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

FY18_010

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 2-18. Comprehensive 2D and 3D CFD modeling will be coordinated to support evaluation and analysis of hydrodynamic scenarios likely at sites such as the Georgiana Slough; 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

This study is needed to understand how flow hydraulics and barrier designs influence movement behaviors of juvenile salmonids at sites such as the Georgiana Slough and Sacramento River junction. These data will be useful for understanding the efficacy of barriers designs at specific locations 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 2018, the focus is on 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
10/01/2017	Modeling work initiated
07/30/2017	CFD modeling of Georgiana Slough Junction
09/30/2017	Annual Report

Expected FY 2018 Project Cost

$100,000

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

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U2RANS Model Development for Fish Bypass Projects

Fact Sheet Number

FY18_011

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 Langrangian 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
10/01/2017	Modeling work initiated
07/31/2017	Development of 3D mesh generator complete; free surface capability development initiated
09/30/2017	Annual Report

Expected FY 2018 Project Cost

$100,000

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

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Central Valley Prediction and Assessment of Salmon (CVPAS)

Fact Sheet Number

FY18_012

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.
- 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 River
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 2018 Project Cost

$390,288

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

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School of Aquatic and Fishery Sciences
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Technical Point of Contact for service agency, academia, or consulting firm

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

Delta Outflow Augmentation Modeling Study

Fact Sheet Number

FY18_013

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 2018 Project Cost

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

Investigator(s)

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Anchor QEA, LLC.

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