Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 8:
Refinement of Carriage Water Routine

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8 Refinement of Carriage Water Routine

During 1992 various studies have been conducted to refine the carriage water routine used in the Minimum Delta Outflow (MDO) model used by DWRSIM. To date, a modeling approach superior to the current routine has not been developed. This chapter outlines specifications for a refined model and suggests studies (or experiments) that will be undertaken to explore alternative methodologies.

Specifications for an MDO Replacement

1. The model must be compatible with DWRSIM, implying two critical design considerations:

    a. The model should operate on a monthly time step.

    b. Input variables to the model are limited to current month inflows and outflows, antecedent inflows and outflows, and cross-channel gate operations.

2. DWRSIM is a planning model, not a forecasting model. Therefore, it must be robust enough to account for future facilities. An empirical model based strictly on historic conditions would not meet such a specification.

3. The model must be able to predict outflow requirements to meet target salinity standards. Previous efforts have focused on developing models that predict salinity from flows. While these efforts were somewhat successful, these models were unable to solve the inverse problem (i.e., predicting flows from salinity).

4. Given that Delta water quality is a complex function of several conditions in addition to inflows and outflows, it would be desirable to develop a model with stochastic characteristics. For example, the model could give outflow requirements for various levels of probability in meeting a water quality standard.

Suggested Experiments

From a roundtable discussion held by the Delta Modeling Section, a number of suggestions for this project resulted. Outlined below are recommended "experiments" to undertake. The term "experiment" is used in recognition of the difficulties associated with this project. Experiments should be conducted on the following stations: Rock Slough, Mallard, Jersey Point, and Emmaton. If a particular experiment looks promising, other stations should be considered.

Statistical Analysis of Observed Data

Partial correlations between observed salinity and various observed or calculated flow parameters at Delta stations of interest should be defined. Correlations with other real-time influences, such as wind or barometric pressure, could also be included in this analysis. Such an analysis should show that project operations have a limited influence on Delta water quality and that other variables must be taken into account to fully explain salinity conditions in the Delta.

This task is not truly experimental in nature. It seems fairly well defined and could be performed independently of the other tasks. It is recommended that this task be undertaken by a student or a consultant with a strong statistics background.

Develop Salinity Relationships Using Steady-State DWRDSM Analysis

The purpose of this experiment is to define isosalinity curves for various combinations of Sacramento River flows and export pumping. These curves would be location specific and specific to a range of other hydrologic parameters, e.g., set bounds on San Joaquin river flow or east side streams flow.

Probability Analysis of Observed Data

Similar to the prior experiment, an attempt could be made to construct from observed data isoprobability curves for various combinations of Sacramento River flows and export pumping that meet a defined salinity level. For this experiment, one will be looking at salinity as an expected value rather than as a deterministic value. For example, suppose one wishes to determine what flows and exports can be maintained to meet a standard of 150 ppm of chloride at Rock Slough. The observed data could be segregated into ranges of Sacramento flow and exports. Within this subset, one can determine the percentage of observations that are at or below 150 ppm chloride. This probability can be plotted for each range of Sacramento flow and exports. Then contours can be plotted through similar probabilities, resulting in a figure that shows the probability of meeting a salinity standard for a given combination of Sacramento flow and export.

To provide enough data for this experiment, daily values should be used. To take into account antecedent conditions, these daily values should be transformed into 28-day running average values. Data should be segregated into similar hydrologic subsets, maybe using ,for example,San Joaquin River flow, east side streams flow, or net Delta outflow.

Probability Analysis of Model Output

If the above experiment appears promising, it should be repeated with data generated by a multi-year DWRDSM run. This run would probably need to be rather large to generate enough data for a statistical analysis.

Optimization Approach

The premise of this approach is that to meet a given salinity standard, a variety of flow combinations can potentially be employed. Therefore, the objective of the optimization problem would be to minimize a "cost" associated with each flow combination. The main constraint would be to maintain the salinity standards. Some work was undertaken on this project back in 1990. The unpublished Delta Modeling Section document "Carriage Water Baseflow Analysis: Methodology and Assumptions" summarizes this work.

Transfer Function Model

An outside contract could be awarded to develop a simplified Delta model. A work proposal was submitted by Dr. Gilbert Bogle in July 1991 to develop a "Delta transfer function" model. Because much of the work outlined in his proposal has already been accomplished, the contract scope and cost may now be much less than originally estimated.

CCWD Modeling

We should remain open to suggestions by Contra Costa Water District and others on how to improve the carriage water routine.