

Reclamation Point(s) of Contact: Joshua Israel, Bay Delta Office, U.S. Bureau of Reclamation, Sacramento CA

2D and 3D CFD Modeling in Support of Fish Passage and Ecosystem Projects in the California Bay Delta Area

Fact Sheet Number

2019_60

Project Description

This work will perform CFD modeling of the facilities and environmental settings for projects conducted by the Sacramento and Delta divisions of the Central Valley Project. In FY 2019, comprehensive 2D and 3D CFD modeling will be coordinated to support evaluation and analysis of hydrodynamic scenarios at two sites: the Fremont Weir section and the Georgiana Slough diversion of the Sacramento River. The modeling results will be available for individual based modeling (IBM) efforts for salmonids and smelt to evaluate how operations may influence project specific hydrodynamics and ESA species in the Delta. The CFD work builds on the past finding that hydrodynamic flow information is important for the effectiveness of project alternatives for fish passage and ecosystem. At present numerical modeling is the main viable option to obtain the needed hydrodynamic variables, in particular, under the project alternative conditions. Field survey is costly and often limited to the existing condition.

Project Need

The study is needed to understand how flow hydraulics and barrier designs influence movement behaviors of juvenile salmonids at sites such as the Fremont Weir section and Georgiana Slough diversion of the Sacramento River. These data will be useful for understanding the fish entrainment at the Fremont and the efficacy of barriers designs at the Georgiana Slough for protecting fish through reduced entrainment into the Central Delta. This work is part of a collaborative studies between Reclamation, U.S. Army Corps of Engineers, and the California Department of Water Resources.

Project Objectives

Perform 2D and 3D CFD modeling of the facilities and environmental settings for several projects conducted by the Sacramento and Delta divisions of the Central Valley Project. In FY 2019, the focus is on two sites: the Fremont Weir and the Georgiana Slough site. Model results support evaluation and analysis of hydrodynamic scenarios likely under conditions implemented through NMFS BiOp IV.2 and IV.2.3. Modeling results will also be available for individual

based modeling (IBM) efforts for salmonids and smelt to evaluate how operations may influence project specific hydrodynamics and ESA species in the Delta.

Schedule of Project Milestones (When Will Data Collection, Analyses, and Reporting Elements be Completed?)

Date	Milestone
10/01/2018	Modeling work continued
07/30/2019	CFD modeling at both Fremont Weir and Georgiana Slough sites
09/30/2019	Annual progress report

Expected FY 2019 Project Cost

\$200,000

Is this Project for a CVP/SWP Biological Opinion or Water Right Decision Compliance? If so, Which Specific Requirement?

I.7.1 and IV.2.2

Investigator

Yong Lai
Technical Service Center
U.S. Bureau of Reclamation
Denver, CO

Reclamation Point(s) of Contact: Joshua Israel, Bay Delta Office, U.S. Bureau of Reclamation, Sacramento CA

U2RANS Model Development for Fish Bypass Projects

Fact Sheet Number

2019_61

Project Description

A number of fish passage projects at the MP Region require accurate hydrodynamic flow information so that the effectiveness of project alternatives for fish passage and habitat restoration may be assessed and evaluated. At present 3D CFD modeling is the main viable option to obtain the needed hydrodynamic variables, in particular, under the project alternative conditions. Field survey is not only costly, it is also limited to the existing condition. In this project, new capabilities such as free surface, mesh generation and non-physical barrier representation are to be developed into an existing Reclamation CFD model U2RANS. Once complete, the new U2RANS can be used for CFD modeling of both physical and non-physical fish barriers.

Project Need

How flow hydraulics and fish barrier designs influence movement behaviors of juvenile salmonids needs to be understood at several projects conducted by the Sacramento and Delta divisions of the Central Valley Project. The only viable way at present is through a combination of 3D CFD modeling and individual based fish movement modeling. 3D flow modeling, however, is rarely used for fish passage projects due to the time-consuming process of carrying out 3D modeling and the tremendous skills required. In recent years, U.S. Bureau of Reclamation has developed a new 3D model U2RANS that has been validated and then used for a couple of fish passage projects on the Sacramento River. Success has been achieved but some limitations were exposed. Further developments and improvements of U2RANS are needed to take the full advantage of 3D modeling capability at Reclamation; these include the free-surface modeling, automated mesh generation, and non-physical barrier modeling (i.e., bubble, sound and light modeling). The 3D flow hydrodynamic results may be predicted by U2RANS which are then used as inputs to the Eulerian Lagrangian Agent Method (ELAM) model to understand fish movement behaviors in response to flow hydraulics.

Project Objectives

Develop new capabilities into the existing Reclamation CFD model U2RANS. New capabilities include the free surface representation, 3D mesh generation, and non-physical barrier modeling related to bubble, sound and light.

Schedule of Project Milestones (When Will Data Collection, Analyses, and Reporting Elements be Completed?)

Date	Milestone
10/01/2018	Model development continued
07/30/2019	Continued 3D mesh generator development; start the free surface capability development
09/30/2019	Annual progress report

Expected FY 2018 Project Cost

\$80,000

Is this Project for a CVP/SWP Biological Opinion or Water Right Decision Compliance? If so, Which Specific Requirement?

I.7.1 and IV.2.2

Investigator

Yong Lai
Technical Service Center
U.S. Bureau of Reclamation
Denver, CO

Central Valley Prediction and Assessment of Salmon (CVPAS)

Fact Sheet Number

2019_62

Project Description

Develop a novel forecasting/analysis tool to better understand the impact of temperature and flow management on ESA-listed species during droughts and climate change in the Central Valley. This system will integrate existing monitoring systems and provide insight into the biological results and effectiveness of actions implemented as part of CVPIA including temperature management, flow management, and potentially habitat restoration.

Project Need

The benefits to be derived from this cooperative agreement include development of a novel modeling and monitoring system for measuring physiological through population level responses on ESA-listed species at appropriate time steps for interpreting metrics important to protecting, restoring, maintaining, and recovering ESA-listed species. This information will be important to understanding integrated monitoring information regarding abundance, productivity, spatial distribution, and diversity observed in ESA-listed species in the Sacramento and San Joaquin rivers and the Delta. The monitoring information generated will keep agencies and stakeholder informed about the status of ESA-listed species in light of flow and non-flow related actions.

Project Objectives

- Collaboratively develop framework and regional coordination of CVPAS
- Expand database and web services (www.cbr.washington.edu/sacramento/data/) for the Sacramento River to include the San Joaquin River, tributaries and SF Bay Delta.
- Develop additional tools to analyze data and generate specific metrics on fish status during freshwater life stages (<http://www.cbr.washington.edu/sacramento/migration/>)
- Extend fish passage models for forecasting juvenile and adult freshwater life stages movement and survival.
- Contribute to the development of a Collaboratorium that provides models and data for analysis of historical and real time status of fish and forecasts effects of Central Valley water operations on ESA-listed species

Schedule of Project Milestones

Date	Milestone
06/30/2018	Develop framework for Collaboratorium
12/31/2018	Expand database services to San Joaquin R
12/31/2019	Egg incubation modeling and tracking to assess temperature management operations on fish survival
06/30/2019	Refinement of passage models with data and movement functions
06/30/2019	Extend passage model to Jan Joaquin and CV tributaries
12/31/2019	Link COMPASS river passage and ePTM Delta passage models
12/31/2020	Functional Central Valley database and modeling system

Expected FY 2019 Project Cost

\$301,052

Is this Project for a CVP/SWP Biological Opinion or Water Right Decision Compliance? If so, Which Specific Requirement?

This work is an extension of one element of the WY 2015 Drought Operations Monitoring Plan

Investigator

Jim Anderson

School of Aquatic and Fishery Sciences
University of Washington

Reclamation Point of Contact: Towns Burgess, Ph.D., Fish Biologist, Bureau of Reclamation, Bay-Delta Office

Delta Outflow Augmentation Modeling Study

Fact Sheet Number

2019_63

Project Description

The UnTRIM San Francisco Bay-Delta model (UnTRIM Bay-Delta model) is a three-dimensional hydrodynamic model of San Francisco Bay and the Sacramento-San Joaquin Delta, which has been developed using the UnTRIM hydrodynamic model (MacWilliams et al. 2007, 2008, 2009, 2015). The model has been shown to accurately predict salinity, tidal flows, and water levels throughout the San Francisco Bay and Sacramento-San Joaquin Delta under a wide range of conditions. UnTRIM will be used to simulate various potential outflow actions, help select the best option, and will be used to evaluate the outcomes of selected actions as compared to other potential outflow actions.

Project Need

The proposed Delta Outflow Augmentation Modeling Study Project has been identified as a critical planning and evaluation tool for outflow augmentation actions. This project will be used for planning outflow implementation and model simulations to support analyses. The planning component of the modeling will be used to develop and analyze potential outflow augmentation scenarios, prior to flow action implementation. The simulations to support analyses will be used to evaluate outcomes of flow augmentation actions, including hypotheses testing and comparison to historical data.

This Project contributes to the understanding of the hydrologic variables and critical habitat for the state and federally endangered Delta Smelt. This modeling project will ensure we select an outflow augmentation action based upon the best scientific information available and that selected actions will have the greatest positive impact on Delta Smelt populations. Hypotheses related to flow and water quality will be used to forecast potential habitat and Delta smelt distribution.

Status

Reclamation has completed an agreement with DWR to fund this work through a subcontract to AnchorQEA (R17AC00170).

Project Objectives

The primary objectives of the Project are to:

- Working with multi-agency technical team to develop a suite of model scenarios that will be used to support possible outflow augmentation actions and to test relevant hypotheses
- Run the UnTRIM Model to simulate outflow scenarios, test hypotheses, guide monitoring during implemented outflow scenarios, and simulate historic outflow conditions for comparison to proposed outflow scenarios
- Develop a hindcast to help understand the results of observed conditions (including outflow augmentation, if implemented) and to compare the observed conditions to alternate scenarios
- Produce a final technical report to document the model simulations and hindcast results.

Schedule of Project Milestones (When Will Data Collection, Analyses, and Reporting Elements be Completed?)

Date	Milestone
April 2018	Team Discussion and Refinement of Approach and Model Scenarios
November 2018	UnTRIM Model Simulations to support analyses and hypothesis testing
December 2018	Hindcast of 2017 Summer and Fall With and Without Outflow Augmentation
March 2019	Final technical report to document the model simulations and hindcast results

Expected FY 2019 Project Cost

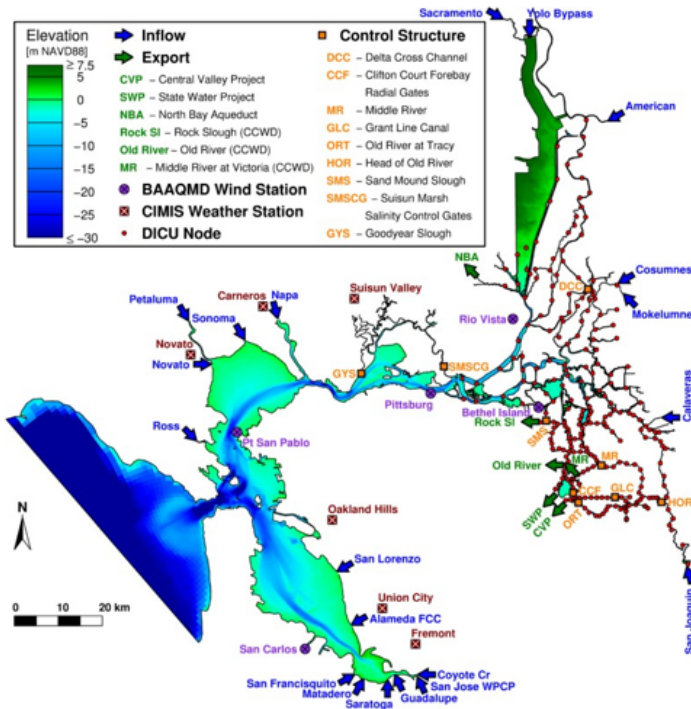
Working on No Cost Extension of \$213,078.00 from FY17.

Investigator(s)

You Chen Chao, Senior Engineer
California Department of Water Resources

Michael MacWilliams, Ph.D., P.E.
Anchor QEA, LLC

Model domain and boundary conditions for the UnTRIM Bay-Delta model



Model domain and boundary conditions for the UnTrim Bay-Delta Model

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Reclamation Point(s) of Contact: Katrina Harrison, Grants Office Technical Representative, BDO-150

Life-Cycle Modeling Project

Fact Sheet Number

2019_64

Project Description

The purpose of this project is to continue development and engagement on the Chinook Salmon Winter-Run Life-Cycle Model (WRLCM). To meet the goals of improving the reliability of water supply and improving the ecosystem health on California's Central Valley. The project is to continue the development of the WRLCM to evaluate the potential effects of water project operations and habitat restoration on the population dynamics of winter-run Chinook Salmon in the California Central Valley.

Project Need

The WRLCM has been used to evaluate the relative impacts of alternative hydrologic management scenarios on winter-run Chinook Salmon using the existing, or hypothetically modified, physical infrastructure of the Central Valley. The goal of this exercise is to identify alternative scenarios that minimize or avoid adverse impacts on the winter-run population relative to a baseline. To increase the WRLCM output utility this project seeks to 1) further develop real-time reporting data applications; 2) develop the capacity to evaluate the impacts of habitat restoration on juvenile salmonid growth and survival; 3) update key life-stage transition functions (e.g., egg mortality model), and 4) improve the accuracy of flow-survival relationships. Collectively, these changes will improve our ability to evaluate the potential effects of water project operations and habitat restoration on the dynamics of winter-run Chinook Salmon populations in the California Central Valley. Further, this project may inform coincident life-cycle modeling efforts (e.g., CVPIA Science Integration Team) by identifying methods for quantifying the value of alternative actions (e.g., habitat restoration) in a life-cycle modeling framework.

Project Objectives

UC Santa Cruz, Principal Investigator Eric Danner and staff will continue the development of the WRLCM by reaching the following over-arching objectives:

1. Model development (e.g., updated egg mortality and flow-survival models) with supporting website and user's guide

2. Study plan development and incorporation of functions to evaluate habitat restoration
3. Regular project updates and coordination with collaborators and stakeholders

Schedule of Project Milestones

Date	Milestone
Once per quarter 10/01/2018–06/30/2022	Planning meetings with USBR (12 total)
To be determined	Planning meetings with stakeholder representatives (12 total)
To be determined	Quarterly Technical Input Meetings (12 total)
05/01/2019	Technical memorandum describing the actions, WRLCM model assumptions, underlying model mechanics and equations (or referring to existing detailed documentation), results and discussion
05/01/2019	Model results in excel spreadsheet or HEC- DSS
05/01/2019	Raw model input and result files
07/01/2019	Draft study plan submitted to CVPIA/IEP/CSAMP
05/01/2019	Presentation to CVPIA/IEP/CSAMP
08/01/2019	Revised study plan submitted to CVPIA/IEP/CSAMP
Ongoing	Expanded LCM public website
09/01/2020, 06/30/2022	Winter Run LCM User's Manual for Technical Audiences. Updated User's Manual
09/01/2019 (and annually as needed)	WRLCM versions
12/01/2019, 12/01/2020	Expanded model interface (i.e., Shiny App)
09/30/2019	General model information document for lay audiences (updated annually as appropriate)
Biannually	Model/Project Updates (twice per year)

Expected FY 2019 Project Cost and Financial Information

\$1.0 Million obligated in FY19 of the \$2.8 Million total estimated amount of agreement. This cooperative agreement is funded under the agreement number R18AC00096, CESU# 3FC810873. Project completion date 06/30/2022

Is this Project for a CVP/SWP Biological Opinion or Water Right Decision Compliance? If so, Which Specific Requirement?

N/A

Investigator

Dr. Eric Danner, Principal Investigator
University of California, Santa Cruz Institute of Marine Science
National Marine Fisheries Service at Long Marine Laboratory
110 Shaffer Rd., Santa Cruz, California 95060

Reclamation Point(s) of Contact

Katrina Harrison, BDO-150
Grants Office Technical Representative
U.S. Department of the Interior
Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, California 95814-2536
E-mail: kharrison@usbr.gov
Phone: (916) 414-2425
Fax: (916) 414-2439