &Ocean Survival of Northeastern Pacific Salmon: Proceedings of the Workshop, U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS–NWFSC–29, pp. 243–247. Peterman, R.M., Pyper, B.J., Lapointe, M.F., and Adkison, M.D.

1996. Optimizing coded–wire–tagging programs for Pacific Salmon. Master’s Thesis. Simon Fraser University. Burnaby, B.C. 108 pp. Pyper, B.J.

List relevant project/field experience and publications/reports.

Conflict Of Interest

This is proposal #0028 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Instructions

To assist Science Program staff in managing potential conflicts of interest as part of the review and selection process, we are requesting applicants to provide information on who will directly benefit if your proposal is funded. Please provide the names of individuals who fall in the following categories and are not listed in the Personnel Form:

- Persons listed in the proposal, who wrote the proposal, will be performing the tasks listed in the proposal, or who will benefit financially if the proposal is funded; and/or
- Subcontractors listed in the proposal, who will perform tasks listed in the proposal, or will benefit financially if the proposal is funded.

Applicant
Submittor
Lead Investigator/Project Director
Primary Staff
Secondary Staff
Subcontractor

Provide the list of names and organizations of all individuals not listed in the proposal who helped with proposal development along with any comments.

Last Name	First Name	Organization	Role

Task And Budget Summary

This is proposal #0028 for the Science Program 2006 solicitation.

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The submission deadline for this proposal has passed. Proposals may not be changed.

Instructions

Use the table below to delineate the tasks needed to carry out your proposal. Tasks in this form should support the narrative description of your project in your proposal document and the informa tion provided in your detailed budget spreadsheet. Each task and subtask must have a number, title, timeline, list of personnel or subcontractors providing services, and associated budget figure.

When creating subtasks, ensure that each activity is counted only once. Please note, the initial task of your table (Task 1) must present all project management/administrative activities supporting your overall proposal.

For proposals involving multiple agencies or organizations (including subcontractors), the table must clearly state the tasks and subtasks performed by each entity.

Task #	Task Title	Start Month	End Month	Personnel Involved	Description	Task Budget
1	Project Management and Administration	1	15	Briggs, David Brun, Desiree	Coordinate tasks, administer contracts, coordinate reporting and TAC meetings,prepare reports, and process invoices.	6,014
2	Statistical Analysis: Spatial	1	5	Cramer, Steve TBD, No. 1 TBD, Bio	Define statistically-relevant delta smelt capture regions for FMWT and STN capture data and relate these regions to salinity, potentially to temperature and turbidity; provide biological support for statistician; supply advice on fisheries biology, especially as pertains to delta smelt; supply advice on trawl gear efficiencies; supply advice on calculation of CPUE from raw data;perform GIS database entry and routine analysis tasks.	27,000
3	Research Historical Water Use, Salinity and Flow	1	6	Guerin, Marianne Denton, Richard	Define and document the influences and alterations on Delta salinity patterns due to various natural, mandated and adaptive management flows; using the strategy documented by Noah Knowles (ref), tease out the portions of 'management influences' that can be ascribed to Chinook salmon management actions relative to other actions – document results; research and document source and amount of water released to Delta from reservoirs for various uses including diversions, exports, salmon, temperature, and 'other'; include b(2) and EWA water. Determine relative water costs for various water management actions.	25,812
4	Statistical Analysis: Delta Smelt	2	15	Guerin, Marianne Pyper, Brian	Perform statistical analyses on smelt population indices using regions and temporal aggregation from Task #2; Develop statistical regression models relating each smelt index to salinity, flow; Interpret and document results.	8,750
5	Concept Development and Synthesis	2	15	Guerin, Marianne Gartrell, Greg	Analysis and synthesis of research findings,contribute to report preparation, document results.	0
6	Temperature Modeling and	2	15	Deas, Mike	Analyze potential temperature changes on the upper Sacramento, on the San Joaquin River, and in the	18,000

	Analysis				Delta due to scenario changes in reservoir operations; Use DSM2 or equilibrium models, and calculate relative 'water costs' for various actions.	
7	DSM2 Historical and Scenario Modeling	4	15	Guerin, Marianne TBD, No. 2	Use DSM2 fingerprinting to document the salinity and volume contributions due to Chinook salmon protection actions relative to other water management actions; run scenarios to investigate the consequences of operational changes on 'delta smelt salinity habitat'. Analyze results from scenarios, and define boundary conditions for Task 8, salmon population models. Calculate relative water costs from various scenarios. Document results.	8,638
8	Salmon Population Models	4	15	Guerin, Marianne Cramer, Steve	Use the exisiting chinook salmon models on the Sacramento R. (IMF) and the San Joaquin R. (SJR Chinook Salmon Model) to calculate the changes in population from operational changes defined by DSM2 scenarios, and calculate relative water costs in comparison with base case. Interpret and document results.	9,286
9	Develop Modeling Tools	4	15	Guerin, Marianne TBD, No. 3	Develop statistical population model of delta smelt population/habitat using regression results from Task 4. Refine Matlab DSM2 model output visualization tool Perform spatial data analysis on Task 4 results. Develop and document GIS database, provide mapping results. Interpret and document results.	13,427

total budget=$116,927

Detailed Budget Upload And Justification

This is proposal #0028 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Using the budget provided via this link as a guide, please complete a budget for your proposal in the software of your choice (e.g. Excel). This document must be in a format and software that can be converted to PDF prior to uploading on the web system.

It is incumbant upon the applicant to fully explain/justify the significant costs represented in the attached budget. This information can be provided either in a text document and uploaded below, or included in your proposal text in a clearly defined budget justification section. If it is not abundantly clear to reviewers what project costs are commensurate with which efforts and benefits, the proposal may receive a poor review and denied funding.

Costs for each task described in the Task and Budget Summary Form and each staff or subcontractor described on the Contacts and Project Staff Form, must be included in your budget. The budget for Task One should represent project management activities, including but not limited to cost verification, environmental compliance, data handling, report preparation, project oversight, and public outreach. The total amount of your budget must equal the total amount represented on your Task and Budget Summary Form and the total budget amount represented on your Project Information and Executive Summary Form.

In a separate text document to be uploaded below, identify any cost share and other matching funds available to support your proposed project. If you identify cost share or matching funds, you must also describe them in the text of your proposal (see explanation of "cost share and other matching funds" in Section Two of the solicitation document).

CBDA may request additional information pertaining to the items, rates and justification of the information presented in your budget. Applications without completed budgets will not be considered for funding.

Uploading The Completed Budget Template

First, convert your completed Budget to a PDF file. Then, use the browse function to locate the PDF version of your document, select the document and click on the upload prompt below.

You have already uploaded this document. View it to verify that it appears as you expect. You may replace it by uploading another document

Uploading The Completed Budget Justification

First, convert your completed Justification text to a PDF file. Then, use the browse function to locate the PDF version of your document, select the document and click on the upload prompt below.

You have already uploaded this document. View it to verify that it appears as you expect. You may replace it by uploading another document

Uploading The Description Of Cost Share/Matching Funds

First, convert your completed Description of Cost Share/Matching Funds text file to a PDF file. Then, use the browse function to locate the PDF version of your document, select the document and click on the upload prompt below.

You have already uploaded this document. View it to verify that it appears as you expect. You may replace it by uploading another document

Schedule Of Deliverables

This is proposal #0028 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Use the table below to delineate the key deliverables and the time necessary to complete them (in months from the date the project's grant agreement is executed). Each Science Program 2006 PSP grant recipient must provide the required minimum deliverables for each project. The required minimum deliverables for each funded proposal are as follows:

- Semi−annual report(s)
- Final Report
- One page project summary for public audience at beginning of project
- One page project summary for public audience upon project completion
- Project closure summary report or copy of draft manuscript
- Presentation at CALFED Science Conference
- Presentations at other events at request of CALFED Science Program staff
- Copy of all published material resulting from the grant

Deliverable	Description	Delivered By: # (In Months From Project Start Date)
Semi−Annual Report #1	Semi−annual report on project progress	6
Semi−Annual Report #2	Semi−annual report on project progress	12
Final Report	Final Report on conclusions and findings of project	15
Project Summary	One page summary of project for public audience	1
Final Project Summary	One page summary of project results for public audience	15
Presentation at CALFED Science Conference	Presentation of research and conclusions for project	15
Project Closure Summary Report	Draft manuscrips for 'San Francisco Estuarine and Watershed Science' journal	15
Other Project Presentations	Project Presentations to be given as requested by CALFED Science Program staff	15
Published Materials and Reports	Provide copies of all published materials adn reports on project resulting from the grant	15
Summary Documentation	Historical data analyses of relative contributions to Delta salinity from individual reservoir and project operations	6
Documentation of Spatial Statistical Analyses	Definition of and documentation for a statistically− and biologically−relevant spatial and temporal aggregation of delta smelt FMWT and STN capture data	5
Documentation of delta smelt population analysis	Spatially explicit regression models relating delta smelt population indices to salinity, or perhaps flow variables, and statistical analyses will be documented, using the regional and temporal aggregations from Task 2	15
Documentation of DSM2 modeling analysis	Modeling analysis of relative contributions to seasonal salinity from various sources or operations using the regional and temporal aggregations from Task 2	15
Documentation of Chinook salmon population modeling	Predictions of salmon populations from each the base case and hypothetical model simulations will be compared, and changes documented to quantify the production of salmon, and the water cost	15

results	**per salmon produced**	
Matlab visualization tool	**A Matlab−specific tool to visualize DSM2 simulations will be documented, plus documentation of the movies produced from comparing simulations.**	**15**
GIS Database	**A GIS−database containing historical data (operational data, reservoir data, salinity) and temperature data from Tasks 3 and 6, respectively, as well as delta smelt data and metadata from the FMWT and STN data from Task 2. Data or analyses from other tasks will be added if appropriate.**	**15**
IEP Newsletter Submission	**Summary of findings from semi−annual report No. 1**	**6**
IEP Newsletter Submission	**Summary of findings from semi−annual report No. 2**	**12**
IEP Newsletter Submission	**Summary of findings from final report**	**15**

If you are unable to provide a Schedule of Deliverables as outlined above, please provide your justification of non−compliance in the text box provided below. The Science Program reserves the right to determine a proposal non−eligible based on an applicants inability to provide the materials requested above.

Letters Of Support Form

This is proposal #0028 for the Science Program 2006 solicitation.

Frequently asked questions and answers for this PSP are now available.

The submission deadline for this proposal has passed. Proposals may not be changed.

Letters Of Support

Should you wish to provide letters of support for your proposed project, you must do so through use of this web form. Letters of support will be provided to independent, panel and public reviewers for reference as part of the overall review process. It is not mandatory to provide letters of support. Failure to do so will in no way affect the review or final determination of your application.

Submission Of These Materials.

To submit Letters of Support, you must do so as .PDF files. To upload these materials, use the browse function to locate the appropriate .PDF version of the documents, select the documents and click on the upload prompt below.

Please ensure your PDF file contains all letters you would like to submit. Individual files (or letters) will not be accepted by the system. The system is designed to receive one single file. Submittal of these documents are not mandatory for your application to be considered under the 2006 Science Program PSP. Failure to submit letters does not impact your ability to compile your proposal along with the supporting forms required for final submission and consideration under the Science Program 2006 PSP.

Letters Of Support *Please upload a PDF version of your letters of support. To upload a document, use the "Browse" button to select the PDF file containing the document.*

1. Project Purpose

CALFED'S Bay-Delta Authority (CBDA) has been charged with a daunting task – supplying a safe and stable supply of water to meet the needs of municipal, recreational, industrial and agricultural users, while at the same time safeguarding the ecosystems supporting the native species of the San Francisco Bay, the Sacramento-San Joaquin Delta, and their watersheds. This task is complicated by the responsibility to protect certain species, such as delta smelt and several species of Chinook salmon, under the Federal and California Endangered Species Acts (ESA and CESA, respectively). The requirements mandated by these acts have placed rigid constraints on the allocation of California's limited water supply, as well as placing severe demands on the financial resources available for environmental protection. Given the natural limitations on the availability of water, the CBDA must work diligently to concurrently provide for each of the beneficial uses of California water supplies, without diminishing any one of them, and without encouraging invasive species.

In the last two years, it has become evident that 'not all is well' with numerous pelagic fish species in the upper San Francisco Estuary, primarily the Delta and Suisun Bay, as abundance indices for many pelagic species have reached record or near-record lows (IEP, 2006). Although some of these species, such as the delta smelt, have undergone long term declines in their abundance indices, the magnitude of the recent declines was unexpected (IEP, 2005). The Interagency Ecological Program (IEP) has been charged with investigating this 'Pelagic Organism Decline' (POD), and their team has made substantial progress in defining the suspected causes of these declines (IEP, 2005).

Delta smelt, a small pelagic fish native only to the California Delta, was listed as a threatened species under the Federal ESA in 1993, and as such has received greater scrutiny in the POD investigations. Delta smelt generally live only one year and have a low reproductive capacity, and thus are more vulnerable than many fish species to extinction. Salinity is generally thought to be the key environmental feature defining delta smelt habitat and their fundamental 'ecological niche' (Bennett, 2005). Summer and fall delta smelt population indices have reached historic lows in the last two years (IEP, 2006). Concurrently, winter run Chinook salmon on the Sacramento River, which were listed as an endangered species in 1990 under the ESA, have seen resurgence in their numbers[i]. Is there a relationship between these observations?

We suspect that changes in reservoir operations to help restore salmon runs – including temperature control releases in the upper Sacramento River in the summer and shifts in export timing - have contributed to changes in fall salinity patterns in the Delta. There has been a decrease in the fall 'Environmental Quality Index' (EQI) for delta smelt developed by the Department of Water Resources (DWR)[ii], and Contra Costa Water District (CCWD) has demonstrated a recent change in fall salinity patterns. These operational decisions may also be related to a shift in the habitat range of the invasive Asian clam. Because seasonal salinity changes have been implicated as a contributory factor in the recent decline of delta smelt, this proposal is motivated by the following hypothesis:

Hypothesis: The changes in upstream reservoir operations - including temperature control in the upper Sacramento River in the summer, spring operations on the San Joaquin River, shifts in export timing, and other upstream uses - have changed seasonal salinity patterns in the Delta that have contributed to the decline of the Delta smelt.

The goals of this project are: to assess the consequences of actions taken to protect threatened or endangered Chinook salmon species relative to other upstream and in-Delta water management actions that have changed seasonal salinity in the Delta, potentially reducing the ability of delta smelt to survive as a species; and, to investigate with modeling scenarios the potential to mitigate for this trade-off through specific operational actions, such as changes in the timing and/or amount of reservoir releases or exports. Although there are clearly many factors influencing the survival of each of these species, we focus in this proposal on two main factors – seasonal salinity changes in the Delta plus the relative importance of operations for temperature and flow control – which we suspect may, in combination, be related to the decline of the delta smelt. As these are factors over which we can exert considerable operational control, the results of the proposed study have practical significance as well.

2. Background and Conceptual Model

Data analyses by CCWD (unpublished) have documented an increase in fall salinity in the western Delta in recent years, while salinity in the other seasons has remained unchanged (Figure 1). Research by DWR has similarly shown a recent decrease in the fall EQI for Delta smelt which is strongly linked to salinity. These changes in fall salinity may also be related to an observed expansion in the habitat range of the invasive Asian clam (IEP, 2006), as there has been a coincident shift in the timing of maximum clam counts and grazing rates to the fall[iii]. Asian clams have been strongly implicated in the disruption of the Delta food web and as a contributory factory in the decline of several delta fish species since their establishment in 1987 (Bennett, 2005; IEP, 2006; Feyrer, 2003). Bennett (2005) presents evidence that an inadequate fall diet may be related to reproductive success for delta smelt, as energy may be allocated to gonad development during this season. If delta smelt experience food limitation in the fall due to Asian clam disruptions, reproductive success the following year may be compromised, a well-known side effect of insufficient nutrition. Bennett recently[iv] presented data showing smelt fecundity has decreased during the Pelagic Organism Decline (POD) years.

In recent years, population indices for juvenile Delta smelt in the summer can be related in a statistically significant manner to western Delta salinity the previous fall. Linking fall salinity with the delta smelt Fall Midwater Trawl (FMWT) population index is a strong predictor of the population of juvenile smelt in the subsequent Summer Townet (STN) Index after the invasion of the Asian Clam, 1987 – 2005 (Figure 2). Natural year-to-year variations in water supply, frequently defined as a 'water year type', show similar strong statistical links to this population index, with a high correlation and significance since 1987 ($r^2 = 0.41$, $p = 0.003$) particularly for a biological variable (Figure 3). Changes in flow patterns in the western and central Delta, such as a shift in the predominant direction of Old and Middle River flow, have similarly been statistically linked to delta smelt population indices (Pete Smith, USGS, private communication), although it is not clear if this is a link between delta smelt population and flow, or if the relationship simply reflects the correlation between salinity and flow. Although exports have frequently been cited as the main culprit in the decline, CCWD statistical analyses comparing seasonal and annual export rates over varying time spans (1967, 1980, 1987, 1995 – 2005/6) with FMWT and STN indices found no statistically significant relationships.

Along with salinity, decreased turbidity (increased water clarity) is another water quality measure that has been linked to delta smelt decline *via* DWR's EQI for the fall. The spread of the aquatic vegetation, *Egeria densa*, has also been linked to decreased turbidity and to a reduced abundance of native fishes where it proliferates (Nobriga *et al*., 2005). Temperature is critically

important for delta smelt when they are spawning, February through June (Bennett, 2005), which has been problematic when water temperatures near the export pumps reach suitable values early in the spawning season. Spawning begins first in warmer waters (Bennett, 2005).

The Sacramento River winter-run Chinook salmon species was listed as Endangered under the CESA in 1989 and under ESA in 1990 (NMFS, 1997). The listing process began in 1985, but was completed only after a series of lawsuits, an extended drought in the late 1980's, and lower than expected returns in 1989 raised the level of concern (NMFS, 1997). They are presently mainly found in the Sacramento River below the Keswick Dam[v], and most spawning is limited to the main stem of the river[vi]. The major factors implicated in their decline are elevated water temperatures in the upper Sacramento River and impediments to migration at the Red Bluff Diversion Dam (RBDD) (NMFS, 1997). In 1997, a Temperature Control Device (TCD) became operational in Shasta Dam, allowing better temperature management while simultaneously allowing releases for power generation (CDFG, 2004b).

Two of the actions considered necessary to avoid extinction of this species, *i.e.*, not just to prevent further decline or to provide for recovery, are the provision of suitably cold water temperature in the upper Sacramento River and the improvement of fish passage to and from the Sacramento River and through the Delta at various life stages (NMFS, 1997). Winter-run Chinook salmon return to fresh water in the winter, spawning in the spring and summer when they mature reproductively. The majority of the returning adults pass the RBDD January through May, peaking in mid-March. Juveniles remain in the Sacramento River and the upper estuary for five to nine months. Emigration back to the ocean occurs September to June, with pulses coinciding with high precipitation and increased turbidity (NMFS, 1997).

The 'Sacramento River Temperature Task Group' has adopted a flexible strategy to hold temperatures below 56°F from May to October at 'Balls Ferry to Bend Bridge to the extent controllable' to comply with the Sate Water Resources Control Board's order WR90-5 (USBR, 2004)[vii]. Closure of the Delta Cross Channel (DCC) and modifications export in timing are also used to manage winter-run, and other, Chinook salmon populations. DCC closure 'steers' juvenile salmon away from the interior of the Delta where survival is relatively poor, with closure allowed for up to 45 days from November to January (CBDSP, 2001). Although DCC closure improves salmon survival, it leads to an increase in salinity in the interior of the Delta.

There are other Chinook salmon species whose populations have been severely diminished in the Sacramento-San Joaquin watershed (NOAA, 2006). The Sacramento spring-run Chinook salmon was listed as a CESA threatened species in 1999 - they are negatively affected at the local scale (CDFG, 2004). The Central Valley fall- and late-fall-run Chinook salmon have been considered 'species of concern' under the ESA since 2004. These fish enter the Sacramento and San Joaquin Rivers from July through March. San Joaquin River populations are severely depressed, with the main impacts being from agricultural and municipal water use activities (WCSBRT, 1999). The strategies for managing these Chinook salmon species have relevance in the current proposal for actions taken on the San Joaquin River.

In addition to Shasta Reservoir releases for temperature control and use of the DCC to influence flow patterns in the Delta, a recent innovation is the use of the 'Environmental Water Account' (EWA) along with the Vernalis Adaptive Management Program (VAMP) flows in conjunction with the operation of the Head of Old River Barrier (HORB). The VAMP consists of pulse flows down the San Joaquin from upstream reservoir releases in the spring, combined with export modifications. When the HORB, at the confluence of the San Joaquin and Old Rivers downstream from Vernalis, is in place, flow from the San Joaquin River is routed away from the south Delta along the main stem of the river to the confluence with the Sacramento, producing

strong flow effects in the interior of the Delta. The EWA is a water account used to compensate exporters for water lost to export reductions considered important for reducing 'take' of several ESA species at the pumps. The funding for EWA can be used to transfer, purchase, bank, borrow or convey water, or use 'tools' referred to as 'variable assets' to modify various operations or regulations (Poage, 2004; Swanson, 2001).

Conceptual Model and Objectives

As discussed in previous sections, the conceptual model behind this project relates seasonal changes in Delta salinity that have degraded the quality of delta smelt habitat, and possibly encouraged invasive species in the fall, to the effects of all water management operations - exports, DCC and HORB, and reservoir operations – relative to those actions taken to protect winter-run Chinook salmon on the Sacramento River and other species of Chinook salmon on the San Joaquin River. These relationships, illustrated in Figure 4, cover three of the PSP priority topics (see Section 5, Relevance), and are closely related to CBDA's goals of improving water quality while restoring and protecting ecosystem health, by managing Delta salinity and by protecting ESA species, respectively.

In the objectives and the scope of work, we have made several reasonable assumptions and have limited the analyses to specific variables to focus the study. Of the three limiting environmental factors for delta smelt habitat - salinity, turbidity and temperature - having sufficient delta smelt 'salinity habitat' is assumed to be the most critical factor for delta smelt year-round, although temperature distribution is critical while spawning, particularly when this occurs near the pumps. We also assume that the FMWT and STN population surveys for delta smelt are the best available population data series since, although admittedly limited in some respects (Bennett, 2005), they have the longest records. The factors limiting Chinook salmon habitat are different for different species and river systems – for winter-run Chinook the temperature of the upper Sacramento River from late spring through early fall is critical. For fall-run Chinook salmon on the San Joaquin and tributaries, spring river flow at Vernalis and operation of HORB are critical. The evidence for factors affecting the fall-run Chinook salmon population is somewhat controversial (SJRG, 2006; Jager, 2006; Baker, and Morhardt, 2001). Although the effect of Frank's Tract on Delta salinity has been discussed as a source of salinity (CBDSP, 2004), we will not consider it here.

The project scope includes historical data analysis, salinity and salmon population modeling, and statistical analyses relating delta smelt population indices to water quality and flow parameters. These approaches will be used to investigate the extent to which changes in reservoir, export, HORB and DCC operations have contributed to the loss of 'environmental quality' in delta smelt habitat, and which changes in these operations can mitigate for the degradation of delta smelt habitat, particularly fall salinity, without harming Chinook salmon species. Specifically, the objectives are to:

- Define the source, relative magnitude and geographical extent of seasonal salinity changes in the Delta that are linked to the operation of reservoirs, export pumps, the DCC, and HORB for the protection of Chinook salmon species
- Assess the contributions of operations taken to protect Chinook salmon species relative to other upstream and in-Delta water management actions that have changed seasonal salinity in the Delta, and determine the associated water costs
- Use spatially-explicit statistical methods and models to link fall and summer delta smelt population measures to select environmental variables, and to predict the effect of operational changes on seasonal salinity and on delta smelt populations

- Use the salinity and volume fingerprinting capabilities of the DSM2[viii] module, QUAL, to quantitatively assess, both historically and with hypothetical scenarios:
  - the effects of individual operations on seasonal salinity changes to delta smelt habitat and population measures
  - the potential for minimizing these salinity changes by altering the source (Sacramento or San Joaquin), quantity, and timing of reservoir releases
- Assess the effects of salmon-related operations on water temperature on the Sacramento and San Joaquin Rivers, and in the Delta by: analyzing historical data and models, and by modeling hypothetical scenarios using DSM2 and/or an equilibrium temperature model (WE, 2002)
- Use salmon population models on the Sacramento and San Joaquin Rivers to assess the effect of hypothetical scenarios on winter-run Chinook salmon (Sacramento River) and fall-run Chinook salmon species (San Joaquin River).

Because salinity is the key factor defining Delta smelt habitat, we will define statistically-relevant regions in the Delta for analyzing salinity data in conjunction with capture data from FMWT and STN datasets. These regions will be used in two ways: to analyze the results of DSM2 simulations on delta smelt salinity habitat due to changes in operations in hypothetical scenarios (see Tasks 6 and 7); and, to develop spatially explicit statistical models of the relationship between salinity patterns and delta smelt population measures (Task 9) and, if time allows, extending the analysis to turbidity and temperature.

The historical data analysis will quantify natural *vs.* managed flow influences on Delta salinity patterns, but will focus primarily on the consequences of actions taken to protect Chinook salmon species, especially winter-run Chinook, relative to other water management actions. DSM2 was selected to model Delta salinity for several reasons. DWR's Delta Modeling section has developed a well-calibrated Historical simulation of Delta flow and salinity in DSM2, currently covering the period from 1991 – mid-2006. This period will have been extended to the period 1987 – end-2006 by January, 2007 (M. Mierzwa, DWR-DMS, private communication), which will be helpful in developing scenarios as it includes periods of low outflow. In addition, DSM2 is typically used in combination with the CALSIM II water operations model in operations studies. Although we do not plan to run CALSIM in the current proposal, the Delta Storage Study could be extended and modified to simulate the effect of hypothetical operational changes investigated in this proposal (Sanjaya Senevirante, private communication). DSM2 has a module that simulates temperature in the Delta (Rajbhandari, 2004). DSM2 is well-supported by DWR, it is well-documented, and it is in the public domain.

Using analyses derived from researching the amount water released for Chinook salmon temperature or flow objectives, scenarios based on the DSM2 Historical simulation will model the effect on salinity regimes in the Delta due to current operations and to hypothetical changes in operations. Reservoir operations for salmon species protection, as well as closure of the DCC, HORB operation, and changes in export patterns, typically occur from May through October for Sacramento River species, and in the spring and fall for San Joaquin River species. Using DSM2's 'fingerprinting' capabilities, it is possible to track the salinity or volume contributions from individual sources, and thus to quantitatively assess individual effects on Delta salinity. Because temperature effects may be minimal in the Delta, the approach may be partly be qualitative, using either DSM2 or an equilibrium temperature model (WE, 2002).

Two models were chosen for investigating the consequences of hypothetical scenarios on Chinook salmon populations in this proposal, one for winter-run Chinook on Sacramento River

and one for fall-run Chinook on the San Joaquin River. Each model is well-documented, is implemented in EXCEL, and has relatively simple boundary conditions. The DSM2 scenarios will be used to set boundary conditions for the IMF model (Cramer *et al*., 2004) to simulate the effect of operational changes on winter-run Chinook salmon populations on the Sacramento and for the SJR fall-run Chinook Salmon Population Model on the San Joaquin (CDFG, 2005).

3. Scope of Work

Table 1 delineates the time frames and general timing for the nine Tasks described below, which appear in order of start date. Tasks 1 and 5 include Cost Share funds that are in-kind contributions from CCWD for staff time, for Dr.'s Briggs, Gartrell and Guerin. CCWD in-kind contributions represent 22% of the total budget. The Technical Advisory Committee will assist in keeping project direction on target, and review should help assure that results are unbiased. See Table 2. The data analyses in Task 3 broadly define the water management changes, and the synthesis of results from Tasks 4, 7 and 9 will provide data for testing the hypothesis.

TASK 1 – Project Management
Investigator: Dr. David Briggs, Desiree Brun
Background – Dr. Briggs has an extensive background in project management (CV attached).
Definition of Work – Standard project management: coordinate periodic reporting and Technical Advisory Committee (TAC) meetings; co-ordinate the timing of major Tasks; administer contracts; communication and distribution of results.
Staffing: Dr. David Briggs will manage the project and Desiree Brun will assist him. Dr. Briggs' time on this task is an in-kind contribution from CCWD.
Output/Deliverable: - Production of semi-annual and final reports and coordinating communication of results to the IEP/POD and to other interested parties.

TASK 2 – Statistical Analysis: Spatial
Investigators: Statistician (TBD); Mr. Steve Cramer, Technical staff
Background - The FMWT (1967 – 2005) and STN (1959 -2006) delta smelt population surveys are composed of capture data and related metadata, such as volume of water sampled and water quality measurements, for 116 stations grouped into 14 regions in the Delta: 100 of these are used for calculating the delta smelt FMWT index. The mean monthly catch, September – December, for each area is multiplied by a weighting factor proportional to the volume sampled; these values are then summed to obtain a monthly index, and the monthly indices are summed to give the FMWT index. There are 32 stations used for the STN survey, which is taken at 2-week intervals. Each survey index is calculated by summing the catch at each station, multiplying by a volume-weighting factor, and then summing the weighted catches over the stations. The STN delta smelt index is the average of first two surveys (Bryant and Souza, 2004).

Many of the analyses of delta smelt population data for POD investigations have used some form of spatial aggregation of the raw capture data (Manly and Chotkowski, 2005; Miller *et al.,* 2005) (Guerin *et al.,* unpublished). When aggregated, the geographical regions have been sensibly but arbitrarily defined. Other researchers have used data from the individual stations without any form of aggregation, for example, to calculate capture probabilities[ix]. What each of these approaches has neglected is the need to legitimately pool data from the sampled stations into statistically appropriate spatial aggregates. Task 2 will address this knowledge gap for both the STN and FMWT capture data. In addition, a simplified approach to temporal aggregation has

typically been employed, for example, CCWD used seasonal or annual data. In many cases, seasonal data, for example using January – March for 'winter', did not overlap well with actual seasonal variability. Although this has produced some useful analyses, the obvious next step is creating a spatially and temporally aggregated dataset that captures the variability in the data.

Definition of Work – Using the historical FMWT and STN data sets, define regions in the Delta where stations can be legitimately aggregated to capture sample variability. Determine if there are spatial patterns in the population data in comparison with salinity, and with temperature and turbidity, as indicators if time allows. Define delta smelt habitat boundaries seasonally, possibly as sub-regions. Investigate the possible time scales for temporal aggregation of the indicator data or flow measurements, in relationship to the aggregated population data. The data, defined regions, and analyses, if appropriate, will be stored in a GIS database.

Staffing: Statistician (TBD) will perform all statistical analyses. Mr. Cramer will provide biological support for issues such as trawl efficiency and CPUE (Catch per Unit Effort) calculation. Technical staff will assist the statistician as needed.

Input: Standard datasets of delta smelt capture data, available *via* Department of Fish and Game staff or *via* the BDAT website[x], with associated parameters.

Output/Deliverable: - Documentation, GIS dataset, and analysis results:

1. Definition of a statistically and biologically-relevant spatial aggregation of delta smelt FMWT and STN capture data.
2. Define delta smelt optimal 'salinity habitat regions' using these aggregations – optimal salinity for smelt is frequently quoted as (0.2 – 2.0) psu.
3. Temporal aggregation – develop an optimal temporal aggregation of salinity data that can be used for comparison with each of the indices.
4. If time allows, a similar analysis of temperature and turbidity data.

The regional and temporal aggregations will be used in Tasks 4, 6, 7 and 9 for further data analysis; regions and time spans will be used in Task 4 for delta smelt population analysis, and in Tasks 6 and 7 in DSM2 model scenarios. Technical staff is for GIS database data entry.

TASK 3 – Research Historical Reservoir Releases and Operational Data

Investigators: Dr. Richard Denton, Dr. Marianne Guerin, technical staff

Background – Dr. Denton observed (Figure 1) that there has been an increase in fall salinity in the western delta in recent years, but not in other seasons. To explain this observation, an initial hypothesis was formulated that a change in the schedule of reservoir releases along the Sacramento River watershed, perhaps combined with increased summer exports, might be the cause. This hypothesis seemed reasonable because the salinity changes appear to be coincident with winter-run Chinook salmon and delta smelt Biological Opinions. After 1993, take limits and conditions to protect winter-run Chinook salmon and delta smelt were applied, so project operations changed and water supply reductions occurred. Dr.'s Denton and Guerin have performed preliminary analyses of Sacramento River flow and Shasta reservoir releases, but they have not been conclusive. Although our initial hypothesis concerned Sacramento watershed operations, because there have also been major changes in San Joaquin operations for other Chinook salmon species, it seems logical to include these in the analyses of the relative effects of water management operations for fish and other uses.

Knowles (2002) investigated natural *vs.* management influences on salinity in the San Francisco Estuary from 1967 to 1987. He found that management effects had their maximum influence in the spring, resulting in an increase in salinity, that year-to-year variations in the

signal were very large and that they exceeded the range of management effects. Patterns in seasonal salinity, however, also reflected the limitations of management capabilities, such as late season releases needed to create flood control storage space for the upcoming wet season. Management impacts were greatest in moderate flow years (Knowles, 2002). If time allows, we will extend Knowles' analysis from 1988 – present.

Definition of Work – This task consists of primary data analysis, and an extension of work started by other researchers. The time period covered, at a minimum, should be 1980 – 2005/6. The period 1987 – 1994 is a drought period, so comparisons are needed between two relatively wet periods, 1980 – 1986, and 1995 – 2005.

1. Determine timing, source and volume of Chinook salmon temperature releases in the Sacramento watershed, and of salmon flow releases in the San Joaquin watershed
2. Examine other possible factors contributing to the fall salinity shift, such as HORB operations, shifts in export timing, or operational changes for flood management
3. Pinpoint the cause of Denton's Fall Vivaldi salinity shift
4. Quantify the relative magnitudes and water costs of reservoir releases for the various uses.
5. Extend Noah Knowles work to the period 1987 – 2006 by: disaggregating the various management flows, if possible, into source of water and timing (e.g., EWA water, exports, temperature management, etc): and, determining, as closely as possible, seasonal salinity in the Delta due to both natural and the disaggregated management influences

Staffing: Denton will perform the majority of the analyses, with Guerin assisting.

Input: In addition to published studies, there are publicly accessible datasets:

1. http://www.usbr.gov/mp/cvo/Temp.html daily averages of releases, reservoir temperature, temperature at compliance locations, and number of gates open at outlet levels in monthly 'Reporting Summary Required by Biological Opinion' from 1996 – 2006.
2. http://wwwoco.water.ca.gov/calfedops/ data generated by the CAFED Ops group, EWA accounting information, salvage information for winter-run Chinook salmon
3. Other websites have other water quality and flow parameters: the IEP website: http://www.iep.ca.gov/dss/; the CDEC website: http://cdec.water.ca.gov/reservoir.html gives reservoir storage data for all reservoirs in the system; the MWQI website with water quality and other data, although the data time series tend to be rather sparse.

Output/Deliverable: - In addition to documentation of the analyses, this work will be submitted to the IEP Newsletter, or, the peer-reviewed journal 'San Francisco Estuary and Watershed Science'. The output will also be used to define boundary conditions for the DSM2 modeling scenarios (see Tasks 6 and 7). In addition, the initial stages of testing the hypothesis will be documented. Note that data will be entered in the GIS database *via* Task 9.

TASK 4 – Statistical Analysis: Delta Smelt

Investigators: Dr. Marianne Guerin, Mr. Brian Pyper, (Technical staff from Task 2 or 9)

Background – The current statistical work developed by CCWD is 'zero-dimensional', *i.e.*, all of the regression relationships, correlation analysis, and Principle Components Analysis were performed using salinity or flow monitoring stations at a single point in the Delta, and compared to either the FMWT or STN indices, both of which are aggregated spatially. In addition, a simplified approach to temporal aggregation was employed, using seasonal or annual data. In many cases, seasonal data, for example using January – March for 'winter', did not overlap well with actual seasonal variability. Although this has produced some useful analyses, the obvious next step is to perform similar analyses using the spatially and temporally aggregated dataset from Task #2. CCWD has found statistically significant relationships between the adult FMWT

and subsequent juvenile STN indices, as have other researchers. For example, r^2 = 0.43 and p = 0.002 over the period 1987 – 2005. In addition, there is a relationship between the juvenile STN index, weighted over the catch volume, to the subsequent Dec FMWT index, r^2 = 0.6 and p = 0.008 for the period 1995 - 2005. This observation may be significant, as it indicates a potential for developing a statistical model for predicting delta smelt populations from simple environmental data and the indices themselves.

Definition of Work – Using the historical FMWT and STN data sets, and the regions defined in Task 2, perform statistical analyses to develop regressions between the two smelt indices and regional salinity and perhaps flow data. These analyses will replicate the strategy of previous 'zero-dimensional' analyses, but in two dimensions, for example, using generalized linear models. If reasonable relationships are developed, they can be applied to the salinity patterns calculated from the DSM2 model scenarios. In addition, an attempt will be made to develop a relationship between juvenile (STN) and subsequent FMWT indices, possibly disaggregated to yield a simple statistical predictive model between fall and summer delta smelt populations.

Staffing: Mr. Pyper will act as a statistical consultant to assist Dr. Guerin in these analyses and to ensure statistical rigor, and perform or define more difficult analyses if needed. The overlap in time means that technical staff from Task 2 or 9 can add any relevant data to the GIS database.

Input: The regionalized dataset developed in Task 2, and other water quality data if required.

Output/Deliverable: Spatially explicit regression models relating delta smelt population indices to salinity, or perhaps to flow variables. All statistical analyses will be documented. Results with statistically significant relationships, will be submitted to the IEP newsletter or for peer review, or included in the Final Report if negative. If indicated, results will be entered in the GIS dataset.

TASK 5 – Concept Development and Synthesis of Results

Investigator: Dr. Greg Gartrell, Dr. Marianne Guerin, (Dr. Richard Denton)

Definition of Work – Dr. Gartrell will lead the task of synthesizing research results to develop a clear picture of the trade-off between delta smelt salinity issues and salmon protection measures.

Staffing: Dr. Gartrell will lead the effort, with Dr. Guerin assisting as needed. The time budgeted for Dr.'s Gartrell and Guerin time on this task is an in-kind contribution from CCWD.

Background – Dr.'s Denton, Gartrell and Guerin have been investigating POD issues since they became apparent in 2005. Their analysis of the relationship between western delta salinity in the fall and delta smelt population indices has generated numerous discussions, including a serious proposal to increase reservoir releases to decrease fall salinity in the Delta with the intent of increasing the likelihood of adult delta smelt survival and successful reproduction. They have also investigated the link between recent increases in fall salinity and the spread of the invasive Asian Clam, as discussed previously in this document. This hypothesis is currently open, and is being investigated in the current IEP/POD workplan (IEP, 2006) and *via* other funding for USGS and academic researchers. A primary driver behind this proposal is the need to extend CCWD preliminary analyses spatially and temporally, and to pin down the cause behind the increases in fall salinity. The main hypothesis in this study was proposed as a leading contender responsible for the changes in seasonal delta salinity patterns. If the preliminary data investigations falsify the hypothesis, an alternate conceptual model will be developed. Dr. Denton will be available to provide input to concept development and synthesis results during the entire project (pers. com.).

Input: Interim results from each of the tasks.

Output/Deliverable: - Synthesis of results to be documented in writing in the semi-annual and final reports; preparation of technical papers to be submitted either to the IEP Newsletter or to journals such as San Francisco Watershed and Estuary Science; other documentation as required.

TASKS 6 and 7 – DSM2 Modeling and Temperature Analysis

Investigators: Dr. Marianne Guerin, Dr. Mike Deas

Background – The most important DSM2 model capabilities for this research are the salinity and volume fingerprinting options. Using these options, it is possible to track the salinity or the volume of water contribution from any source in the model domain. The DSM2 Historical simulation is currently used to simulate historical flow and salinity conditions in the Delta. Model results for salinity and Dissolved Organic Carbon (DOC) appear in the MWQI Weekly Water Quality Report. The current model dataset of boundary conditions replicates flow and salinity conditions in the Delta for the period 01/1991 – 06/2005, with a one-year spin-up period in 1990. By January, 2007, the model will be extended back to 01/1987 – 12/2006, with a one year spin-up period in 1986. DSM2 is remarkably well-calibrated for salinity (and for DOC). DSM2 also has the capability of modeling temperature (Rajbhandari, 2004).

Although the focus on water temperature is not as detailed as for salinity, there are model studies and field data that are available. These efforts include flow and temperature modeling and monitoring on the Sacramento River and San Joaquin River, as well as within portions of the Delta (AD and RMA, 2002; Deas *et al*., 1997). Although temperature control in the Delta from reservoirs on the Sacramento and San Joaquin Rivers is largely impractical, these operations may have an effect on Delta conditions so historical data will be investigated to determine the potential magnitude of such effects. If the DSM2 temperature module turns out to be impractical for modeling in the Delta, an equilibrium model based on local meteorological conditions is an alternative. For example, by calculating temperature on a daily basis then aggregating up to larger time steps, we may be able to get a representative average at a few points during several time periods to test practicality of the task.

Definition of Work – Using the historical DSM2 model and results from Tasks 2 and 3 to develop boundary conditions, we will run a series of scenarios, sketched below, and analyze the resultant salinities in the regional aggregation from Task 2, and in the delta smelt 'salinity habitat regions'. If possible, we will determine the temperature effects in the Sacramento and on the San Joaquin and in the Delta (if any) under each of these scenarios based on existing studies, field data, and/or using the methods outlined above. The DSM2 Historical Model will be used as a Base case, covering the period 1986/7 – 2006. Using the regions defined in Task 2 and DSM2 volume and salinity fingerprinting, modeled salinities will be aggregated over the resultant regions using either monthly time periods or the temporal aggregation from Task 2. The source of the salinity in each of these regions will be determined using fingerprinting output, and used to calculate the costs of water associated with salinity reductions as appropriate. One set of scenarios will investigate releasing additional 'Hypothetical EWA Water' down both the Sacramento and the San Joaquin Rivers to create a more favorable 'salinity habitat' for delta smelt in the fall. Depending on the results of Task 3, there may be up to nine scenarios. DSM2 is easy to run, and the main DSM2 tools for analyzing output have already been developed, so this work will be relatively straightforward.

The scenarios are expected to answer the following questions, or similar ones, about the relationship between delta smelt salinity habitat and changes in reservoir operations, DCC and HORB operational changes, and changes in exports:

1. Base case – What is the source of the fall salinity shift? Reservoir releases, changes in the timing of exports, or, something else? In addition, what are the flow conditions on Old and Middle Rivers during HORB operations? One scenario.

2. Scenario 'Shift' – Given the answer to the Base case questions, does shifting Sacramento temperature releases to the fall decrease salinity enough to improve delta smelt habitat, and, does it increase salinity enough in other months to degrade smelt salinity habitat? One Scenario: Run DSM2 by SHIFTING reservoir releases for winter-run Chinook salmon temperature protection, or some other operation if indicated, to the fall.
3. Scenario 'Add EWA' – As in the previous scenario, if we ADD an equivalent amount of release down the Sacramento during the Fall to decrease salinity in the smelt 'salinity habitat', how much effect would this have on fall salinity? What would happen if we send the equivalent amount down the San Joaquin River in the fall instead? In each case, can we then increase fall base case exports and decrease exports in the summer without hurting fall smelt salinity habitat? Four Scenarios: Run DSM2 by ADDING extra reservoir releases down each of the rivers. Shift the timing of exports in each case.
4. Scenario 'Change Operations' – Using information from Task 3, what is the effect of operational changes on flow near the export pumps and on delta smelt regional salinity from: keeping the DCC always open or closed; or, not installing HORB in spring or fall? Two Scenarios – Conditions TBD pending results of the base case scenario and the analysis in Task 3. Compare each change with the Base Case.
5. Scenario 'Change Exports' How much of decrease would it take in export operations to create an optimal delta smelt salinity habitat all year? One scenario.

Note that the salinity (and flow) effects will be determined regionally and temporally over each scenario, and fingerprinting results will be analyzed to quantify the magnitude of each of the changes by source location, and to quantify the potential 'water cost' for relevant operations. MATLAB tools will be developed in Task 9 to automate the analyses.

Staffing: Dr. Deas will be responsible for all temperature-related analyses. Dr. Guerin will perform and analyze DSM2 models and scenario output.

Input: Using the DSM2 Historical model as a Base case, the DSM2 salinity modeling input is the regionalized dataset from Task 2, and operational and boundary conditions for hypothetical scenarios from Task 3. For the temperature analysis, raw data input will be meteorological data and historical temperature data in the Delta (this is sparse). Much of the data needed will have been organized in Task 3, or is available from previous analyses (Deas *et al.,* 1997).

Output/Deliverable: The main output from this work will be an analysis of contributions to seasonal salinity from various sources or operations using the regional and temporal aggregations, *i.e.,* the delta smelt 'salinity habitat', developed in Task 2. In addition, the water costs to change salinity for delta smelt habitat improvement will be calculated. For the Historical model, this work will quantify the source of seasonal salinity changes noted by Denton. For hypothetical scenarios, this work will quantify the operational changes and reservoir releases that contribute to salinity changes, as well as reservoir releases or operational changes needed to optimize delta smelt salinity habitat. The DSM2 modeling has value independent of this research – the scenarios could also be used to determine the movement of pesticides, real or hypothetical, through the Delta. CCWD currently has a beta-version of a MATLAB visualizer that is capable of visualizing DSM2 flow and salinity output, as well as the difference between two model outputs (See Task 9). DSM2 analyses will be included in the semi-annual reports and the final report. Boundary conditions for the salmon population models in Task 8 will be developed from each of the hypothetical scenarios. Results will be entered in the GIS dataset.

TASK 8 – Salmon Population Modeling

Investigators: Dr. Marianne Guerin, Mr. Steve Cramer

Background – The purpose of this task to assess potential changes to two Chinook salmon populations, winter-run on the Sacramento River and fall-run on the San Joaquin, from the flow or operational changes used in the hypothetical scenarios developed in Tasks 6 and 7. In addition, the cost of water for salmon protection will be calculated.

The Winter-run Chinook Salmon Integrated Modeling Framework (IMF) model (Cramer *et al.*, 2004) was developed by a team of fisheries consultants to predict the change to winter-run Chinook population by changes in water management, harvest regulation, hatchery augmentation, and stream habitat alteration. The model, implemented in EXCEL, is intended to be used to understand probable responses of fish populations. Specific parameters that will be varied in this proposal include reservoir release water temperature, DCC operation, export flow, and Sacramento River flow at Freeport or salinity at Collinsville. The San Joaquin River (SJR) Fall-run Chinook Salmon Population Model (CDFG, 2005) is also implemented in EXCEL. Specific parameters that will be varied in this proposal include the daily position of HORB in each of the years simulated and the maximum flow level HORB will operate within, and San Joaquin River flow at Vernalis on a daily basis. The model predicts salmon escapement abundance from various tributaries (Stanislaus, Tuolumne, Merced and San Joaquin Rivers), and several water accounting tables, such as the amount of water used for fishery beneficial use as a percentage of October through July run-off.

The IMF and the SJR Chinook salmon population models have each received positive and negative reviews (SJRG, 2006; Jager, 2006; Smith, 2004). The strength of these models in the context of this proposal is that they are simple, and the boundary conditions needed to run the models are variables being tested in our scenarios. Other conceptual models have been developed with more complex formulations (Jager and Rose, 2003; Newman and Rice, 1997), but they are not suitable for our purposes.

Definition of Work – Run the two salmon population models to predict populations on the Sacramento and the San Joaquin Rivers using the DSM2 hypothetical scenario boundary conditions and operations. Compare these populations to the base historical salmon population predictions, and document the changes. Calculate the costs of water associated with population improvements. The winter-run Chinook salmon has a higher ESA-value, so changes that improve or degrade this population naturally have higher significance.

Staffing: Mr. Steve Cramer will assist Dr. Guerin in setting up and interpreting the output from the Chinook salmon models, to ensure biological rigor and appropriate usage.

Input: Flow, operations and salinity conditions from the DSM2 modeling scenarios will be used as the inputs to the two salmon models. The conditions on salmon age structure, etc. are included in the database for each of the models, and will not be varied unless necessary.

Output/Deliverable: Salmon population predictions from the Base Case model simulations will be compared to changes in salmon populations from each of the scenarios, and the associated water costs for improvements calculated. Results will be documented in the Final Report, and possibly in the IEP Newsletter if interesting.

TASK 9 – Visualization and Regional Analysis of DSM2 Output

Investigators: Dr. Guerin, Technical staff

Background – CCWD currently has a beta-version of a DSM2 output visualization tool developed in MATLAB for visualizing flow or salinity output, as well as the ability to calculate and visualize the difference between two model outputs. This tool will be refined for this project. For the spatial analyses, the intent is to use results of Tasks 4, 6 and 7 to develop a statistical,

spatially-explicit predictive delta smelt population model. If in Task 4 spatially-explicit statistical relationships can be developed, similar to the zero-dimensional relationships developed from delta smelt population indices, then additional work will be done in this task to apply the model developed from historical data to the output from the hypothetical DSM2 scenarios.

Definition of Work – Produce visualizations of each of the DSM2 runs, as well as the salinity differences between the scenarios, i.e., 'residual models'. Use MATLAB and/or GIS statistical tools to analyze spatial delta smelt regressions and other results developed in Task 4. These analyses will be combined with the results of the hypothetical DSM2 scenario models in the event a statistical model predicting fall and summer delta smelt populations can be developed using flow and salinity variables from Task 4. Two types of specialized software packages will be purchased for use – MATLAB statistical tools, and GIS Arcview tools.

Staffing: Dr. Guerin will perform the more complex data analysis tasks. Technical staff will perform routine programming or GIS database tasks.

Input: DSM2 model output from Tasks 6 and 7. Regional and temporal aggregation analysis from Task 2, and data from Task 3.

Output/Deliverable: The MATLAB visualization tool will be documented, and the resulting visualizations exported as 'movies'. This task will develop, populate and finalize the GIS database. Statistical population models developed from the spatial analyses and DSM2 output salinities will be prepared for publication in either the IEP newsletter or in a refereed journal.

4. Feasibility

This is an exploratory proposal, with a short time frame (15 months) and focused objectives to quickly produce results and analyses relevant to water management issues for Chinook salmon species and POD issues, particularly delta smelt. We have limited our focus to ESA species whose survival exerts the greatest influence on operations. We will analyze historical data to tease apart some of the relationships among the main operational factors controlling Delta flow and salinity regimes and upstream temperature control. The principal investigators for the data analysis tasks are each expert in their fields, and/or are intimately familiar with the associated datasets and issues. We will then use numerical models to investigate how these factors relate to delta smelt habitat, salmon population measures, and management options at intermediate time and spatial scales – kilometers and months, respectively. Each model used is well-known to the researcher responsible for the Task, and each model is already calibrated for the base case – existing conditions. None of the work proposed here has any contingencies, or any dependence on the outcome of other projects.

Dr. Briggs will coordinate the overall management of the project, while Dr. Gartrell will coordinate the conceptual and data synthesis aspects. The smaller tasks within each task are prioritized, so time constraints can be managed without impacting other tasks. The intent is to select an appropriate academic statistician for Task 2, but there is a fall-back option available – U.C Davis has a statistical consulting service available at reasonable rates.

5. Relevance

The focus of the project includes all aspects that the topic Selection Panel regarded as adding high value: analysis and synthesis of existing information (Tasks 2, 3, 4 and 5); modeling (Tasks 7, 8 and 9) which serves to integrate the data and analyses in this project; and, an interdisciplinary nature, as the proposal includes biological, water management and statistical

components. The intent of the modeling is to clarify and quantify system level responses, such as changes in salinity and fish populations, to changes in water management, and to calculate the associated water cost. This proposal is also cross-cutting, addressing key components within three research topics – Environmental Water, Trends and Patterns of Populations, and Habitat Availability – and several questions within each topic as follows:

Topic 1 – Environmental Water

- Question: What effect could a different amount of environmental water have on fisheries?

Answer: Four of the hypothetical scenarios in Task 7, concern the effect of changes in the release of EWA water on Chinook salmon species and on delta smelt 'salinity habitat'; the salmon population modeling, Task 8, then uses the hypothetical conditions to predict population effects.

- Key components: 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.

Answer: The proposal analyzes two Chinook salmon populations under different EWA-usage scenarios; and, predictions of salmon populations from each model simulation will be used to quantify the water cost per salmon produced. DSM2 output will be used to calculate the water cost to reduce salinity when appropriate, which effects delta smelt viability.

Topic 3 – Trends and Patterns in Populations and System Response to a Changing Environment

- Question: What are the driver/response relationships of key species and/or structures or system water operations? How are these relationships best described? What are the implications for management strategies of the type of response of species or structures?

Answer: The drivers are reservoir operations, exports, and control structure operations, and the delta smelt and Chinook salmon respond to them, we will describe these relationships statistically and by using existing models; the proposal investigates the implications of management strategies on the amount of water needed to control delta smelt 'salinity habitat', and to protect ESA species such as winter-run Chinook salmon.

- Key components: Response variable selection; driver selection and justification; and, demonstration of heavy use and synthesis of existing information

Answer: The driver variables are upstream reservoir operations, exports, and others; the response variables are salinity and temperature physically, and Chinook salmon and delta smelt biologically; and, the driving intent behind this proposal is to combine data analysis with synthesis.

Topic 4 – Habitat Availability and Response to Change

- Question: How will future scenarios affect abiotic and biotic drivers and how will these drivers, in turn, affect key species? How will key species respond to these changes? What are the implications for management strategies of the type of response of species or structures?

Answer: We address the question of how much water is needed for ESA species.

- Key components: This project includes an analysis of current habitat extent and condition, and spatially explicit data on delta smelt relative abundance and demographic characteristics Tasks 2 and 4, in which delta smelt 'salinity habitat' is defined, and justified statistically. In addition, the project develops and uses spatially explicit models and databases to he potential effects of anticipated stressors on existing habitats in Tasks 2, 4, and 9.

In their recent Work Plan (IEP, 2006), the IEP POD work team detailed their working hypotheses. As the analyses in the current proposal address several of their spatial and temporal hypotheses for delta smelt, the datasets, analyses and results documented in the deliverables should provide additional value to the POD investigations. The results of this proposal will be widely distributed via IEP newsletters and through peer-reviewed journals if appropriate. In addition, the members of the TAC (see Table 2) will have access to all results for review if desired. Dr. Ted Sommer, who is on the IEP/POD team, and also on the TAC for this project, suggested that project results could be presented at internal POD work group meetings.

6. Qualifications

Dr. Gartrell's extensive and detailed knowledge of Delta hydrodynamics and water management history clearly provides the expertise and experience needed to synthesize the results from this proposal into a coherent picture of the relationships between seasonal salinity and delta smelt decline, Chinook salmon survival, and water management. He has held leadership positions in the California Bay-Delta Public Advisory Committee (BDPAC) and in various aspects of CALFED operation and roundtables. Dr's Gartrell, Briggs and Denton are recognized experts in Delta modeling and in Delta water management issues. Dr. Denton has been involved in many of the fundamental CALFED decision-making processes, such as the application of X2 as an operational criterion. Dr. Denton was Designated Chair of CALFED Operations and Fish Forum, and was recently replaced by Dr. Briggs.

Dr.'s Gartrell, Denton and Guerin have collaborated successfully in the POD problems, and are recognized for developing significant relationships between salinity and the delta smelt decline. Dr. Guerin has expertise in transport modeling at all spatial scales, with extensive practical and theoretical experience, and has managed or worked in numerous multi-disciplinary projects in academia and government research laboratories. Dr. Deas is an acknowledged expert in modeling temperature issues on the Sacramento and San Joaquin watersheds, and on temperature modeling in general. He directed a major proposal for the USGS on historic flow and temperature modeling on the Sacramento. Mr. Cramer is the author of the IMF model used in this proposal. He has been a fisheries consultant for 18 years after serving 14 years with the Oregon Department of Fish and Wildlife. The focus of his research and consulting has been the population dynamics of salmon and steelhead. Mr. Pyper is a biometrician with expertise in fish population dynamics modeling, stock assessment, experimental design, time series analysis, Bayesian statistics, and risk assessment.

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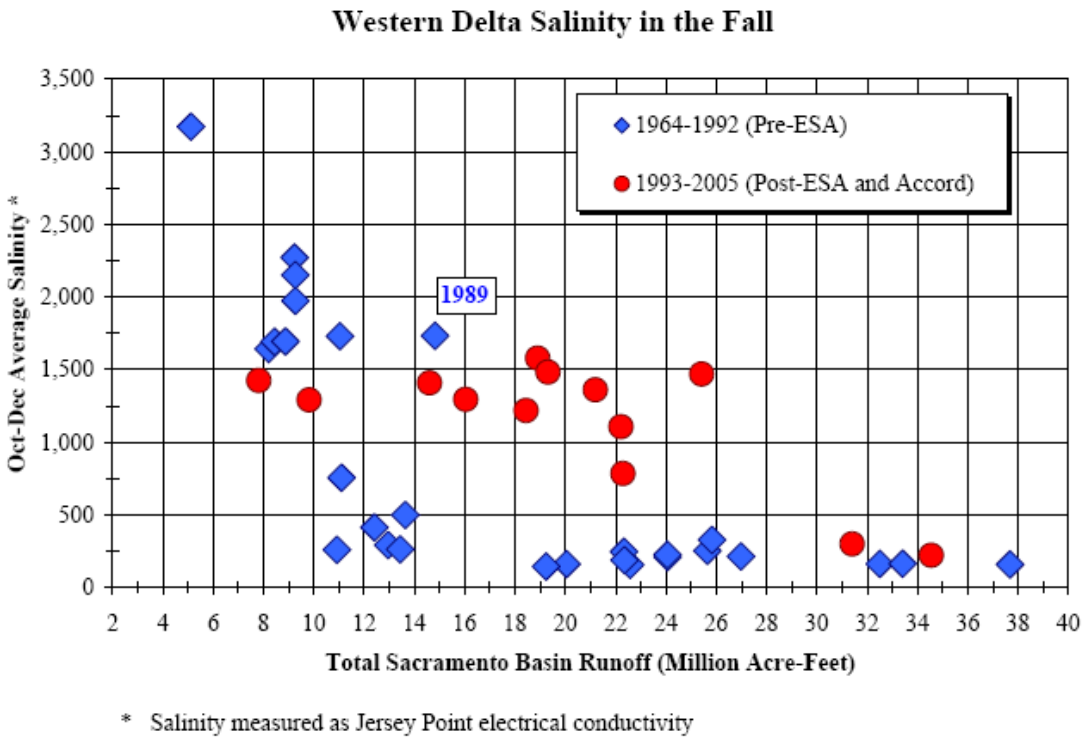
[i] http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR2005-allspecies.pdf
[ii] http://www.swrcb.ca.gov/agendas/2006/june/0607_03pres.pdf
[iii] Estuarine Ecology Team Meeting, August 28, 2006, SFSU, Tiburon Center.
[iv] Estuarine Ecology Team Meeting, May 17, 2006, U.C. Davis
[v] http://www.usbr.gov/mp/battlecreek/about.html
[vi] http://www.fws.gov/pacific/planning/main/docs/CA/sacriver/Final%20CCP/Appendix%20F.pdf
[vii] http://www.usbr.gov/mp/cvo/ocap/OCAP_BA_Apps/AppB/Tech_Memo_on_U_Sac_Temp_Anal.doc
[viii] http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/dsm2/dsm2.cfm
[ix] Matt Nobriga, Estuarine Ecology Team Meeting, August 28, 2006, SFSU, Tiburon Center.
[x] http://baydelta.water.ca.gov/index.html



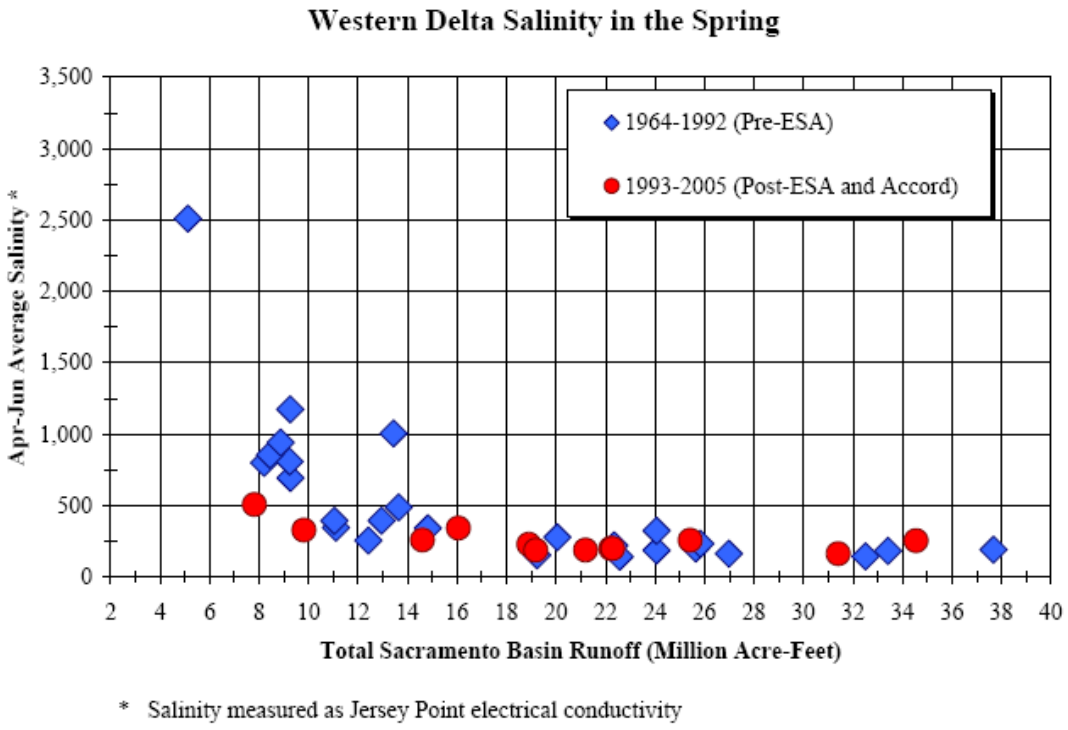


Figure 1. Variation of salinity at Jersey Point in the Western Delta with Sacramento Basin Outflow showing a recent increase in fall salinity. This increase is not seen in other seasons – spring salinity is shown for comparison.

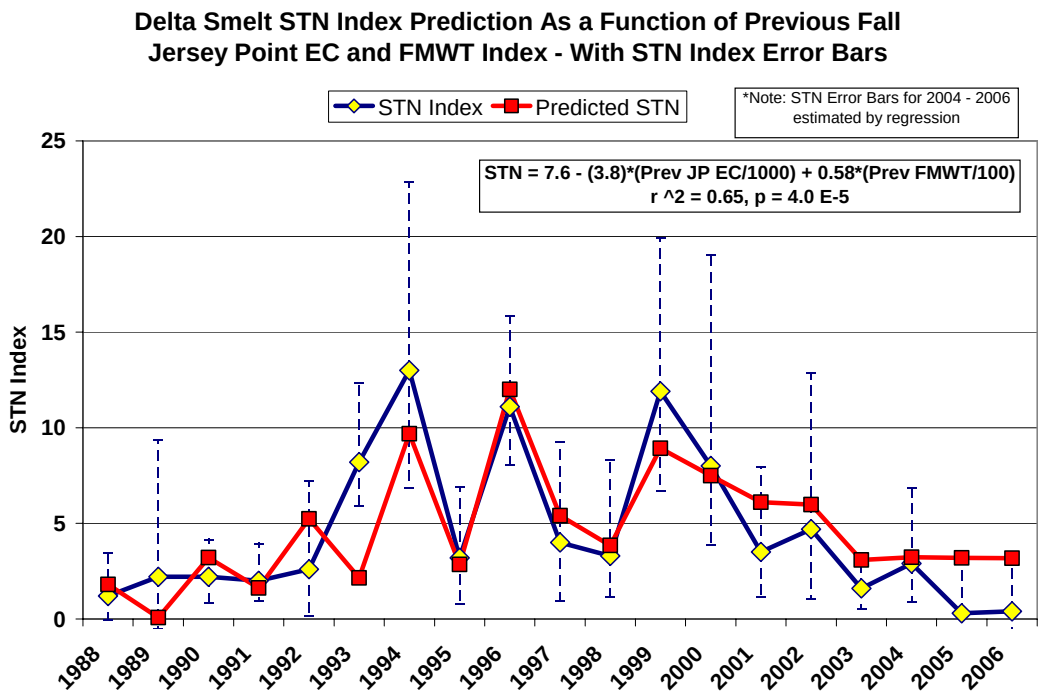


Figure 2. Western Delta salinity linked with the delta smelt FMWT population index is a strong predictor of the population of juvenile smelt the subsequent summer.

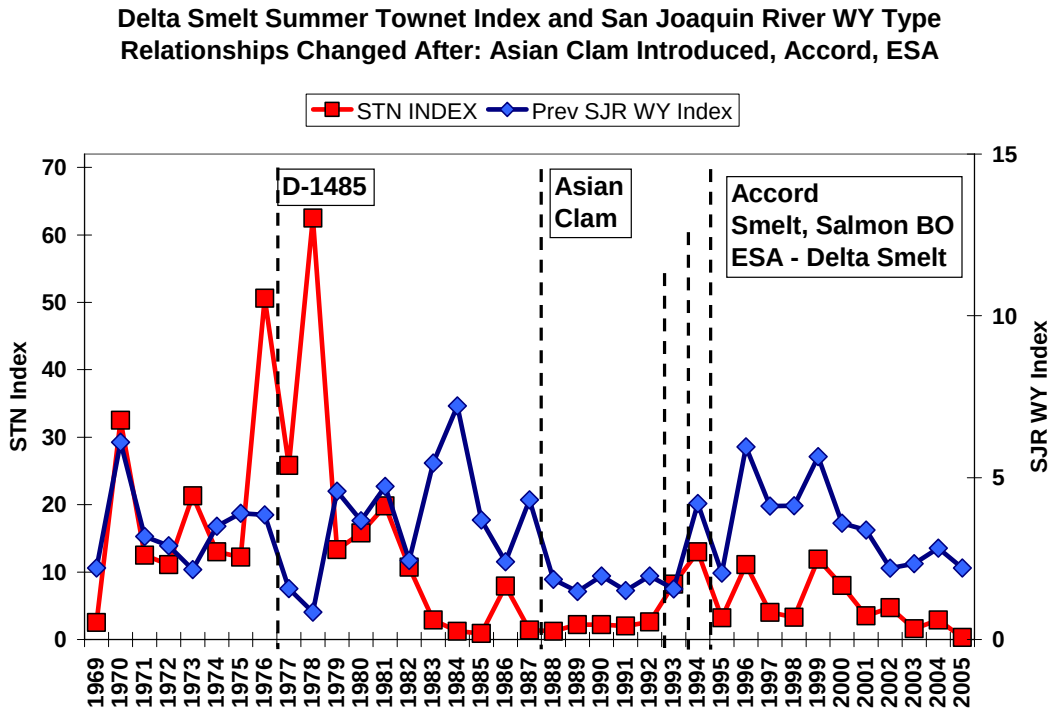


Figure 3. Since the invasion of Asian Clam in 1987, the summer delta smelt population Index (STN) has shown strong statistical correlation, and visual relationship, with the San Joaquin Water Year Index. The timing of other significant events is shown for completeness.

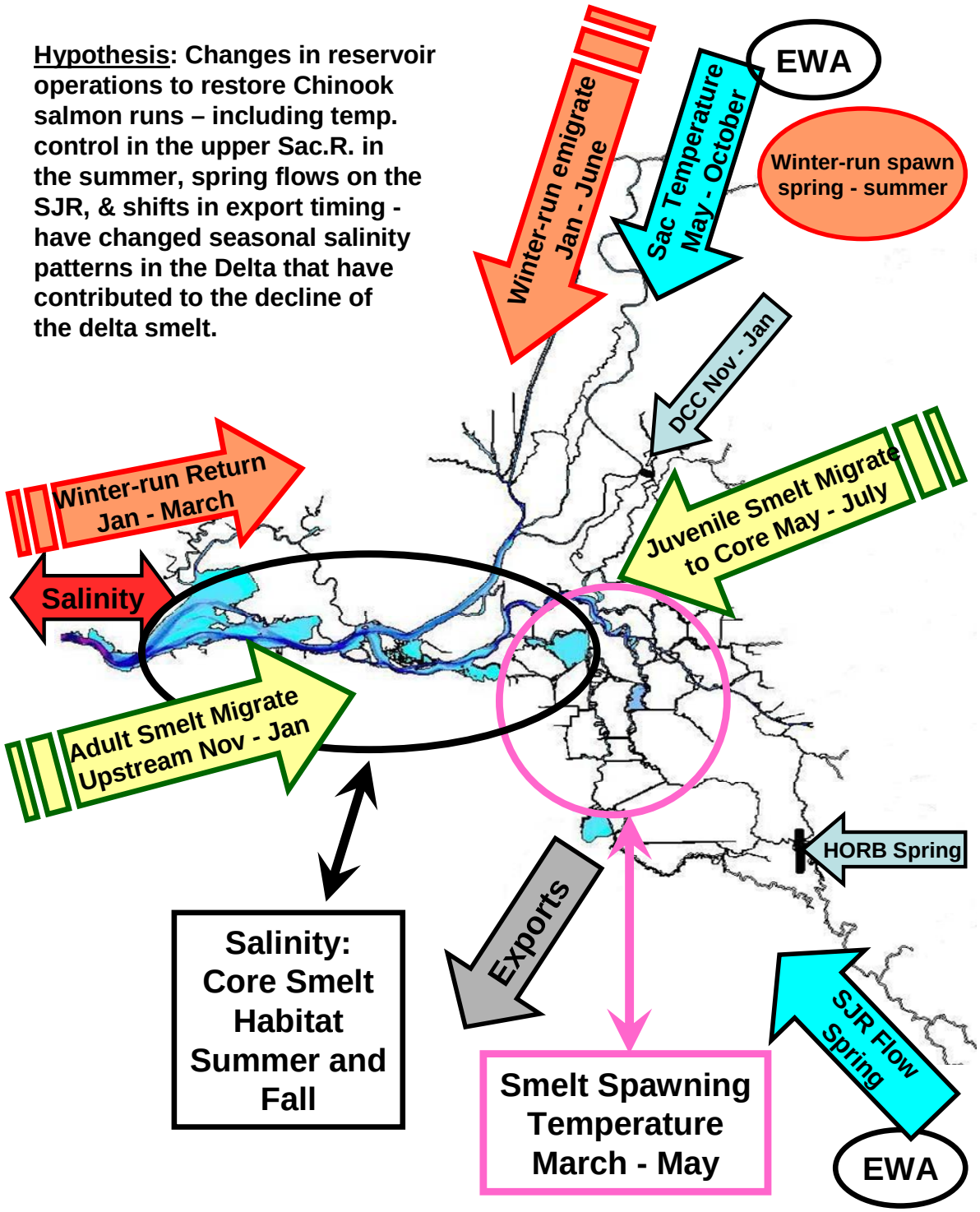


Figure 4. Conceptual model detailing the timing and physical and biological factors underlying the work proposed to test the hypothesis. The salinity in the smelt 'core habitat' is under tension from various sources, as illustrated above.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Technical Advisory Committee Meeting		■				■					■				
Semi-Annual or Final Report Due						■						■			■
Month of Project:															
1. Project Management															
Coordinate tasks	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Administer contracts	■		■		■										■
Coordinate TAC meetings and reports		■				■					■	■			■
2. Statistical Analysis: Spatial															
Define relevant delta smelt capture regions	■	■	■	■	■										
Relate regions to salinity and population	■	■	■	■	■										
Biological support on fisheries, gear, CPUE	■	■	■	■	■										
Document Results; add to GIS database				■	■										
3. Research Historical Water Use, Salinity and Flow															
Define natural, mandated flows	■	■	■	■	■										
Use N. Knowles' strategy	■	■	■	■	■										
Define 'salmon influences'; relative costs if possible	■	■	■	■	■										
Research water released for all uses, e.g., temperature	■	■	■	■	■										
Define relative b(2) and EWA water releases	■	■	■	■	■										
Document results				■	■	■									
4. Statistical Analysis: Delta Smelt															
Statistical analysis smelt population using Task 2 regions		■	■	■	■	■									
Develop stat. models of smelt population/habitat			■	■	■	■	■	■	■	■	■	■	■	■	■
Biological and statistical support			■	■	■	■	■	■	■	■	■	■	■	■	■
Interpret and document results			■	■	■	■	■	■	■	■	■	■	■	■	■
5. Concept and Data Synthesis															
Expert Analysis, synthesis of research findings		■			■	■					■	■			■
Contribute to reports, document results		■			■	■					■	■			■
6. Temperature Modeling															
Review Historical temperature data		■	■	■	■	■									
Calculate temperature changes on Sacramento, SJR				■	■	■					■	■	■	■	■
DSM2 temperature or equilibrium modeling - Delta					■	■					■	■			
Document results						■					■	■		■	■
7. Historical DSM2 Model															
Use DSM2 salinity fingerprinting				■	■	■	■	■	■	■	■	■			
Use DSM2 volume fingerprinting				■	■	■	■	■	■	■	■	■			
Run operational change scenarios									■	■	■	■	■		
Analyze results, including water costs									■	■	■	■	■	■	■
Document results						■					■	■		■	■
8. Salmon Population Models															
Use IMP Chinook salmon model- Sac R				■	■	■	■					■			■
Use SJR salmon model (Marsden et al)						■	■					■			■
Biological Support; calculate water costs						■	■					■		■	■
Interpret and document results						■						■			■
9. Develop GIS database and MATLAB Tools															
GIS database: build and add Task 3 and 4 data				■	■	■	■	■	■	■	■	■	■	■	■
Refine MATLAB dynamic visualization tool				■	■	■	■	■							
Combine DSM2 salinity and stat. delta smelt models				■	■	■	■	■							
Standard and regional data analysis tasks						■	■	■	■	■	■				
Documentation						■						■			■

Table 1 – This Table shows the expected task timeline for the proposal. The Technical Advisory Committee meetings occur one month after the start of the proposal, and just before the semi-annual reports. Reports will be completed at months 6, 12 and at the end of the project.

Name and Contact information	Expertise/Relevance
Pete Smith Research Hydrologist, USGS Placer Hall 6000 J Street Sacramento, CA 95819-6129 Tel: (916) 278-3125; Fax: (916) 278-3070 Email: pesmith@usgs.gov	Delta modeling Hydrodynamic analysis Tasks 4, 7
Tara Smith Chief, Delta Modeling Section, Bay-Delta Office California Department of Water Resources 1416, 9th Street, Room 215-7 Sacramento, CA 95814 Email: tara@water.ca.gov Tel: (916) 653-9885; FAX: (916) 653-6077	DSM2 Modeling Tasks 7, 9
Ted Sommer Chief, Interagency Program Office of Water Quality California Department of Water Resources 3251 S Street Sacramento, CA 95816 Tel: 916-227-7537 Email: tsommer@water.ca.gov	Fisheries Biologist IEP/POD Team Delta smelt Tasks 4, 7
Gary Bobker Program Director, The Bay Institute 500 Palm Drive, Suite 200 Novato, CA 94949 Tel: 510-506-0150 Email: bobker@bay.org	Ecosystem Restoration Environmental issues Tasks 5, 8
Mike Chotkowski Fisheries Biologist, Scientific Support Branch Mid-Pacific Region, U.S. Bureau of Reclamation 2800 Cottage Way Sacramento, CA (530) 753-1194	Fisheries Biologist IEP/POD Team Task 2
David Fullerton Principal Resource Specialist Metropolitan Water District of Southern California 916-650-2616 office; 916-502-4737 cell 916-650-2625 fax Email: dfullerton@mwdh2o.com	Hydrodynamic analysis Data Analysis Delta modeling Tasks 3,7

Table 2- Technical Advisory Committee Members. The TAC will meet about one month after project initiation, and again just before the six month and one year proposal summaries are due.

References Cited

(AD and RMA) AD Consultants, and Resource Management Associates, Inc. 2002. *Stanislaus River Modeling Report*. Prepared for the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, California Department of Fish and Game, Oakdale Irrigation District, South San Joaquin Irrigation District, and Stockton East Water District.

Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco estuary, California. San Francisco Estuary and Watershed Science. Vol. 3, Issue 2 (September 2005), Article 1.
http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art1

Bryant, M. and K. Souza. 2004. Summer tow net survey and fall midwater trawl survey status and trends. IEP Newsletter.

CDFG (California Department of Fish and Game). 2005. San Joaquin River fall-run Chinook salmon population model. San Joaquin Valley Southern Sierra Region, California Department of Fish and Game.

CDFG (California Department of Fish and Game), Habitat Conservation Division. 2004. Sacramento River Spring-run Chinook Salmon, 2002 – 2003 Biennial Report

CDFG (California Department of Fish and Game), Habitat Conservation Division, 2004b. Sacramento River Winter-run Chinook Salmon, 2002 – 2003 Biennial Report

CBDSP (CALFED Bay-Delta Science Program), Science in Action. 2001. Scrutinizing the Delta Cross Channel.

CBDSP (CALFED Bay-Delta Science Program), Science in Action. 2004. Demystifying the Delta.

Cramer, S.P., M. Daigneault, and M. Teply. 2004. Understanding and running the winter-run Chinook salmon IMF model. Integrated Modeling Framework (IMF) users Guide.

Deas, M.L. C.L. Lowney, G. K. Meyer; C.B. Cook, J.Anderson, and M. Kirkland, 1997. Sacramento River Temperature Modeling Project. Center for Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of California, Report No. 97-01.

Feyrer, F., B. Herbold, S. A. Matern, and P. B. Moyle. 2003. Dietary shifts in a stressed fish assemblage: consequences of a bivalve invasion in the San Francisco Estuary. Environmental Biology of Fishes 67: 277-288.

Jager, H.I. and K.A. Rose. 2003. Designing optimal flow patters for fall Chinook salmon in a Central valley, California, river. North American Journal of Fisheries management 23:1-21.

Jager, H.I. 2006. Review of final draft 11-28-05 San Joaquin River Fall-run Chinook Salmon Model.

Knowles, N. 2002. Natural and management influences on freshwater inflows and salinity in the San Francisco Estuary at monthly to interannual scales. Water Resources Research, Vol. 38, No. 12.

Poage, Victoria. 2004. Why we do a 'post-VAMP shoulder' for delta smelt. IEP (Interagency Ecological Program for the Sacramento-San Joaquin Estuary) Newsletter. Vol. 17, number 2.

IEP (Interagency Ecological Program for the San Francisco Estuary). 2005. Interagency Ecological Program Synthesis of 2005 Work to Evaluate the Pelagic Organism Decline (POD) in the Upper San Francisco Estuary. Available at: http://science.calwater.ca.gov/pdf/workshops/IEP_POD_2005WorkSynthesis-draft_111405.pdf

IEP (Interagency Ecological Program for the San Francisco Estuary). 2006. Interagency Ecological Program 2006-2007 Work Plan to Evaluate the Decline of Pelagic Species in the Upper San Francisco Estuary. Available at: http://science.calwater.ca.gov/pdf/workshops/POD/IEP_POD_2006-7_Workplan_010906.pdf#search=%22iep%202006%20workplan%20pod%22

Manly, B. and M. Chotkowski. 2005. Progress Report on analysis of historical fish and zooplankton population trends. Available at: http://www.science.calwater.ca.gov/pdf/workshops/POD/CDFG_POD_Analysis_of_historical_pelagic_fish_trends.pdf

Miller, B.J., Mongan, T.R. and A. Britton. 2005. The co-occurrence of delta smelt and prey in the summer. Available at: http://science.calwater.ca.gov/pdf/ewa/EWA_Miller_co-occurrence_113005.pdf

Newman, K. and J. Rice. 1997. Statistical model for survival of Chinook salmon smolts out-migrating through the lower Sacramento-San Joaquin system. Interagency Ecological Program for the San Francisco Bay/Delta Estuary.

NOAA (NOAA's National Marine Fisheries Service). 2006. Chinook Salmon.

(NMFS) National Marine Fisheries Service, Southwest Regional Office. 1997. Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. Available at: http://swr.nmfs.noaa.gov/hcd/recweb.htm

Nobriga, M. L., F. Feyrer, R. D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river Delta: spatial patterns in species composition, life history strategies and biomass. Estuaries.

Poage, Victoria. 2004. Why we do a 'post-VAMP shoulder' for delta smelt. IEP (Interagency Ecological Program for the Sacramento-San Joaquin Estuary) Newsletter. Vol. 17, number 2.

Rajbhandari, H. 2004. Modeling dissolved oxygen and temperature in DSM2 planning studies. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin and Suisun Marsh. Annual Progress Report.

Smith, G. 2004. Finding sound science on salmon. The Discovery Institute Inquiry.

SJRG (San Joaquin River Group). 2006. Technical Memorandum: Review of the California Department of Fish and Game's "San Joaquin River Fall-run Chinook Salmon Population Model".

Swanson, Christina. 2001. The first annual state of the environmental water account report. Bay Institute of San Francisco.

USBR (Unites States Bureau of Reclamation). 2004. Long-Term CVP OCAP and CVP-SWP OCAP Biological Assessment. Available at: http://www.usbr.gov/mp/cvo/ocap_page.html

WE (Watercourse Engineering). 2002. Historic Flow and Temperature Modeling of the Sacramento River: 1970 -2001. Submitted to USGS.

WCSBRT (West Coast Salmon Biological Review Team). 1999. Status Review Update for Deferred ESUs of West Coast Chinook Salmon.

Marianne Guerin

Associate Water Resources Specialist
Contra Costa Water District, P.O. Box H20, Concord, CA 94524, 925-688 8344

Selected Career Achievements

- Fifteen years experience developing and using hydrodynamic transport and geochemical transport models
- Developed a 3-D hydrogeochemical transport code, GMT3D
- Principal author of funded NSF interdisciplinary project characterizing and modelling floodplain contamination in Hungary.
- Authored or co-authored over 30 peer-reviewed or technical publications.
- Developed TOUGH2 models of preferential fracture flow and transport in the unsaturated zone at Yucca Mountain.
- Expertise in hydrological transport modelling, including:
  + Königstein uranium mine (Germany) at a regional scale.
  + Suface application of mining waste waters at Ranger Uranium Mines (Australia).
  + Laboratory experiments in soils
- Developed, managed and co-taught week-long short course on Reactive Transport Modelling for an international multidisciplinary audience of environmental scientists and engineers.
- Project development and management experience in multidisciplinary settings.

Academic Qualifications

University of Maryland, Ph.D. in Mathematics, 05/94.

Humboldt State University, B.A. in Mathematics, 06/85 (*Summa cum Laude).*

San Joaquin Delta College, Stockton, CA. A.A. Degree, 06/79.
Electron Microscopy Certificates: Materials, 06/79, *Biological, 01/79.*

Professional History

Contra Costa Water District, Concord, CA 01/2005 – Present.

Savannah River Ecology Laboratory, The University of Georgia, 11/2000 – 04/2004
Adjunct Assistant Research Scientist, Department of Crop and Soil Science, Consultant, 08/03 – 01/04, Post-doc, 11/00 – 04/03.
- Developed novel experimental techniques in soils research,
- Developed hydrogeochemical models and uncertainty models
- Wrote proposals and published research results.

Lawrence Berkeley National Laboratory, Earth Science Division, *Staff Scientist,* 06/99 – 06/00.
- Developed numerical and mathematical models of unsaturated flow and transport.
- Analyzed environmental and isotope data at Yucca Mountain, NV (tritium and ^{36}Cl)..

Australian Nuclear Science and Technology Organisation (ANSTO), Environmental Chemistry Group, Lucas Heights, AU, *Senior Research Scientist,* 05/93 – 04/99.
- Developed the reactive hydrogeochemical transport model, GMT3D
- Authored or co-authored over twenty technical publications
- Applied and developed hydrological transport models

ANSTO (continued)

- Principle investigator for the hydrology of the Magella Land Application Area at Ranger Uranium Mines, NT, AU. Analysed and interpreted environmental data.
- Formulated and applied contaminant transport models for the Konigstein uranium mine.
- Project manager for the Database Activity, part of the Managing Mine Wastes Project.
- Principal scientist and project manager for an intensive week-long course entitled 'Multicomponent Contaminant Transport – The Coupling of Chemistry with Mass Transport and Fluid Flow'.

Department of Health, Housing and Community Services, Health Care Modelling Group, Canberra, AU, *Professional Officer*, 1993.

Industry Commission, Economic Modelling Group, Canberra, AU, *Professional Officer*, 1992.

University of Kentucky, Department of Mathematics, *Instructor*, 1990.

Hewlett-Packard, Solid State Research Laboratories, *Technician*, Palo Alto, CA, 1979 – 1982.

- Performed Auger, X-Ray, TEM and SEM analyses.

Academic Accomplishments

- President, Graduate Student Steering Committee, University of Maryland, 1987-8
- President, Mathematics Club, Humboldt State University, 1982-3
- Honorable Mention, National Mathematical Modelling Competition, 1984.

Refereed Publications

Guerin, M. and J.C. Seaman. 2002. Characterizing mineral colloids using acoustic and electroacoustic spectroscopy: A review. April, 2004.

Guerin, M., Seaman, J.C., Lehmann, C., and A. Jurgenson. 2002. Acoustic and electroacoustic characterization of variable charge mineral suspensions. April, 2004.

Seaman, J.C., M. Guerin, B.P. Jackson, P.M. Bertsch, and J. Ranville, 2003. Analytical Techniques for Characterizing Complex Mineral Assemblages: Mobile Soil and Groundwater Colloids. In Geochemical Surface Controls on Trace Element Fate, ed. W. Kingery and H. Selim, CRC Press.

Guerin, M. and J.C. Seaman. 2001. Accounting for diffuse layer ions in triple layer models. J. Colloid Interface Sci. **250**:492-495.

Guerin, M. 2001. Tritium and ^{36}Cl as constraints on fast fracture flow and percolation flux in the unsaturated zone at Yucca Mountain. J.Contam. Hydrol. **51:**257-288.

Brown. P, M. Guerin, S. Hankin and R. Lowson. 1998. Uranium and other contaminant migration in groundwater at a tropical Australian uranium mine. J.Contam. Hydrol. **35**:295-303.

Guerin, M. and C. Zheng. 1997. GMT3D – Coupling MT3D and MODPHRQ for modelling multicomponent transport. CTAC '97 Conference Proceedings. Editors: Noye, John, M. Tuebner, and A. Gill. pp. 265 – 272.

Auslander, J. and M. Guerin. 1997. Regional proximality and the prolongation. Forum Math. **9**:761-774.

Selected Reports

M. Guerin, Brown. P, S. Hankin and R. Lowson. 1999. Hydrological Factors Associated With the Formation of Surface Evaporites at a Tropical Australian Uranium Mine. ModelCARE'99 Conference Proceedings.

Guerin, M., D. Denton and A. Garvie. 1999. MMWDB – A Physical, Chemical and Biological Database Used to Quantify the Environmental Effects of Mine Waste. Sudbury '99 Conference Proceedings.

Guerin, M. and C. Zheng. 1998. GMT3D – Coupling Multicomponent Three Dimensional Transport with Geochemistry. MODFLOW '98 Conference Proceedings. pp.413-420.

Carroll, D., E. Clayton and M. Guerin. 1998. Visualisation of Multi-Component Transport in Groundwater Modeling. MODFLOW '98 Conference Proceedings. pp.211-215.

Lowson, R.T., P. L. Brown and M. Guerin. 1998. Contaminant Transport Associated with Uranium Mine and Mill Tailings. Uranium Mining and Hydrogeology II. International Conference and Workshop.

Guerin, M, P. L. Brown, S. Hankin, R. T. Lowson and M. G. McIntyre. 1998. A Final Report to Ranger Uranium Mines; Monitoring and Modeling Mass Transport in the Magella Land Application Area..559C/Australian Nuclear Science and Technology Organisation Report ANSTO

Guerin, M., P.L. Brown, R.T. Lowson, N. Merrick, and C.Z. Zheng. 1997. Multicomponent Contaminant Transport - The Coupling of Chemistry with Mass Transport and Fluid Flow. 2 Volumes (Short Course).

A Report to Ranger Uranium Mines on Monitoring and Modeling Mass Transport in the Land Application Area. Australian Nuclear Science and Technology Organisation Report ANSTO/C478.

Brown, P.L., R.T. Lowson and M.Guerin. 1996 Material Transport Modeling in the Large-Scale Area Around the Königstein Ore Deposit and the Königstein Mine. Part II - Final Report Australian Nuclear Science and Technology Organisation Report ANSTO/C4l39.

Guerin, M. and R. McDougall, A SALTER Data Base Aggregation Facility, Industry Commission Research Memorandum, 1992.

Strausser, Y. and M.Guerin, Quantitative Analysis of the Oxygen Content of Chromium Films by Auger Electron Spectroscopy, Hewlett Packard Technical Memo No. 82-SSL-8, 1982.

Technical Presentations (2000 – 2006)

M.Guerin, T. Smith and Rich Lossee. Taste-testing for TDS, Geosmin and MIB. CWEMF Annual Meeting, Asilomar, CA. March, 2006.

M. Guerin and J. Seaman. (2003) Characterizing soil clay suspensions using acoustic spectroscopy. The University of Georgia, Department of Crop and Soil Science.

M. Guerin and J. Seaman. Quantifying uncertainty in the geochemical model of a soil solution. AGU Fall meeting at San Francisco, CA, USA, December 2002.

M. Guerin and J. Seaman. Hydrogeochemical modelling – Theoretical Models and Transport Models. (2002) OTKA/MTA/NSF 'Tizsa Workshop'. Natural Attenuation of Metals along the Tisza River-Floodplain-Wetlands Continuum. Budapest, HU. (Invited).

M. Guerin, J. Seaman and J. Hutchinson. Geochemical uncertainty models and sediment characterization. (2002) OTKA/MTA/NSF 'Tizsa Workshop'. Natural Attenuation of Metals along the Tisza River-Floodplain-Wetlands Continuum. Budapest, HU. (Invited)

Seaman, J.C., S.A. Aburime, E. Galligan, M. Guerin, and J. Singer. 2002. Vadose transport processes in an irrigated watershed. Agronomy Abstracts, Annual ASA Meetings. Indianapolis, IN, Nov. 10-14.

Quantifying Uncertainty in Reactive Transport Models, U.S. Geological Survey, Menlo Park, CA., May, 2001.

Non-conservative behavior of 'conservative' tracers, Seminar at Chalmers Technical University, Gotenburg, Sweden. April, 2001.

European Geophysical Society, Nice, France Non-conservative behavior of 'conservative' tracers, March, 2001.

Tritium and ^{36}Cl as Constraints on Fast Fracture Flow and Percolation Flux in the Unsaturated Zone at Yucca Mountain, Nevada, Lawrence Livermore National Laboratory Seminar. June, 2000.

Professional Development

- Introduction to ArcView GIS, ESRI Short Course, U. of GA, May, 2001.
- UCODE – Universal Inversion Code. Colorado School of Mines Short Course. October, 1999.
- Applied Inverse Modeling, Colorado School of Mines Short Course. October, 1999.
- PEST Workshop, Colorado School of Mines Short Course. October, 1999.
- Introduction to Artificial Neural Networks for Business and Industry, AIMAZE, Sydney, Australia. August, 1997.
- Aquifer Heterogeneity and Optimal Capture of Contaminants, Centre for Groundwater Studies, CSIRO Division of Groundwater Resources, Sydney, Australia. July, 1997.
- ANSTO Quality Management, ANSTO Training, June 10, 1997 – September 09, 1997.
- 'Project Management', CPMC, Feb. 24-26, 1997, ANSTO.
- Principles and Applications of Chemical Reaction Modelling in Groundwater, Colorado School of Mines (IGWMC), May 13-17, 1996, Golden, CO, USA. (2.8 CE units)
- Fundamentals of Groundwater Science, Technology and Management, Centre for Groundwater Studies, CSIRO Division of Groundwater Resources, Nov 27 – Oct 02, 1995, Brisbane, Australia.
- Chaos: Theory and Numerics, SIAM Short Course, May 20, 1995, Snowbird, Utah, USA.
- Short Course on Speciation and Chemical Equilibrium Modelling of Inorganic Aqueous Systems, ANSTO Chemical Engineering, March 22-23, 1995, ANSTO.
- Three-Dimensional Modelling of Contaminant Transport and Remediation Designs Using MODFLOW and MT3D, Colorado School of Mines (IGWMC), Jan 30 – Feb 2, 1995, Golden, CO, USA. (2.2 CE Units)

BUDGET SUMMARY	Total Amount for Year 1	Total Amount for Year 2	Total Amount for Year 3	Total Amount for All Years
Total Costs for Task One	$ 4,354.67	$ 1,658.92	$ -	$ 6,013.59
Total Costs for Task Two	$ 27,000.00	$ -	$ -	$ 27,000.00
Total Costs for Task Three	$ 25,812.43	$ -	$ -	$ 25,812.43
Total Costs for Task Four	$ 5,804.14	$ 2,945.69	$ -	$ 8,749.83
Total Costs for Task Five	$ -	$ -	$ -	$ -
Total Costs for Task Six	$ 14,400.00	$ 3,600.00	$ -	$ 18,000.00
Total Costs for Task Seven	$ 6,429.11	$ 2,209.27	$ -	$ 8,638.37
Total Costs for Task Eight	$ 4,604.14	$ 4,682.11	$ -	$ 9,286.25
Total Costs for Task Nine	$ 11,754.39	$ 1,672.84	$ -	$ 13,427.23
Total Costs for Project Tasks	$ 100,158.89	$ 16,768.83	$ -	$ 116,927.71
1/Cost Share	$ 15,181.00	$ 10,455.00	$ -	$ 25,636.00
2/ Other Matching Funds	$ -	$ -	$ -	$ -

1/ *Cost share funds* are specifically dedicated to your project and can include private and other State and Federal grants. Any funds listed in this line must be further described in the text of your proposal (see Chapter 3, Section D, of the PSP document)

2/ *Other matching funds* include other funds invested consistent with your project in your project area for which the ERP grant applicant is not eligible. Any funds listed in this line must be further described in the text of your proposal (see Chapter 3, Section D, of the PSP document)

Proposal #0028
The Consequences of Operational Decisions on Water Quality:
Reconciling Delta Smelt, Salmon, And Human Needs

Detailed Budget Breakdown by Task and by Fiscal Year

Contra Costa Water District

		Year 1			Year 2			Year 3		
BUDGET FOR TASK ONE (Administrative)	**TOTAL AMOUNT TASK 1 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Briggs, David (In-kind)	$ -	$ -	40	$ -	$ -	24	$ -	$ -		$ -
Brun, Desiree	$ 2,738.18	$ 47.21	42	$ 1,982.82	$ 47.21	16	$ 755.36	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ 2,738.18**			**$ 1,982.82**			**$ 755.36**			**$ -**
Benefits as percent of salary	39%			$773.30			$294.59			$0.00
Personnel Total (salary + benefits)	**$3,806.07**			**$2,756.12**			**$1,049.95**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
NONE	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)	58%			$ 1,598.55			$ 608.97			$ -
Total Costs for Task One	**$ 6,013.59**			**$ 4,354.67**			**$ 1,658.92**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK TWO	**TOTAL AMOUNT TASK 2 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
None	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Cramer Fish Sciences subcontractor	$ 5,000.00			$ 5,000.00			$ -			$ -
Academic Statistician subcontractor	$ 20,000.00			$ 20,000.00			$ -			$ -
Technical Staff subcontractor	$ 2,000.00			$ 2,000.00			$ -			$ -
	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ 27,000.00**			**$ 27,000.00**			**$ -**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)				$ -			$ -			$ -
Total Costs for Task Two	**$ 27,000.00**			**$ 27,000.00**			**$ -**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK THREE	**TOTAL AMOUNT TASK 3 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Guerin, Marianne	$ 3,557.25	$ 47.43	75	$ 3,557.25	$ -		$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ 3,557.25**			**$ 3,557.25**			**$ -**			**$ -**
Benefits as percent of salary	39%			$1,387.33			$0.00			$0.00
Personnel Total (salary + benefits)	**$4,944.58**			**$4,944.58**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Richard Denton subcontractor	$ 18,000.00			$ 18,000.00			$ -			$ -
	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ 18,000.00**			**$ 18,000.00**			**$ -**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)	58%			$2,867.85			$ -			$ -
Total Costs for Task Three	**$ 25,812.43**			**$ 25,812.43**			**$ -**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK FOUR	**TOTAL AMOUNT TASK 4 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Guerin, Marianne	$ 2,162.75	$ 47.43	25	$ 1,185.75	$ 48.85	20	$ 977.00	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ 2,162.75**			**$ 1,185.75**			**$ 977.00**			**$ -**
Benefits as percent of salary	39%			$462.44			$381.03			$0.00
Personnel Total (salary + benefits)	**$3,006.22**			**$1,648.19**			**$1,358.03**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Cramer Fish Sciences subcontractor	$ 4,000.00			$ 3,200.00			$ 800.00			$ -
Other Costs Subtotal	**$ 4,000.00**			**$ 3,200.00**			**$ 800.00**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)	58%			$ 955.95			$ 787.66			$ -
Total Costs for Task Four	**$ 8,749.83**			**$ 5,804.14**			**$ 2,945.69**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK FIVE	**TOTAL AMOUNT TASK 5 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Gartrell, Greg (In-kind services)	$ -	$ -	40	$ -	$ -	24	$ -	$ -		$ -
Guerin, Marianne (In-kind services)	$ -	$ -	25	$ -	$ -	25	$ -	$ -		$ -
	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
None	$ -			$ -			$ -			$ -
Other Costs Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)				$ -			$ -			$ -
Total Costs for Task Five	**$ -**			**$ -**			**$ -**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK SIX	**TOTAL AMOUNT TASK 6 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
NONE	$ -	$ -		$ -	$ -		$ -	$ -		$ -
Personnel Subtotal	**$ -**			**$ -**			**$ -**			**$ -**
Benefits as percent of salary				$0.00			$0.00			$0.00
Personnel Total (salary + benefits)	**$0.00**			**$0.00**			**$0.00**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Watercourse Engineering, Inc. subcontractor	$ 18,000.00			$ 14,400.00			$ 3,600.00			$ -
Other Costs Subtotal	**$ 18,000.00**			**$ 14,400.00**			**$ 3,600.00**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)				$ -			$ -			$ -
Total Costs for Task Six	**$ 18,000.00**			**$ 14,400.00**			**$ 3,600.00**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK SEVEN	**TOTAL AMOUNT TASK 7 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Guerin, Marianne	$ 2,629.95	$ 47.43	40	$ 1,897.20	$ 48.85	15	$ 732.75	$ -		$ -
Personnel Subtotal	**$ 2,629.95**			**$ 1,897.20**			**$ 732.75**			**$ -**
Benefits as percent of salary	39%			$739.91			$285.77			$0.00
Personnel Total (salary + benefits)	**$3,655.63**			**$2,637.11**			**$1,018.52**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Technical Staff subcontractor	$ 3,000.00			$ 2,400.00			$ 600.00			$ -
Other Costs Subtotal	**$ 3,000.00**			**$ 2,400.00**			**$ 600.00**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)	58%			$ 1,392.00			$ 590.74			$ -
Total Costs for Task Seven	**$ 8,638.37**			**$ 6,429.11**			**$ 2,209.27**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK EIGHT	**TOTAL AMOUNT TASK 8 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Guerin, Marianne	$ 2,407.00	$ 47.43	25	$ 1,185.75	$ 48.85	25	$ 1,221.25	$ -		$ -
Personnel Subtotal	**$ 2,407.00**			**$ 1,185.75**			**$ 1,221.25**			**$ -**
Benefits as percent of salary	39%			$462.44			$476.29			$0.00
Personnel Total (salary + benefits)	**$3,345.73**			**$1,648.19**			**$1,697.54**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Cramer Fish Sciences subcontractor	$ 4,000.00			$ 2,000.00			$ 2,000.00			$ -
Other Costs Subtotal	**$ 4,000.00**			**$ 2,000.00**			**$ 2,000.00**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)	58%			$ 955.95			$ 984.57			$ -
Total Costs for Task Eight	**$ 9,286.25**			**$ 4,604.14**			**$ 4,682.11**			**$ -**

		Year 1			Year 2			Year 3		
BUDGET FOR TASK NINE	**TOTAL AMOUNT TASK 9 All Years**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 1**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 2**	**Amount per hour**	**Number of Hours**	**Total Amount for Year 3**
Personnel										
Guerin, Marianne	$ 2,015.86	$ 47.73	32	$ 1,527.36	$ 48.85	10	$ 488.50	$ -		$ -
Personnel Subtotal	**$ 2,015.86**			**$ 1,527.36**			**$ 488.50**			**$ -**
Benefits as percent of salary	39%			$595.67			$190.52			$0.00
Personnel Total (salary + benefits)	**$2,802.05**			**$2,123.03**			**$679.02**			**$0.00**
Other Costs	**Total All Years**			**Total Year 1**			**Total Year 2**			**Total Year 3**
Technical Staff subcontractor	$ 3,000.00			$ 2,400.00			$ 600.00			$ -
Matlab and GIS software				$ 6,000.00						
Other Costs Subtotal	**$ 3,000.00**			**$ 8,400.00**			**$ 600.00**			**$ -**
Overhead Percentage (Applied to Personnel Costs Only)	58%			$ 1,231.36			$ 393.83			$ -
Total Costs for Task Nine	**$ 13,427.23**			**$ 11,754.39**			**$ 1,672.84**			**$ -**

Budget Justification: **Note that additional detail is available in the proposal documentation in the 'Scope of Work' section.**

TASK 1 – Project Management
Investigator: Dr. David Briggs, Mrs. Desiree Brun
Cost:
$6014 for Mrs. Brun's work
$0 for Dr. Briggs (in-kind).
Definition of Work – Ms. Brun will provide support for project management tasks, including but not limited to coordination of periodic reporting and Technical Advisory Committee (TAC) meetings; coordinating the timing of major Tasks; administering contracts; coordinating distribution of results. Dr, Briggs will manage the project.
Output/Deliverable - Production of semi-annual and final reports; coordinating the communication of results to the IEP POD team and to other interested parties.

TASK 2 – Statistical Analysis: Spatial
Investigators: Statistician (TBD); Mr. Steve Cramer, Technical staff #1
Cost –
$20,000 contract for Statistician (TBD); (UC Davis statistical consulting is $100/hr).
$5,000 contract for expert advice from Mr. Cramer, Cramer Fish Science.
$2,000 contract for Technical staff to add data to GIS database (See Tasks 9)
Output/Deliverable: -
Statistician:

1. Definition of a statistically and biologically-relevant spatial aggregation of delta smelt FMWT and STN capture data.
2. Define delta smelt optimal 'salinity habitat regions' using these aggregations – optimal salinity for smelt is frequently quoted as (0.2 – 2.0) psu.
3. Temporal aggregation – develop an optimal temporal aggregation of salinity data that can be used for comparison with each of the indices.
4. If time allows, a similar analysis of temperature and turbidity data.

Mr. Cramer – Expert advice and support for interpreting fish trawl data for STN, FMWT
Technical staff #1 – Add data to GIS database.

TASK 3 – Research Historical Reservoir Releases, Related Temperature and Operational Data
Investigators: Dr. Richard Denton, Dr. Marianne Guerin
Cost:
$18,000 contract for Dr. Denton's primary analyses and documentation
$7,812 for Dr. Guerin to assist Dr. Denton in the analyses
Output/Deliverable: - In addition to documentation of the analyses, this work will be submitted to the IEP Newsletter, or, the peer-reviewed journal 'San Francisco Estuary and Watershed Science'. The output will also be used to define boundary conditions for the DSM2 modeling scenarios (see Tasks 6 and 7). In addition, the initial stages of testing the hypothesis will be documented. Data will be entered in the GIS dataset in Task 9.

TASK 4 – Statistical Analysis: Delta Smelt
Investigators: Dr. Marianne Guerin, Mr. Brian Pyper
Cost:
$4,750 for Dr. Guerin's analyses and documentation
$4,000 for Mr. Pyper to assist Dr. Guerin with the statistical analysis
Output/Deliverable: Spatially explicit regression models relating delta smelt population indices to salinity, potentially to flow variables. All statistical analyses will be documented. Positive results, such as statistically significant relationships, will be submitted to the IEP newsletter or for peer review, or included in the Final Report if negative. If indicated, results will be entered in the GIS dataset in Task 9.

TASK 5 – Concept Development and Synthesis of Results
Investigator: Dr. Greg Gartrell, Dr. Marianne Guerin, (Dr. Richard Denton)
Cost:
$0 for Dr. Gartrell's time (in-kind)
$0 for Dr. Guerin's time (in-kind)
Output/Deliverable: - Synthesis of results to be documented in writing through the semi-annual and final reports; preparation of technical papers to be submitted either to the IEP Newsletter or to journals such as 'San Francisco Watershed and Estuary Science'.

TASK 6 Temperature Analysis
Investigators: Dr. Mike Deas
Cost:
$18,000 contract for Dr. Deas to analyze temperature effects through data analysis and modeling
Output/Deliverable: Analysis of historical temperature data. Temperature modeling using DSM2 and/or equilibrium models to quantify real and hypothetical temperature changes in the upstream reaches of the rivers, and to calculate associated water costs.

TASK 7 DSM2 Modeling
Investigators: Dr. Marianne Guerin
Cost:
$5,638 for Dr. Guerin to set-up and run then analyze DSM2 output.
$3,000 contract for Technical staff #2 to assist Dr. Guerin by performing initial data organization, running routine models, by using QA/QC procedures, and by producing graphs and tables.
Output/Deliverable: The main output from this work is an analysis of relative contributions to seasonal salinity from various operations using the regional and temporal aggregations from Task 2, *i.e.*, the delta smelt 'salinity habitat', and calculations of relative water costs to change salinity for delta smelt habitat improvement. For the Historical model, this work will quantify the source of seasonal salinity changes noted by Denton. For hypothetical scenarios, this work will quantify the operational changes and reservoir releases that contribute to salinity changes, as well as reservoir releases or operational changes needed to optimize delta smelt salinity habitat. Boundary conditions for the salmon population models in Task 8 will be developed. If indicated, results will be

entered in the GIS dataset. Results will be documented in the Final Report, and possibly in the IEP Newsletter.

TASK 8 – Salmon Population Modeling

Investigators: Dr. Marianne Guerin, Mr. Steve Cramer
Cost:
$4,750 for Dr. Guerin's analyses and documentation
$4,000 for contract Mr. Cramer to assist Dr. Guerin with running and interpreting the output of the salmon population models to ensure biological rigor and appropriate usage.
Output/Deliverable: Salmon population predictions from the Base Case model simulations will be compared to changes in salmon populations from each of the scenarios, and the associated water costs for improvements calculated. Results will be documented in the Final Report, and possibly in the IEP Newsletter if interesting.

TASK 9 – Visualization and Regional Analysis of DSM2 Output
Investigators: Dr. Guerin, Technical staff #3
Cost:
$5,638 for Dr. Guerin to set-up and run then analyze DSM2 output
$3,000 contract for Technical staff to assist Dr. Guerin
$6,000 for technical software packages and GIS on-line training courses

1. MATLAB Statistics Toolbox - $800
2. MATLAB mapping toolbox - $900
3. ArcGIS ArcView - $1500
4. ArcGIS Spatial Analyst Extension - $2500
5. GIS on-line training for Dr. Guerin - $300

Output/Deliverable: The current MATLAB visualization tool will be refined and documented, and the resulting visualizations exported as 'movies'. The GIS database will be developed, populated and finalized. Statistical population models developed from the spatial analyses and possibly from DSM2 output salinities will be prepared for publication in either the IEP newsletter or in a refereed journal.

Cost Share Description:

Tasks 1 and 5 include Cost Share funds that are in-kind contributions from CCWD for staff time, Dr.'s Briggs, Gartrell and Guerin. This is itemized in the individual tasks. CCWD in-kind contributions represent 22% of the total budget.

TASK 1 Project Management Dr. David Briggs will manage the project, and the time budgeted on this task is an in-kind contribution from CCWD.
In-kind contribution Dr. Briggs:
Year 1 $5610
Year 2 $3467

TASK 5 – Concept Development and Synthesis of Results
Dr. Gartrell will lead the effort, with Dr. Guerin assisting as needed. The time budgeted for Dr.'s Gartrell and Guerin time on this task is an in-kind contribution from CCWD.
In-kind contribution Dr. Gartrell:
Year 1 $6967
Year 2 $4306

In-kind contribution Dr. Guerin:
Year 1 $2604
Year 2 $2682

California Home

Signature

The applicant for this proposal must submit this form by printing it, signing below, and faxing it to +1 877-408-9310. Send exactly one form per transmission.

Failure to sign and submit this form will result in the application not being considered for funding. The individual submitting this proposal will receive e-mail confirmation as soon as this signature page has been processed.

The individual signing below declares that:

- all representations in this proposal are truthful;
- the individual signing the form is authorized to submit the application on behalf of the applicant (if applicant is an entity or organization);
- the applicant has read and understood the conflict of interest and confidentiality discussion under the Confidentiality and Conflict of Interest Section in the main body of the PSP and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent provided in this PSP; and
- the applicant has read and understood all attachments of this PSP.

Proposal Title: The Consequences of Operational Decisions on Water Quality: Reconciling Delta Smelt, Salmon, and Human Needs

Proposal Number: 2006.01-0028

Applicant Organization: Contra Costa Water District

Applicant Contact: Mr. Walter Bishop

Applicant Signature Walter J. Bishop **Date** 8/30/06