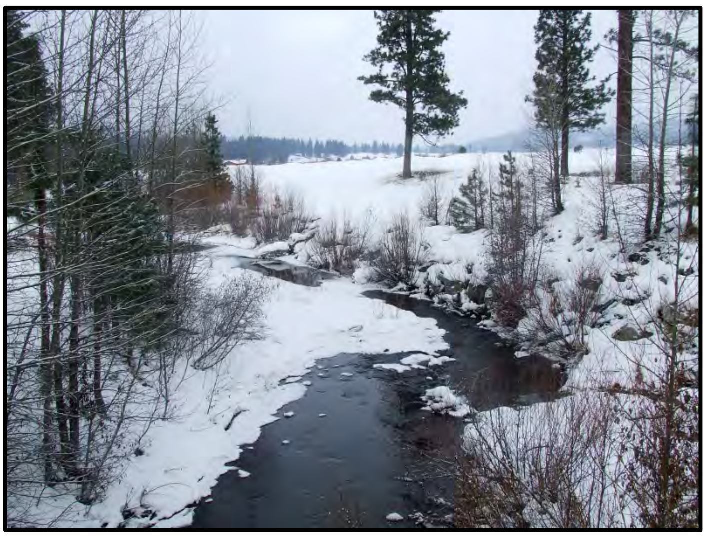
California Water and Environmental Modeling Forum

2012
ANNUAL MEETING
SESSION ABSTRACTS

With Links to Presentations



Lake Natoma Inn
702 Gold Lake Drive
Folsom, California

Session 1. DSM2 Applications and Development – Part 1

DSM2 User Group Update **– Min Yu (DWR)** **2 MB**

As part of the CWEMF's and the Department of Water Resources Delta Modeling Section's public outreach effort, a DSM2 User Group was initiated in January 2004. This presentation will highlight past key User Group activities and present current efforts to make more accessible DSM2-related resources to DSM2 users.

Validation of DSM2 QUAL for Simulation of Various Cations and Anions: Prepared for Metropolitan Water District of Southern California **– Shankar Parvathinathan (MWH)**

Delta Simulation Model II (DSM2) has proven to be reliable for simulating EC (Electrical Conductivity) in the Delta. However, concerns about DSM2's ability to simulate other salinity constituents using the existing model calibrated for EC, created the premise for this validation study.

This study evaluated the ability of the DSM2 model to simulate the transport of seven cations (Calcium, Magnesium and Sodium) and anions (Chloride, Sulfate, Bromide and Bicarbonate Alkalinity) based on observed data at six different Delta locations. The validation effort was based on limited available monitoring data on cations and anions in the Delta, which do not adequately cover the range of seasonal flow and salinity conditions. Boundary water quality conditions for the DSM2 model were generated from available EC data using regression equations relating EC and various ions that were validated using cation-anion charge balance analysis. Four different statistical metrics, including RMSE (the root mean square error), NRMSE (normalized root mean square error), and bias were applied to evaluate the performance of the model in simulating various ions.

The results of this study showed that the DSM2 model performs equally well in simulating cation and anion concentrations in the Delta. The range and magnitude of errors in the simulation of cations and anions are comparable to EC simulation results at the six Delta locations. Magnitudes of model errors in predicting ionic concentrations were found to increase with increasing salinity at the observed locations. Overall, DSM2 is shown to be capable of simulating various cations and anions in the Delta adequately well. However, it is recommended that more cation and anion data be collected in the future for improved validation of the model results in the Delta, especially in the San Joaquin River.

Estimating Delta Bromide Based on DSM2-Simulated EC Fingerprints **1.2 MB**
Siqing Liu (DWR)

The presence of bromide in the Sacramento – San Joaquin Delta is a significant concern to municipal consumers of Delta-source water. Including bromide in the management of drinking water quality is helped by being able to study historical spatial and temporal patterns of Delta bromide and being able to actually forecast bromide in the Delta and in the water delivered through the California Aqueduct. However, DWR Delta Modeling Section's current capability for simulating Delta bromide using Delta Simulation Model II (DSM2) is limited to first simulating daily electrical conductivity (EC) at Clifton Court and then converting to bromide using one of two equations, depending upon the simulated volumetric fingerprints here. Presented and compared are six new regression-based methods for estimating bromide throughout the Delta wherever and whenever EC has been measured or simulated.

DSM2 Version 8.1 Bug Fix and Recalibration Status Update **– Lianwu Liu (DWR)** **3.7 MB**

Bug Fix and Recalibration: The bug fix in channel area calculation (presented at DSM2 User Group meeting Oct. 2011) affects results both in Hydro and Qual. The model has been recalibrated by adjusting Manning's coefficients in Hydro. The recalibrated Hydro results are very close to the 2009 mini-calibration results. Qual was recalibrated after we improved the model convergence (see DSM2 newsletter Aug. 2011). No substantial differences resulted as this recalibration, since the recalibrated Hydro results are almost identical to the 2009 mini-calibration. The EC results are somewhat improved compared to the 2009 mini-calibration results.

Improved Calibration: The bug fixes/code changes didn't change the model behavior/results significantly. We are working on improving the calibration by making necessary changes/corrections to the model setup/input. The areas we have been working on include: Martinez EC discrepancy; Delta Cross Channel flow; minimum stage lower than observed at most of stations; Franks Tract representation. We have also found that NAVD88 is better than NGVD29 when comparing stages at Delta stations. This improved version of recalibration will use NAVD88. Auto-Calibration will be used to optimize calibration coefficients.

Session 2. Topics in Water Management and Supply

Estimates of Agricultural Water Demand in California using Cal-SIMETAW – M.N. Orang (DWR), R.L. Snyder (UC Davis), S. Geng (UC Davis), and S. Sarreshteh (UC Davis) 10 MB

The Cal-SIMETAW computer application program is a new tool for estimating daily soil water balance to determine crop evapotranspiration (ET_c) and evapotranspiration of applied water (ET_{aw}) for use in California water resources planning. ET_{aw} is a seasonal estimate of the water needed to irrigate a crop assuming 100% irrigation efficiency. The model accounts for soils, crop coefficients, rooting depths, seepage, etc. that influence crop water balance. It provides spatial soil and climate information and it uses historical crop category information to provide seasonal water balance estimates by combinations of county and detailed analysis units (DAU/County) over the State.

In the Cal-SIMETAW project, huge soil and climate database were developed to spatially characterize ET_c and ET_{aw}. Oracle Spatial 11g was used to store the daily climate data, i.e. maximum (T_x) and minimum (T_n) temperature and precipitation (Pcp), which were derived from monthly PRISM (USDA-NRCS) data that cover California on a 4×4 km grid spacing. Because the PRISM data are monthly and daily data are needed to determine ET_{aw}, daily NCDC climate station data, back to October 1997, were used with the PRISM data to estimate daily T_x, T_n, and Pcp. Cal-SIMETAW also can employ near real-time reference evapotranspiration (ET_o) information from Spatial-CIMIS, which is a model that combines weather station data and remote sensing to provide a grid of ET_o information. Using the weather generator, CALSIMETAW projects possible impacts of climate change on water demand.

CalSim Modeling of San Joaquin River Interim Flow Objectives 3.2 MB
Tom FitzHugh (Reclamation)

Customized CalSim modeling was conducted to analyze a proposed agreement between the Bureau of Reclamation and Merced Irrigation District (MID) to meet an interim spring pulse flow standard on the San Joaquin River (SJR) at Vernalis during 2012-2013. In order to simulate the range of possible operations and flow standard releases that could occur during 2012-2013, a position analysis was conducted where the model was run over a range of hydrologic conditions. Modifications were made to the standard CalSim SJR model to allow for greater flexibility in terms of how the standard was defined and met, and to set initial conditions such as reservoir storages and instream flow schedules so that they were representative of conditions after a wet year such as 2011. The model was used to evaluate flows at Vernalis and on SJR tributaries, reservoir storages, and Reclamation purchases of water from MID, in support of Reclamation's negotiations with MID and the Environmental Assessment on the proposed agreement.

San Joaquin Basin Development for CalSim3 – Ian Ferguson (Reclamation) 3.6 MB

The CalSim3 approach to system component definition has been applied in the San Joaquin Basin, producing a new model that will be joined with the existing Sacramento River CalSim3 application. Major development required in this effort has included disaggregation and conversion of West Side CVP demands to a land-use basis at a higher resolution relative to CalSim2, applying a standardized template to all demands and diversions on the East Side tributaries, disaggregation of San Joaquin River water quality computations, and integration with the dynamic groundwater model.

[Theoretical Concepts for Sustainable Groundwater Management in Interconnected Stream-Aquifer Systems](#) **– Jeff Davids (Davids Engineering|H2oTech)** **6 MB**

Freshwater streams and the ecosystems they support are a vital natural resource. Recently, declines in anadromous fish populations have led to several proposals for sustainable management of these stream systems, with a specific emphasis on improving and maintaining stream health in relation to fisheries. Many of the systems in consideration have intensive anthropogenic water uses, and consequently, the streams have been rendered artificially ephemeral due to surface-water diversions and groundwater pumping. What does sustainable groundwater management of these artificially ephemeral stream-aquifer systems entail? Assuming stream sustainability thresholds can be developed, how should aquifer systems in direct connection with these streams be managed to support the proposed metrics?

Two theoretical concepts are developed to provide a framework for understanding and discussing groundwater management in the aforementioned settings. First, Potential Capture Thresholds (PCT), defined as the maximum amount of water that could potentially be captured due to pumping while still being able to reach a steady state in the groundwater system, can be useful in bracketing the order of magnitude of sustainable groundwater extractions. The PCT can be exceeded for brief periods (assuming the pumping well(s) has a high enough Stream Depletion Factor), but in the long run the PCT cannot be consistently exceeded without inducing overdraft. Second, limiting groundwater extractions to at or near the PCT can guard a basin from overdraft, but can still lead to the violation of stream sustainability metrics. Therefore, Sustainable Capture Thresholds (SCT) can be a helpful in delineating the magnitude of groundwater extractions that, over time, will not cause the stream to cross its sustainability thresholds. Third, differentiating between potential groundwater storage and sustainable groundwater storage can be a valuable in method in bounding the amount of aquifer storage that can be sustainably exercised. Finally, how do these concepts vary over space and time in response to changes in aquifer and stream geometry, riparian vegetation, and aquifer and stream properties? We use MODFLOW-2005 with the StreamFlow Routing Package (SFR2) to help illustrate and test these theoretical concepts for sustainable groundwater management.

Session 3. Salinity and Nutrient Management

[Nutrient Management Planning and Tracking](#) **– John Dickey (PlanTierra)** **2.6 MB**

Concern about groundwater pollution from irrigated lands (landscaping, recycled water projects, dairy facilities, and cropland) has expanded interest in fate and transport of pollutants in these systems, often in the context of new regulatory processes. Rationale and concepts for developing and implementing practical, usable tools to facilitate nutrient management planning and tracking will be presented. The same toolset could be extended to incorporate other constituents (e.g., salinity, pesticides), and other management practices. The toolset is intended to benefit land managers (growers and other irrigators), coordinating groups and agencies (e.g., coalitions under the Long-term Irrigated Lands Regulatory Program), regulatory agencies, and the public. It is intended to be developed and managed primarily at the level of the actual land managers and their coalitions, and to be relatively flexible and open. Thus, a broad range of land management types could be accommodated with a consistent platform, maximizing the breadth of application and utility. This consistency and breadth would be advantageous from the standpoints of efficient development, as well as technical, user, and regulatory review and acceptance.

Simulating Salinity and Nutrient Management: Data Streams and Simulation Capabilities **– Randy Hanson and Claudia Faunt (USGS)**

Data and hydrologic-simulation tools are needed to effectively manage salinity and nutrient levels to achieve sustainability of water resources in the Central Valley. Salinity and nutrient concentrations need to be monitored at various points in the hydrologic system, including along rivers, in diversions, within selected vegetation and soils, in return flows, and in shallow groundwater. This may be achieved by using a combination of land-based and remote-sensing techniques that can cover the diversity of locations. These data streams become the observations needed to both calibrate and update the hydrologic simulations. To accurately simulate the pathways and sources of salinity and nutrients, the hydrologic components of storage, use, and movement of water need to be linked with the salinity and nutrients in the context of a physically-based integrated hydrologic model. In addition to representing the many pathways and sources, the simulation tools may also need to provide selected linkages between salinity and evapotranspiration that would reflect changes in plant water consumption (ET) with changes in salinity or nutrients.

DWR Ag Drainage Program **– Joseph Tapia (DWR)** **5.5 MB**

The Westside of the San Joaquin Valley has been experiencing mounting problems with the management and disposal of agricultural drainage water. The drainage problem is an outgrowth of imported water, naturally saline soils, and the valley's distinctive geological makeup. DWR has identified approximately 1.5 million acres on the Westside that are located in the drainage problem region. Since 1991, DWR has been monitoring drainage water for minerals, metals and depth to water. The data is geo-referenced and compiled in the department's database. Maps depicting the concentration and groundwater depth are developed and shared with various interested agencies. Trends are also graphed and published annually in the Department Drainage Management Report.

Real-Time Wetland Salinity Management **13 MB**
Nigel Quinn (Berkeley National Laboratory/Reclamation)

In the Water Control Plan for the San Joaquin Basin the Central Valley Regional Water Quality Control Board allows an excursion from conservative salinity loads mandated under the salinity and boron TMDL provided stakeholders demonstrate substantial progress toward the adoption of a real-time salinity management program. The objective of such a program is to make better use of the assimilative capacity of the San Joaquin River by coordinating the timing of west-side salt loads with dilution flows provided by the east-side tributaries so as to consistently meet River salinity objectives at Vernalis. Data sharing, forecast modeling and information dissemination are key to development of a real-time salinity management program. Reclamation has been cooperating with Grassland Water District to develop a prototype program. This talk will describe some of the progress made in advancing this concept over the past 12 months and provide a window on future planned activities over the next two years.

Session 4. Technical Analysis in Support of California Water Plan Update 2013 **0.2 MB**

Developing Agricultural Land Use for Multiple Future Scenarios for the California Water Plan Update **– Tom Hawkins (DWR)** **0.6 MB**

Annual irrigated agricultural water use in California averages about 30 million acre-feet per year. What the future irrigated agricultural water use could be is mainly dependent upon how much land is available for irrigated crops and what the crop mix might be. Urbanization of agricultural land is the largest factor affecting available land for irrigation. The profitability of irrigated farming will affect the crop mix. DWR is using UPlan, an urbanization model developed by the University of California at Davis, to develop urban footprints for various future scenarios. For each scenario, the urban footprint developed will be used with a current irrigated agricultural footprint to estimate the amount of irrigated agricultural land that is urbanized and lost to production. This information will be used with agricultural economic production models to develop acreage estimates for crops that would result in the highest profitability for that scenario.

Evaluating Resource Management Strategies for an Uncertain Future for the California Water Plan Update 2013 **– Rich Juricich (DWR) and David Groves (RAND Corp.)** **4.9 MB**

This presentation describes the technical approach proposed by the California Department of Water Resources (DWR) to evaluate the performance of alternative regional resource management strategies in meeting future water management objectives as part of the 2013 Update of the California Water Plan.

The California Water Plan, mandated by state law and updated every five years, is used to guide regional and statewide water policy decisions. DWR is working collaboratively through a rigorous public outreach process to look out to the year 2050 to define multiple plausible future scenarios that consider how future population growth, development patterns, a changing climate, and other uncertainties interact to affect water management. The Water Plan has identified over two dozen resources management strategies that California's regions can invest in to help reduce water demand, improve operational efficiency and water transfers, increase water supply, improve flood management, improve water quality, and practice resource stewardship. The evaluation of these strategies in Update 2013 will provide decision support and guidance to California's regions and the State legislature about promising investments to improve water management in California.

Working the White Space, Connecting the Dots between Models and the People that Need to Use Their Results **– Lisa Beutler (MWH)** **3.6 MB**

This practical session will focus on integrating the people that need to use and/or understand modeling results into the process of building and applying them. After reviewing the basics of collaborative modeling, the discussion will turn to application of those steps in the Water Plan. Using the Water Plan as a mini case study, we will consider how collaborative modeling can provide a more realistic assessment of the models and advance good planning. In closing we will briefly discuss overcoming barriers to the approach and ways session participants can apply lessons learned to their own work.

Dialogue on Critical Long-Term Technical Improvements to Support Integrated Data & Analysis **– Rich Juricich (DWR)** **0.9 MB**

As part of Update 2013, the California Water Plan will provide a roadmap and describe key actions needed to improve water resources information and analysis for integrated water management by State government, and by the many other research institutions, and federal, Tribal, regional, and local water management entities. This presentation will describe some of the current analytical tool improvements and data integration activities to be highlighted in the Water Plan. Participants will be solicited for their ideas, priorities, and vision with respect to current efforts under way to integrate analytical tools, and improve data, data sharing, and data management.

Session 5. Central Valley Flood Protection

Identifying Floodplain Restoration Opportunities in the Sacramento and San Joaquin Valleys **– John C. Hunter (AECOM), Kevin G. Coulton (AECOM), Ray McDowell (DWR), Stacy Cepello (DWR), Matt Wacker (HT Harvey & Assoc.), Lee D. von Gynz-Guethle (AECOM), Jonathan McLandrich (AECOM), Eryn Pimentel (AECOM), and Stephen Blanton (AECOM)** **3.2 MB**

Floodplain restoration opportunities were analyzed to support development of a framework for the Central Valley Flood System Conservation Strategy in conjunction with the Central Valley Flood Protection Plan (CVFPP). This GIS-based analysis considered floodplain inundation potential (FIP) and other opportunities and constraints. It was conducted for 2-mile-wide corridors along the Sacramento and San Joaquin rivers and their major tributaries. Outside of urban areas, there were more than 320,000 acres of floodplain that has FIP for inundation by a 2-year event. Less than 40% of this floodplain remains hydrologically connected to the river system. Riparian and wetland vegetation covers only about a third of this connected floodplain, and the majority of this floodplain is bounded by levees whose physical condition is of higher concern. These results indicate that floodplain restoration opportunities are widespread and the potential exists to integrate restoration into the flood management actions of the CVFPP. Maps displaying a combination of FIP, hydrologic connectivity, land cover, and infrastructure have been an important tool for using these results to identify restoration opportunities.

Flood Damage Evaluation for 2012 Central Valley Flood Protection Plan 0.5 MB

Anna Fock (MWH)

Flooding in California's Central Valley has cause direct damages to structures, contents, agriculture, and business production. As part of the development of the 2012 Central Valley Flood Protection Plan (CVFPP), a suite of modeling simulations were performed for various flood events (return periods of 10, 25, 50, 100, 200, and 500 years), and their results were applied as inputs to the flood damage evaluation using the U.S. Army Corps of Engineers' (USACE) economic model, HEC-FDA. Models simulated before the HEC-FDA are for reservoir operations, riverine hydraulics, estuary hydraulics, floodplain hydraulics, and levee performance. ParcelQuest data from June 2010 were used to develop the parcel inventory for the 500-year floodplain in these two river basins. Preliminary field surveys were conducted for 14 counties in the Sacramento and San Joaquin River basins to get information like foundation height, depreciation, and the construction class. These surveys data were then applied in the statistical analysis of the parcel inventory. Marshall Valuation Service data were used to estimate the replacement value of the structures based on factors such as structure category, occupancy type, construction class, construction quality, depreciation, and building square footage. HEC-FDA provided the expected annual damages (EAD) and annual exceedences probabilities (i.e., likelihood of being flooded in a given year) for each impact area assessed. Comparing EADs across the different CVFPP approaches were used to indicate the relative performance of each approach in flood damage reduction.

CVFPP Life Risk Analysis 0.5 MB

Steve Cowdin, Natalie King, and David Ford (David Ford Consulting)

A life risk calculation (LRC) method was developed for the 2012 CVFPP. This LRC method incorporated commonly used procedures for assessing life risk, as influenced by flood hazard, system performance, and vulnerability and exposure of people. The method was tied to the CVFPP economic risk analysis, using common numerical descriptions of flood hazard and levee system performance. Exposure of people was tied to exposure of property. With this strategy, computations for economic and life risk were accomplished with the USACE HEC-FDA software application.

The CVFPP HEC-FDA models were modified to estimate expected annual life risk for the No Project and with-project (CVFPP approaches) conditions. Modifications included: (1) replacing residential structures' economic values with persons/structure estimates based on 2000 census data, adjusted for likely evacuation prior to a flood event; and (2) replacing depth-% damage functions with depth-% mortality functions, based on empirical research of life loss in New Orleans during Hurricane Katrina. The HEC-FDA models were then run to estimate changes in life risk attributable to the approaches, compared to the No Project condition. Life risk is the long-term average annual number of lives potentially lost in an identified area, considering a given climate and land use condition, with a specified plan of flood control protection in place.

The resulting life risk values are *conditional*: they represent consequences for a given area with a specified set of hydrologic and hydraulic conditions of the system, with best representation of performance of system levees and other features, and with stated assumptions regarding public warning and response. As such, the results are informative *indices* of life risk, and the estimated values provide a reliable metric for comparing the life-risk reduction attributable to the proposed 2012 CVFPP approaches.

Regional Economic Effects of Improving Flood Management in California's Central Valley

Vincent Barbara (MWH) 0.9 MB

Flooding in California's Central Valley would not only cause direct damages to structures, contents, agriculture, and business production, but would also cause ripple, or indirect and induced, economic effects to the region in the form of lost employment and lost industry output. Flood management improvements may reduce these negative economic effects and support other economic activities. This analysis estimated the ripple economic effects related to implementation of the proposed State Systemwide Investment Approach (SSIA) in the 2012 Central Valley Flood Protection Plan (CVFPP) for two primary factors: (1) proposed flood management improvements will reduce business losses, and (2) proposed improvements to flood protection facilities will introduce construction expenditures. Avoided business losses were evaluated as part of the economic damage analysis for the 2012 CVFPP, and a reconnaissance-level cost estimate of field and non-field costs was performed for the SSIA. The analysis used the Impact Analysis for Planning input-output model (IMPLAN) to estimate multiplier effects for annual long-term reductions in business losses and annual short-term construction period expenditures.

Session 6. 2012 HydroGeoSphere Enhancements and Applications

Linkage of HydroGeoSphere Simulation and Differential Evolution Optimization Models: An Enhancement – Chin Man W. Mok (AMEC), Miao Zhang (AMEC), Raghu Suribhatla (AMEC), and George Matanga (AMEC)

The authors are developing a decision support system (DSS) which provides a valuable simulation-optimization tool to assist water managers in assimilating water-resource data, simulating the response of hydrologic processes under fully-integrated surface-water and groundwater systems, coping with uncertainties, and making optimal decisions for cost-effective management of water resources. Due to complexity of hydrologic systems, managers' knowledge of such systems is most often incomplete and predictions of future circumstances are inherently uncertain. The DSS allows water managers to account for uncertainties associated with model parameters, forecasting of hydrologic events, water supplies, and water demands. Furthermore, It provides an integrated framework for building, evaluating and communicating the net impact of their decisions to different stakeholders. The DSS includes several modules linked with each other to facilitate optimal objective decision-making subject to specified operational and regulatory constraints. One of the modules involves the linkage of the HydroGeoSphere numerical model and a Differential Evolution (DE) optimization model. HydroGeoSphere is a physically-based numerical model which is increasingly being applied to simulate the outcome of different water management strategies. The DE method has the flexibility to deal with non-linearity of the objective and constraint functions. In this presentation, we will describe the conceptual framework of the DSS and HydroGeoSphere-DE linkage.

San Joaquin Valley HydroGeoSphere Model (SJVHGSM): An Application
Kirk Nelson, Lisa Rainger, Nigel Quinn, and George Matanga (Reclamation)

An application of HydroGeoSphere for the San Joaquin Valley has been developed for the evaluation of potential land subsidence impacts due to additional groundwater withdrawal during drought years in the San Joaquin River Basin. This application makes use of a recently incorporated land-subsidence module in HGS that is based on the SUB package of MODFLOW. This module incorporates Terzaghi's 1D instantaneous compaction principle, allowing for subsidence simulation capabilities. Model parameterization has been based primarily on the physical and hydrological input data used in the construction of the USGS Central Valley Hydrologic Model (CVHM), the premise being that use of common datasets will increase model confidence (in the event of consistent results) and/or facilitate understanding of the most important governing processes of a given problem (in the event of significant differences in model results, because these differences can be linked to differences in process representations); this can also help to identify the appropriate range of conditions to which the various modeling tools that are available can be applied. Model calibration has been undertaken using historical water level and compaction data for the period 1961 through 1982, and model verification based on data from 1982 to 2003. Initial focus is in the vicinity of the Delta-Mendota Canal (DMC) for the purpose of analyzing additional groundwater pumping that has been proposed in the case of dry-year conditions.

Application of a Fully-Integrated Surface-Subsurface Numerical Model in Conjunctive Analysis of Water Flow at a Large Scale
George Matanga and Lisa Rainger (Reclamation)

In the management of basin-wide water systems, there is an increasing emphasis on problems that require conjunctive analyses of surface and subsurface hydrologic processes, as well as their interactions along the surface/subsurface interfaces. Success of conjunctive analyses of the hydrologic processes will mainly depend on availability of robust fully-integrated surface and subsurface hydrologic numerical models that conceptually account for the hydrologic processes within and at the interface of surface and subsurface water regimes. Until recently, surface and subsurface water regimes have been analyzed separately, with source/sink assumptions providing a lumped estimate of the water budget components that are not directly simulated. For instance, in surface water-flow models, subsurface interactions are highly simplified, whereas subsurface water-flow models are driven by groundwater recharge estimates and treat the surface features such as lakes and streams as input or discharge locations (boundary conditions) for surface-water flow. However, within the framework of conjunctive management of scarce water resources, an integrated model is required that accounts for all processes within both surface/subsurface flow domains in a physically-based manner. A major step is towards integration of surface and subsurface water systems into a single framework. When the surface and subsurface water equations are solved simultaneously, the model is referred to as fully-integrated surface-subsurface numerical model. The linked model is the one in which surface and subsurface flow equations are solved separately, with the results of one model being used as boundary conditions for the other model. Iteratively-coupled model refers to a model in which the two equations are solved iteratively to achieve successive convergence between the results of the two equations. In this work, a fully-integrated model, known as HydroGeoSphere, is applied to demonstrate model application to a water-resource system at a regional scale.

Session 7. Advances in Climate Change Assessment 1.7 MB

Living on the Edge: Climate Change and Extremes in California 6.5 MB
Michael Anderson (DWR)

Much of climate change and water management has focused on changes in the mean conditions. An area of increasing interest is the low probability, high impact extreme event and its representation in climate change studies. In this talk an overview of California relevant extreme events will be presented along with methodologies for tracking the change in extremes and extracting extremes information from global climate change models.

Modeling the Effects of Climate Change on ET and Yield in California's Central Valley
Mike Tansey (Reclamation), Francisco Flores and Chuck Young (Stockholm Environment Institute) and Justin Huntington (Desert Research Institute) 4.5 MB

Long term planning for the management of California's water resources requires assessment of the effects of future climate changes on both water supply and demand. Considerable progress has been made on the evaluation of the effects of future climate changes on water supplies but less information is available with regard to water demands. This study addresses water demands by examining the effects of climate change on soil evaporation, plant transpiration, growth, and yield for selected types of agricultural and urban vegetation. The assessments are performed for representative groups of agricultural crops growing in characteristic geographic regions of the Central Valley using downscaled climate futures selected to span a wide range of the existing GCM results. The objective of this approach is to produce a data set that can be used by others for planning studies and economic assessments.

An existing model, the Land, Air, and Water Simulator (LAWS) has been modified to include algorithms that account for effects of atmospheric temperature, radiation, humidity, wind speed, and CO_2 concentrations on plant water use, growth, and yield. The model was calibrated with historical CIMIS station data and ITRC estimates of crop ET and yield at four locations spanning the Central Valley. Five bias-corrected spatially downscaled (BCSD) future climate projections of temperature and precipitation were prepared for the early, mid and late 21st century using the Hybrid Delta Ensemble (HDe) method at each of the four CIMIS locations. Analysis of historical CIMIS meteorological data was used to develop reasonable estimates of future solar radiation, wind speed and dew point temperatures used to compute ET by the Penman-Monthieth method. Future CO2 projections corresponding to each of the future climate projections were prepared from the IPCC emission scenarios.

The simulation results reveal that atmospheric as well as soil conditions can exert complex and opposing influences on important evaluation metrics such as plant transpiration rates and cumulative water use, initiation and duration of the growing season, biomass production and crop yields. The magnitude of changes over the course of the 21st century relative to historic conditions can be significant.

An Extended-Delta EFDC Hydrodynamic Model Framework for Sea Level Rise Analysis to Support Resource Management Planning for the Sacramento San Joaquin Delta **3 MB**

Silong Lu (Dynamic Solutions), Paul Craig (Dynamic Solutions), Christopher Wallen (Dynamic Solutions), Zhijun Liu (Dynamic Solutions), Andrew Stoddard (Dynamic Solutions), William McAnally (Dynamic Solutions), and Eugene Maak (US Army Corps of Engineers)

An advanced surface water model framework has been developed by the U.S. Army Corps of Engineers, Sacramento District to evaluate cause-effect interactions of the Sacramento and San Joaquin Rivers, wastewater facilities, agricultural canals, irrigation withdrawals, pumping stations and tidal forcing on circulation, salinity, water temperature, sediments, and water quality. The Extended-Delta hydrodynamic model framework, based on the public domain Environmental Fluid Dynamics Code (EFDC), includes the Sacramento River (from Verona) the San Joaquin River (from Vernalis), the Delta, Suisun Bay, San Pablo Bay, San Francisco Bay and the Pacific Ocean offshore to the Farallon Islands. Using historical tide gage records for San Francisco Bay and data developed by the U.S. Army Corps of Engineers, scenarios based on land subsidence and low, intermediate, and high rates of sea level rise are developed to simulate changes in water levels, shoreline inundation, and salinity after 50 and 100 years. An overview of the EFDC model, key data sources, and the methods used to account for sea level rise and land subsidence on model bathymetry and open ocean boundary conditions will be presented. Model results will be presented (a) to demonstrate calibration and validation of the Extended-Delta EFDC hydrodynamic model at key station locations; and (b) to show potential impacts of sea level rise and land subsidence. The Extended-Delta EFDC model provides the US Army Corps of Engineers and other Federal, state/local agencies and Stakeholders with an advanced model framework. It is seen as an essential tool for increased understanding of the consequences of natural events and/or conditions such as sea level rise in planning level evaluations and it is the standard with which we will determine the significance of project impacts.

Threshold Analysis Approach for Incorporating Climate Change into the Central Valley Flood Protection Plan **– Mathew Young (MWH)** **1.3 MB**

A Threshold Analysis Approach is proposed for incorporating climate change considerations into the Central Valley Flood Protection Plan. The major challenge of incorporating climate change for flood management planning is that predictions of extreme precipitation and runoff events are highly uncertain. It is difficult to obtain detailed regional precipitation information from GCMs, and flood risks are also influenced by human settlement patterns and overall flood risk management choices. Existing approaches use changes in average conditions and a top-down risk management approach; this is useful for water supply planning but not the extreme events considered in flood management.

The Threshold Analysis Approach is a bottom-up approach focusing on vulnerability and associated investments, aimed at improving adaptation regardless of which climate change scenarios may be realized (rather maximizing benefits under selected scenarios). The thresholds or vulnerabilities can be assessed at system, regional, and community levels. A pilot study was conducted using a draft Feather-Yuba coordinated operation model developed under the DWR Central Valley Hydrology Program. The vulnerability of exceeding release capacity and downstream flow objectives was assessed using a surrogate index of atmospheric rivers. The results show promise for the proposed methodology; however, additional research is needed for a full application.

Session 8. WRIMS 2 and its Applications

Overview of WRIMS 2 and Different LP Solvers **– Sanjaya Seneviratne (DWR)** **0.5 MB**

Water Resources Integrated Systems Modeling 1 (WRIMS 1) is the engine currently used to run CalSim 2.0 and CalLite. The Water Resources Simulation Language (WRESL) was designed more than 12 years ago to serve as flexible language interface to the linear programming (LP) solver and databases. Lahey Fortran compiler was used to enable this task. Over the years modeling community has imposed more demands on CalSim and CalLite to solve extreme problems that WRIMS 1 could not handle. Hence WRIMS 2 was developed to improve the capabilities of CalSim/CalLite models.

Evaluator and Run Time Debugger **– Hao Xie (DWR)** **0.8 MB**

The run time of WRIMS 2 contains formulating LP problems from wresl code, interacting with dll, dss time series, and look up table, and performing LP solving with XA. The development of WRIMS 2 involves utilizing Java to replace Fortran and its compiler during the run time. The new design of WRIMS v2 results in run time saving and maintains the same accuracy comparing to WRIMS 1. On-going improvements including a run time debugger (part of the GUI) will assist users on application developments.

GUI for WRIMS 2 **– Nicky Sandhu (DWR)** **1.3 MB**

WRIMS2 is a model that works with data from tables in text files, time series and code written in a custom language. The user interface provides an integrated development platform for users to input data, edit code, compile, run, debug and view output within the same environment. The user interface leverages the Eclipse platform (www.eclipse.org) for a generic development environment for programming languages and customizes it for WRIMS2 modeling. This talk will cover the vision and implementation status of the GUI.

Interactive GUI & Alternate Solvers **– Kevin Kao (DWR)** **0.4 MB**

New syntax for WRIMS 2 will be introduced to separate system schematics from operation rules. The system schematics can be linked with GUI object interactively; The changes in the system schematics will be reflected in the automatically generated WRESL code. The operation rules using this new syntax will be more flexible than the legacy WRESL language.

The roadmap for supporting alternative LP solvers in WRIMS 2 will be presented. In addition to XA solver, both open-sourced and proprietary solvers will be supported.

WRIMS 2 in CalLite Applications **– Nazrul Islam (DWR)** **4.2 MB**

CalLite model is in the process of migrating from WRIMS 1 to WRIMS 2 software platform. An analysis has been performed to investigate if any significant error is generated from this migration. The results do not indicate any issues. CalLite GUI has been linked with WRIMS 2 without any major modifications. CalLite model also incorporates new WRIMS 2 features for forecast allocation module, automated WSI-DI generation process, multistep optimization module, and daily time step modeling.

Session 10. Multi-Dimensional Modeling

3-D Hydrodynamic and Sediment Transport Modeling in the San Francisco Estuary using the UnTRIM Bay-Delta Model **– Michael MacWilliams and Aaron Bever (Delta Modeling Associates, Inc.)**

The UnTRIM Bay-Delta model is a three-dimensional hydrodynamic and salinity model of San Francisco Bay and the Sacramento-San Joaquin Delta, which extends from the Pacific Ocean through the entire Sacramento-San Joaquin Delta. The UnTRIM Bay-Delta model has been used in studies of San Francisco Bay and the Sacramento-San Joaquin Delta for California DWR, USBR, USGS, and the US Army Corps of Engineers. The model calibration and validation conducted as part of these studies demonstrate that the UnTRIM Bay-Delta model is accurately predicting flow, stage, and salinity in San Francisco Bay and the Sacramento-San Joaquin Delta under a wide range of hydrologic conditions.

The three-dimensional UnTRIM San Francisco Bay-Delta Model was coupled with the Simulating WAves Nearshore (SWAN) wave model and the SediMorph morphological model, to develop a three-dimensional (3D) hydrodynamic, wind wave, and sediment transport model of San Francisco Bay and the Sacramento-San Joaquin Delta. This coupled 3-D hydrodynamic, wind wave and sediment transport model has been calibrated using available wind wave and suspended sediment data in Suisun Bay and San Pablo Bay.

This presentation will give an overview of some of the recent applications of the UnTRIM Bay-Delta model, which include simulation of sediment transport in San Francisco Bay and some recent high resolution model applications in South San Francisco Bay.

Progress Towards a 3D Bay-Delta Model Using SELFE **– Eli Ateljevich (DWR)** **6.5 MB**

This talk is an overview of the ongoing DWR application of SELFE to the Bay-Delta. The talk will describe the SELFE formulation and modeling suite, including similarities and differences with other models and particularly on geometry. We will include some of our assumptions including treatment of key boundaries and preliminary results from a validation simulation we did characterizing X2 movement in 2010-2011 on a domain extending to Rio Vista. We will also cover progress on hydraulic structures, geometry, and progress towards the full Delta domain. We will add some qualitative comparisons with REALM and describe the intersection between the two projects. Finally the talk closes with some comments on the architecture and the challenges of community implementation.

Simulating Mobile Community Ecosystem Dynamics in EFM Sim **7.4 MB**
Stephen Andrews (RMA), John DeGeorge (RMA), and John Hickey (U.S. Army Corps of Engineers)

EFM Sim is a generic software tool designed to simulate the spatial and temporal evolution of riverine and wetland ecosystems. Users develop simulations by inputting study area boundaries and spatially distributed physical data such as DEMs, soil maps, or water elevation maps, and defining vegetation and animal communities of interest. The population sizes and two-dimensional spatial distributions of the communities are simulated using the software, and evolve in response to the input physical data and sets of user-defined rules. Rules may be specified for vegetation communities in order to parameterize growth, recruitment, response to environmental stressors, spatial spreading, and succession. Mobile animal communities grow and move across the study area in response to rules specifying instinctual, foraging, and flocking/schooling (density-driven) behavior. Embedded mapping and animation tools in the software provide quick visualization of results, facilitating their analysis. We present a general introduction to the software tool followed by an example application for a mobile community in the Sacramento-San Joaquin Delta.

Session 11. Reservoir Reoperation, Hydrodynamics, and Economics, Oh My

Reservoir Reoperation of the Delta Tributaries: The Mokelumne River Case **3.3 MB**
Nathan Burley and Jay R. Lund (UC Davis)

Reservoir operations play a key role in determining Delta water quality and flows. This talk presents reservoir modeling on the Mokelumne River - a direct tributary to the Delta, that explores operational changes to flood control rules in an effort to produce more environmentally beneficial flows. These environmental flows are likely to have more benefits in the Mokelumne River itself, however water quality benefits and food web production will likely be exported to the Delta. Other results regarding water supply, hydropower and flood control impacts of reservoir reoperation will also be presented.

Folsom Dam Reoperations with Climate Information – Trade-offs for Flood and Water Supply **– Jay Lund and Katherine Maher (UC Davis)** **0.6 MB**

RES-SIM modeling is used to explore the value of climate information for the operation of Folsom Dam for managing floods and water supply. Flood and water supply performance trade-off curves are developed for 170 different flood operating rules utilizing various forms of ENSO, precipitation, and snowpack information.

Historical Delta Hydrodynamics – **Laura Doyle and William Fleenor (UC Davis)** **3.2 MB**

Two dimensional hydrodynamic modeling is used to explore the evolution of hydrodynamics and salinity in the Delta. Results are discussed in terms of the relative effects of changes in geometry, changes in inflows, and changes in in-Delta diversions.

Transitions in the Delta Economy – **Josué Medellín-Azuara (UC Davis), Ellen Hanak (PPIC), Richard E. Howitt (UC Davis), Jay R. Lund (UC Davis)** **1.4 MB**

The Sacramento San Joaquin Delta provides habitat for fish and a physical venue for transporting water across the states. Since its development in the late 1800s the Delta has also supported mostly agricultural production, commercial, and recreation as population in some places in the Delta grows. The Delta and its fragile environment are threatened by the catastrophic damage that could be caused by a major earthquake over its fragile levees. This would impair water exports south of the state with significant economic losses. In this paper we analyze the region-wide economic impacts of permanently flooded islands, increased salinity and larger habitat designated areas in the Delta. The magnitude of the impacts from flooded islands and habitat may be significant yet small in comparison to the size of the Delta economy as a whole. Changes in salinity due to a dual conveyance facility for exporting water or to sea level rise are more likely to affect areas in which no high value crops are currently grown. Therefore, impact from decreased yields and thus revenues under those conditions is insignificant. Finally, increasing recreation may partially overcome the economic impacts of permanently flooded areas and habitat. Planning priorities in anticipation for the Delta changing landscape are discussed.

Adaptive Management – What Could it Possibly Mean? - **Jay Lund (UC Davis)** **0.1 MB**

Various institutional structures are explored for adaptive management and compared with the functional characteristics likely to be needed for effective adaptive management of the Delta.

Session 12. DSM2 Applications and Development – Part 2

Modeling for Litigation – **Jamie Anderson (DWR)** **2.1 MB**

Creating modeling studies, analyzing the results, and presenting the study findings take on a different flavor when they are being done to support litigation. DWR's Delta Modeling Section has been conducting studies with the Delta Simulation Model 2 to support the State in some Delta related litigation. Unique challenges and insights gained from working on the Jones Tract levee failure case will be discussed.

Effects of SWP and CVP Exports on Stage and Circulation in the South Delta **7.7 MB**
Ming-Yen Tu (DWR)

The State Water Resources Control Board (SWRCB) is in the process of reviewing and updating the 2006 Bay-Delta Plan. The review may result in the potential amendments to the South Delta salinity objectives in the Bay-Delta Plan. Under the review process, SWRCB states that poor water circulation (null or stagnant zones) contributes to bad water quality in the South Delta, and that the SWP and CVP are responsible for improving the water circulation conditions while raising water levels so that the farmers are able to divert water. The purpose of this study is to conduct a DSM2 analysis to analyze whether and to what extent SWP and CVP exports, and the agricultural temporary barriers, actually influence the null zones and water circulation in South Delta. Based on one definition of a null zone, (little to no movement of water over a day), the preliminary modeling results show that null zones happen under both with- and without-exports conditions. Compared with the without-exports condition, the timing and locations of null zones shift under the with-exports condition, and the differences appear small in terms of the frequency of null zone occurrence in a 21-year simulation. The stage results show that the stages are lower under with-exports conditions, and the agricultural temporary barriers do help improve the stage for farming purposes.

Modeling Delta Flow-Turbidity Relationships with Artificial Neural Networks **3.6 MB**
Paul Hutton (MWDSC)

The 2008 USFWS biological opinion triggers CVP-SWP export curtailments based on Delta turbidity conditions for protection of the adult delta smelt life stage. An Artificial Neural Network (ANN) has been developed to faithfully mimic the flow-turbidity relationships as modeled in DSM2, the purpose of which is to provide a rapid transformation of this information into a form usable for operations planning as well as for long-term planning through the CalSim model. Preliminary findings and recommendations for future work are presented.

DSM2-PTM Simulations in Support of National Marine Fishery Service's study on Particle Movement in the Sacramento-San Joaquin Delta **– Joey Zhou (DWR)** **5.2 MB**

In the late summer of 2011, the National Marine Fisheries Service's (NMFS) requested the Department of Water Resources Bay-Delta Office (DWR-BDO) Delta Modeling Section staff to conduct a set of Delta Simulation Model II – Particle Tracking Modeling (DSM2-PTM) simulations to aid in improving the outmigration success of threatened California Central Valley steelhead in the Sacramento- San Joaquin Delta. Although the study wasn't originally developed for the 2012 joint stipulation between NMFS, DWR, and USBR, the results were used to gain a larger understanding of flows and particle movements in various areas of the Delta as operation triggers for April and May of 2012 were being developed.

This study investigates the effects of San Joaquin River flow, exports, and Head of Old River Barrier (HORB) on particle movement in the Delta. The assumed flow and operations for the scenarios are synthetic but based on Delta historical hydrodynamic record and facilities operations. The study contained may different combinations of hydrologies including combinations of Vernalis flows and Old and Middle River flows and combinations of Vernalis flows and import export ratios as defined by the Salmon Biological Opinion. Results included tracking the particles' fates at Delta boundaries and movement into junctions along the San Joaquin River.

Session 13. IWFM & IDC 2011 Enhancements and Applications

Public Release of the California Central Valley Groundwater-Surface Water Simulation Model C2VSIM (Coarse Grid) **– Charles Brush (DWR)** **1.8 MB**

The Department of Water Resources is preparing the public release of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim). The historical run of C2VSim model simulates water movement through the Central Valley's land surface, surface water and groundwater flow systems from October 1921 through September 2009 using a monthly time step. The coarse grid version of C2VSim was developed using DWR's Integrated Water Flow Model (IWFM) application (v.3). In the final phase of model calibration, parameter values were calibrated for each model node and element. In the past year, input data were developed for water years 2004-2009 and new surface water inflow and diversion data were compiled for the entire simulation time period. Model documentation, including a user manual, are currently being prepared and reviewed. C2VSim provides numerous water budgets including robust estimates of ungaged water resources variables such as groundwater pumping rates, changes in groundwater storage, and flow rates between groundwater and rivers, and how these have evolved since the 1920's. The model can also be used for both understanding the historical evolution of water resources in the Central Valley of California, and in planning studies including, for example, studying the response of the hydrologic system to extended droughts, and estimating the impacts of groundwater substitution water transfer programs. Preliminary results will be presented.

California Central Valley Simulation Model (C2VSIM) Enhancement: Phase I – Spatial Refinement - Ali Taghavi (RMC), Tariq Kadir (DWR), Reza Namvar (RMC), Mesut Cayar (RMC), Charlie Brush (DWR), and Emin Dogrul (DWR)

12.7 MB

The California Central Valley Groundwater Surface Water Simulation Model (C2VSIM) has been developed by the California Department of Water Resources (DWR), and simulates the surface water and groundwater hydrologic conditions in the Central Valley, CA. The current C2VSIM grid has a finite element grid with 1393 nodes and 1392 elements, and an average element size of six square miles. The current model has successfully been applied to numerous water resources and hydrologic studies over the course of past two decades.

However, much of the scientific, regulatory, and water management studies, as well as other potential applications such as CALSIM integration, Water Portfolio analysis for the California Water Plan updates, and other regional and Central Valley wide hydrologic analysis require a model with more refined spatial and temporal resolution. Therefore, an enhanced C2VSIM is being developed to meet these emerging needs. The enhancement is conducted in several phases; Phase I, spatial refinement; and Phase II, refinement and enhancement of spatial and temporal source data.

The enhanced C2VSIM grid contains 30,179 nodes and 32,537 elements, with an average element area of 0.6 square miles. The criteria used for refinement of C2VSIM grid includes, but is not limited to a node spacing of 0.5 miles along the water courses, such as streams, rivers and unlined canals; a node spacing of 1.5 miles at the model boundaries; alignment of model grid with water management regions such as Depletion Study Areas (DSA), and Detailed Analysis Units (DAU); as well as consideration to geologic and hydrologic features in the Central Valley.

Under the Phase I, all spatial data and temporal data for the period 1922-2004 are converted over from the original C2VSIM to the refined grid. The refined model is evaluated for quality of simulation and a verification of calibration results is also conducted. The refined model will be updated for hydrologic period through 2009, documentation will be prepared, and the model will be available to users for potential regional applications.

Applying IDC to the Sacramento Valley in Support of the Regional Groundwater Model SacFEM – Lee Bergfeld and Patrick Ho (MBK Engineers)

1.6 MB

The IWFM Demand Calculator, IDC, was used to simulate daily root-zone processes to develop time-series of deep percolation and groundwater pumping as coupled, paired-data input for SacFEM. SacFEM is a finite-element groundwater model of the Sacramento River Valley originally developed in 2008. This more recent work updated the root-zone water budget using the latest updates to the IDC model. In addition, detailed water budget data for certain flow terms for a large irrigation district in the Colusa Basin were used to calibrate the IDC model. The capability to simulate ponded crops in the IDC model was used to simulate rice crops. IDC output was combined with GIS data and processed with scripting tools to generate the paired time-series of deep percolation and groundwater pumping. Deep percolation and groundwater pumping were calculated as a function of the land-use and available surface water to meet agricultural demands for applied water for over 120,000 SacFEM model elements.

Yolo County Integrated Hydrologic Model: Experiences with IWFM v4.0 Can Dogrul (DWR)

1 MB

To test its capabilities IWFM v4.0 was applied to Yolo County. The finite element grid and most of the input data for the Yolo County IWFM model was obtained from an older IGSM model for Yolo County whereas the parameters for the root zone module were mostly developed from scratch. This presentation will point out experiences gained during the model development and calibration process, the support tools developed to help the users, the level of effort necessary to develop an IWFMv4.0 model, and the benefits of using IWFM v4.0. Future directions in engine development and possible linkage methods to CalSim will also be discussed.

Session 14. Turbidity, Delta Smelt, and Suspended Sediment

Effects of Turbidity and Hydrodynamics on Distributions of Delta Smelt **3.8 MB**
Pete Smith (USGS, retired)

Turbidity and hydrodynamics (flows and salinity) can have a significant effect on the observed horizontal distributions of adult delta smelt in the Sacramento-San Joaquin Delta. Delta smelt have an apparent affinity for a turbid environment that is indicated by their catch numbers increasing significantly in fish sampling surveys during fall and winter when turbidity increases above 12-15 NTU (Nephelometric Turbidity Units). Turbidity in the Delta is affected most by suspended sediment. Levels of turbidity often fluctuate significantly during winter, and sometimes fall, with natural inflow events carry large sediment loads into the Delta and transport and distribute that sediment load throughout the Delta based on interior hydrodynamics. Understanding the nature of turbidity patterns in the Delta is helpful for management of delta smelt, especially with regard to reducing entrainment mortality of adults at the state and federal export facilities in the south Delta

In this presentation I will use measured data for turbidity and delta smelt catch distributions, delta flows, sediment loads, and delta smelt salvage sampling at the water export fish facilities to help explain the effects of turbidity and hydrodynamics on delta smelt distributions. The emphasis will be on analyses of data from the earlier, less-studied portion of the historic record before the pelagic organism decline.

Identification of Factors Affecting Survival and Abundance of Delta Smelt (Hypomesus transpacificus) Using a Different Analytical Framework, the "Effects Hierarchy" **3 MB**
BJ Miller (SLDMWA)

The delta smelt is a small fish listed under state and federal Endangered Species acts. Its abundance declined sharply beginning in 2000, falling to and remaining at record low levels in 2002 until a still-unexplained increase in abundance in 2011. The causes of the sharp decline have received much attention; one of the hypothesized causes is entrainment at state and federal water export pumps in the southern Sacramento-San Joaquin Delta. Measures to reduce entrainment have resulted in reduced deliveries of water to areas south of the Delta.

This study presents results of a three-plus decade, retrospective analysis of factors affecting the survival and abundance of delta smelt, especially factors responsible for the sharp decline in abundance in this century. Two aspects of the study are covered, the development and use of an analytical framework, the "effects hierarchy," and results of a multiple regression analysis based on that framework.

This analysis identified density dependence and prey density as factors with important effects on abundance and also found effects of predation and water temperature.

Sediment Transport Dynamics in the Sacramento-San Joaquin Delta **9.4 MB**
Scott Wright, Dave Schoellhamer, and Tara Morgan (USGS)

Declines in the populations of several species of pelagic fishes in the Sacramento-San Joaquin Delta and San Francisco Estuary — delta smelt, longfin smelt, striped bass, and threadfin shad — have led to new studies and research on the biology and ecology of all four species. High turbidity has been described as an important feature of delta smelt habitat in several recent studies. While further research and studies are needed to more precisely define the relationships between turbidity, habitat, and smelt movement, it is desirable to develop predictive tools for suspended sediment (and turbidity) so that management actions that attempt to improve smelt habitat through manipulation of the turbidity field can be evaluated. To support the development of such numerical models, the USGS initiated a field study in 2010 of sediment transport dynamics in the Delta. The study has several components aimed at providing boundary conditions, calibration data, and empirical parameters for numerical models. Turbidity and suspended-sediment concentration and flux are being measured at Delta boundaries and interior sites, allowing for the development of sediment budgets for various Delta regions. Bed sediment particles sizes are being monitored seasonally throughout the Delta to document large scale regions of erosion and deposition during the wet and dry seasons. Suspended-sediment particle sizes, settling velocities, turbulence, bed roughness, erosion rates, and near-bed sediment fluxes are being measured at multiple sites on a rotating basis, in order to better understand fundamental physical processes as fine spatial scales. These integrated datasets provide an excellent foundation for understanding sediment transport processes and informing numerical models of the Delta, across a broad range of time and space scales. Initial findings from the study will be presented.

Web Based Data Visualizations for Real Time Sensor Networks and Forecast Data **4.8 MB**
David Osti (34 North)

It feels like we are all suffering from information overload. Data is collected and stored at different locations and in different formats by different organizations. How can we sift through all this data in a timely manner? How can we organize all this data to make sense of it all? I think there is an easy solution...use our eyes more.

We visualize information to see patterns and connections to things that matter and then design that information so that it makes more sense or it tells a story or allows us only to focus on the information that is important. Also, visualizing information can look really cool.

34 North, the creator of the web based open source software project OpenNRM, builds tools that bring together separate datasets to better visualize real time conditions in our environment and incorporates prediction models to show what might happen in the future. In the case of turbidity in the Sacramento Delta, we generate spatial contour maps of point time series data based on linear interpolation over a modeled geometry using cutting edge web 2.0 technologies. This visualization is available 24/7 on www.baydeltalive.com.

Session 15. Modeling Needs and Challenges

Water Temperature Modeling Needs and Challenges **0.2 MB**
Mike Deas (Watercourse Engineering)

Water temperature modeling has a long history in computational water quality assessments, with the initial river and reservoir models appearing coincident with the advent of the business (and now personal) computer. Simplifications of the governing equations of flow and heat exchange have largely given way to solution of the full form of the hydrodynamic and advection diffusion equation. Still, new demands on necessary or desired analyses continue to challenge simulation modelers.

This presentation will discuss some of the needs or requirements of current temperature simulations for aquatic systems. Several of these needs remain unchanged from the past: data limitations for geometric specification, boundary conditions, calibration data, and other factors. However, specification of future conditions currently presents interesting challenges for modelers. For example specifying climate change boundary conditions and testing for model robustness under an “untested” hydrologic and meteorological regime. Other examples include developing representative simulations for large system changes, such as dam removal. Finally, there is a trend towards long-duration analyses, where, even though computational speed has increased remarkably in the last few decades, simulation times are still undesirable. Examples of needs and challenges, and how some have addressed these issues will be presented in this talk.

Needs and Challenges of Modeling Mercury in the Delta **2.2 MB**
Stephen McCord (McCord Environmental)

Hydraulic mining activities in the late 1800’s and early 1900’s left behind 10 million pounds of mercury. Mercury-laden sediments are now scattered throughout the Delta and its watershed. While this formidable diffuse source of pollution is predominantly insoluble and non-toxic, biochemical processes in waterways (especially wetlands) produce methylmercury, a highly bioaccumulative neurotoxin. Methylating conditions and their controls are the focus of current studies.

A watershed mercury model is needed for the Delta to track inorganic mercury from sources to methylating environments, and then methylmercury from those environments into food webs. These critical processes operate at time scales ranging from diurnal (such as photodemethylation and tidal exchange) to seasonal (such as reservoir stratification) to decadal (such as sediment transport from Sierra Nevada mine sites to the Delta), and respond to physical, chemical, and biological drivers. Modeling strategies for addressing public health and environmental concerns will need to consider these broad ranges of factors, time scales, and space scales. Such challenges can be addressed through focused monitoring and study.

This presentation will describe the current knowledge gained from monitoring and field studies, summarize current regulations driving actions to address mercury contamination, and propose a modeling framework to focus future efforts.

A New Validation Strategy to Climate Change Impact Study Approaches **- Jianzhong Wang, Hongbing Yin and Francis Chung (DWR)**

This presentation will review features of various approaches adopted in recent climate change impact studies in California Department of Water Resources, including scenario based vs. ensemble based approaches, and direct use vs. indirect use approaches. The use of different evaluation approaches introduces a new layer of uncertainty in the climate change impact study on water resource management.

To help reduce this layer of uncertainty, a brand new validation strategy, based on historical simulations of climate change impacts on water resources management in CVP/SWP in the period of 1980 to 2009 by different approaches, is introduced to tell how close simulated impacts from each climate change impact approach are to real climate change impacts occurring in this period.

Session 17. Poster Session

Use of Two Dimensional Hydraulic and Sediment Transport Modeling in Design of Salmonid Rearing Habitat in the Sacramento River Floodplain **1.5 MB**
Paul Frank and Mark Tompkins (Newfields Ecosystem Science, Engineering, and Design)

Impacts associated with construction of a pump station to replace the Red Bluff Diversion Dam on the Sacramento River will be mitigated through construction of a three-quarter mile long, 23 acre perennial, off-channel open water and riparian wetland habitat in East Sand Slough, an off-channel area immediately adjacent to the Sacramento River. Since the 1960s, East Sand Slough has been inundated annually by backwater from Red Bluff Diversion Dam. The new off-channel habitat area will be connected to the main stem Sacramento River at low flow in three locations. The design for the habitat contains open water, riverine wetlands, and riparian shrub scrub environments intended to support habitat for rearing fish and establish native vegetation communities adapted to the site conditions. The design analyses required an understanding of the complex hydraulic and sediment flow patterns at both these connection sites and in the newly constructed channel to understand habitat conditions and avoid maintenance problems due to erosion or sedimentation that could threaten the long-term viability of the constructed habitat. We used the hydrodynamic and sediment transport modules of the Bureau of Reclamation's SRH2D model to simulate a range of flow events in the proposed design configuration. We were able to validate the hydraulic and sediment transport predictions of the model by comparing existing conditions model results with sediment transport data collected during an approximately 5-year flow event, which occurred on Sacramento River towards the end of the design process (approximately 95,000 cfs in March 2011).

Development of a Modeling Framework for Assessing Flood Management Performance and Floodplain Habitat Creation in the South Delta 1 MB

Paul Frank, Mark Tompkins, and Jeremy Thomas (Newfields Ecosystem Science, Engineering, and Design)

River-floodplain connectivity is increasingly being recognized as critically important for the survival of native fish species in the San Francisco Bay Delta and for reducing flood risk throughout the Bay-Delta and Central Valley systems. Levee setbacks, bypasses, and off-stream flood storage and attenuation are often proposed as actions that would expand the floodplain habitat and reduce downstream flood risk. However, the complex network of channels, islands, bridges, and other infrastructure in the Delta makes it difficult to quantitatively assess the improvements proposed actions would actually make.

We present a modeling framework developed with publicly available tools from the USACE Hydraulic Engineering Center (HEC) that is currently being used by multiple stakeholders to simultaneously and quantitatively evaluate the flood attenuation and ecosystem restoration benefit of levee setbacks and bypass channels in the South Delta. Unlike most previous studies, these efforts assign equal weight to flood and ecosystem benefits. Results of these modeling efforts have shown significant improvements in both floodplain habitat and flood management performance in the South Delta, and are informing ongoing planning efforts in the Delta including the Bay Delta Conservation Plan (BDCP).

Using Nitrate Stable Isotopes to Identify Dominant Nitrate Sources and Processes Impacting Groundwater and Surface Water in the Central Valley, California

Megan Young (USGS), Thomas Harter (UC Davis), Carol Kendall (USGS), and William Stringfellow (University of the Pacific)

The dual stable isotopic composition of nitrate ($\delta^{15}N$ and $\delta^{18}O$-NO_3) can be used to identify dominant sources and processes controlling the distribution of nitrate in groundwater and surface water systems. Elevated nitrate concentrations are found in many drinking water wells throughout the Central Valley, California, and rivers in this area also receive nutrients from various anthropogenic sources. Nitrate derived from animal and human waste tends to have distinctly higher $\delta^{15}N$-NO_3 values in comparison to nitrate derived from synthetic fertilizers, providing a way to distinguish between dominant nitrate sources in a water sample if biological processes have not significantly altered the nitrate concentration. Since biological processes cause predictable shifts in both the $\delta^{15}N$ and $\delta^{18}O$ of the nitrate, coupled to decreases in nitrate concentrations, water samples collected across spatial and/or temporal gradients can be used to determine if source signals or biological processing is the dominant control on nitrate concentrations within a given area.

We have conducted extensive nitrate isotope sampling in locations throughout the Central Valley, including first-encounter groundwater directly beneath dairies, 200 domestic drinking water wells, and surface waters of the San Joaquin River and tributaries in order to better understand the sources and processes controlling nitrate concentrations. By using a combined isotopic and geochemical approach, the impact of manure-derived nitrate could be clearly seen in the first-encounter groundwater beneath dairies. However, nitrate isotopes indicated that although manure-derived nitrate appeared to be present in some of the domestic drinking water wells, the dominant source of nitrate to the majority of the drinking water wells was synthetic fertilizer. In the surface waters of the San Joaquin River and tributaries, nitrate isotope compositions and concentrations varied significantly with season, flow, and location, reflecting the influences of changing biological processes, water sources, and surrounding land use.

Correctly identifying nutrient sources to groundwater and surface water is critical to making effective water management decisions. Nitrate isotopes provide information about sources and biological processes controlling dissolved nitrate concentrations, and therefore can be used to identify critical contamination sources to surface and groundwater and to test nitrate distribution models.

CALVIN Groundwater Update **– Heidi Chou, Prudentia Zinkalala, Christina Buck, Jay R. Lund, Josué Medellín-Azuara (UC Davis)** **2.2 MB** **Link to Poster**

Updates are being made to the CALVIN hydro-economic optimization model of California's intertied water supply and delivery system. These updates better reflect water demands, groundwater availability, and local water management opportunities. This poster will focus on updates to groundwater in CALVIN, which includes changing CALVIN groundwater parameters based on California Department of Water Resources' (DWR) California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the United States Geological Survey (USGS) Central Valley Hydrologic Model (CVHM) model inputs and results. Two projects, using the respective groundwater models by DWR or USGS model as a base, are underway to update CALVIN's groundwater representation, specifically basin inflows, reuse, return flows, capacities, and costs. When these sub-projects are completed and analyzed, a CALVIN model with updated groundwater representation based on C2VSIM and CVHM will emerge. For this poster, a preliminary comparison of these sub-projects and a summary comparison between the DWR and USGS models will be presented and discussed.

Enhancement of the Sacramento-San Joaquin Delta Island Consumptive Use Estimates and Water Quality Redetections **– Lucas Siegfried and William E. Fleenor (UC Davis)**

A collaborative, integrated approach was used to predict better Delta Island Internal Use of water (DICU) values and water quality variables, predicting both quantity and quality on a higher resolution time step and basing both diversion and return locations on topography rather than simple geographical approximation. The delta island known as the Fabian Tract was selected for this study based on available data and island accessibility. A combination of historical diversion and return location data, water rights claims, and LIDAR digital elevation model data were used to predict where diversion and return locations are located on the Fabian Tract. The accuracy of the predicted diversion and return locations was analyzed through ground-truthing. To calculate water requirements and runoff returns from agricultural land-use, incorporating soil and land-use characteristics as well as weather data, the IWFM Demand Calculator (IDC) was selected based on model capabilities, ease of use, applicability, and recommendations. For the IDC model, the Fabian Tract was manually divided into subregions, representing fields, levees, ditches, and roads, through the use of ArcGIS. SMS 10.0 was used to generate a grid, representing the Fabian Tract and the developed subregions, to be used in the IDC model. Using ArcGIS, the subregions were joined to form diversion and return watersheds representing the total area supplied by a given water source or the total drainage area for a given return. The IDC model was run for both wet and dry year conditions. The results of each IDC model simulation were joined to the ground-truthed diversion and return subareas in ArcGIS to allocate diversion and return water sources on the Fabian Tract. The IDC model results were then compared to the current DICU estimates used in the DSM2 model and a sensitivity analysis of the IDC model was performed.

Towards a Systems Analysis of Yolo Bypass Uses and Opportunities
Robyn Suddeth (UC Davis)

Progress towards a systems model integrating agricultural, wildlife, fish, and flood uses of the Yolo Bypass will be presented.

San Joaquin River Restoration Daily Flow Model **– Todd Vandegrift (USBR, TSC)**
Link to Poster

A daily operations model for the San Joaquin River Restoration Program was developed in RiverWare, a versatile hydrologic modeling software package. The model simulates hydrology along the San Joaquin restoration reaches from Millerton Lake to the Merced River, and along the Chowchilla and Eastside Bypasses. Daily Friant Dam operations are modeled as well as downstream routing, losses, and operations (bifurcations, diversions, etc.). Daily inflows are identical to those used in the Daily Disaggregation Tool and match CalSim II. Monthly diversions and some downstream inflows are taken from CalSim II results, with monthly to daily flow patterning applied where appropriate. Daily Friant releases are modeled independently from CalSim II, including restoration release flow schedules and flood control. The model has the ability to schedule restoration releases in differing patterns, following the constraints defined in the Settlement. The model simulates the operational challenges associated with forecast error and its effects on restoration allocations and scheduling, and flood control operations. The model results include Millerton parameters such as storage, pool elevation, and releases, and downstream river flows on a daily timescale. Currently, results are being used in the Reach 2B and Reach 4B site specific studies, and the CVHM groundwater modeling studies.

2D Hydrodynamic Modeling in the Yolo Bypass to Support Habitat Evaluation 1.6 MB
Chris Campbell, April Sawyer, and Chris Bowles (cbec, inc.)

The Yolo Bypass is a major seasonal floodplain in the Central Valley and the Delta that provides rearing habitat and serves as a migratory pathway for juvenile Chinook salmon and splittail. In support of the Central Valley Flood Protection Plan (CVFPP) Restoration Opportunity Assessment (ROA), two-dimensional (2D) hydrodynamic modeling was performed using MIKE 21 FM to predict seasonal inundation patterns in the Yolo Bypass under a range of flows to understand habitat conditions for juvenile Chinook salmon and splittail. Prior habitat use studies in the Yolo Bypass (e.g., Sommer et. al., 2005) have shown the importance of sustained inundation in the Yolo Bypass, resulting in increased fish residence time. However, the hydrology of the Yolo Bypass is complex with inundation possible from multiple sources with varying degrees of alteration and timing. As such, the aim of this analysis is to investigate habitat evaluation criteria in the Yolo Bypass under a range of flow conditions and in years when spatial and temporal trends in juvenile Chinook salmon use were monitored. Historical hydrology for two high performing years and two low performing years for juvenile Chinook salmon and splittail were simulated and used to test and/or improve existing habitat evaluation criteria and identify differences in high and low performing years.

Fisheries enhancement in the Yolo Bypass is a key component of the BDCP with the goal to improve passage, reduce stranding, and increase floodplain rearing and spawning habitat while maintaining flood control and agricultural functions. Through better understanding of baseline conditions, this study will help inform fisheries enhancement measures.

Adventures in Multibeam Bathymetry in the Sacramento-San Joaquin Delta 1.3 MB
Shawn Mayr, Scott Flory, and Wyatt Pearsall (DWR)

The underwater world of the Delta is becoming less and less mysterious all the time. New technology is being applied by DWR scientists to map river beds in detail. Underwater sand dunes, scour holes, sunken ships, and all kinds of interesting features are coming into the light. Data sets that are available include areas in Middle River, Lower Mokelumne, Miner Slough, the Sacramento Deep Water Ship Channel, and other key locations of interest in the Delta.

Bathymetric information is a basic building block for many different environmental, fisheries, hydrodynamic, sediment, geological, and engineering studies and aids project implementation. Hydrodynamic modelers, biologist, engineers, geologists, construction inspectors, reclamation districts, and ecological scientists depend on detailed, up-to-date bathymetric information.

Changes in Flows and Water Levels in Delta due to Climate Change
Phillip Mineart (URS)

A relatively simple method to estimate the frequency of occurrence of water levels in the Delta under future climatic condition is presented. Downscaled stream flow data in the major streams that flow to the Delta based on the results from several climate models were analyzed for recurrence interval. Frequency distributions for each of the synthetic records were developed in 50-year segments: 1975 to 2025, 2026 to 2075, and 2051 to 2100. Water levels in the Delta were estimated from derived relationships between the tributary inflows to the Delta and San Francisco Bay tide levels. The stage/ inflow relationships were then used to generate a long period of record for water levels in the Delta that was both stationary (constant mean and variance over time) and representative of the same climatic conditions. The relationship was verified with a comparison to the frequency curve for Venice Island derived from long-term measured data. Using the relationships, a monte carlo analysis was used to generate future water levels in the Delta for the different climate change scenarios with sea level rise (SLR) values of 16 inches in 2050 and 55 inches in 2100. Uncertainty (or errors) in the inputs and derived relationships were included in the monte carlo analysis. These future projections of water levels were then statistically analyzed to develop recurrence intervals including uncertainty for years 2050 and 2075. A comparison between the existing conditions and projected 2050 and 2075 conditions provide an estimate of the increase in water level that can be expected in the future due to climate change and SLR.

SLR and climate change may have a dramatic impact on the future of the Delta. It is important for future planning that these effects be taken into account. The study described above provides a relatively simple method for estimating the future conditions in the Delta that includes uncertainty.

Suspended Sediment Predictions in California **- George Nichol** **7.5 MB**

A proposed method of predicting the suspended sediment concentrations in the streams and rivers of California's 12 Level III Ecoregions is presented. Existing USGS data sets of flow and suspended sediment concentrations, along with Rapid Geomorphic Assessments, would be used to determine the sediment loads coming from stable and unstable watersheds. This method gives the suspended sediment concentrations coming off of a watershed into a stream. A geomorphic model would then be used to generate the sediment load generated within the stream channel itself, and this load added to that coming from the watershed. A stream hydrodynamic/sediment transport model would then be used to transport this combined suspended sediment load downstream and give the suspended sediment concentration predictions.

The Effect of Using Yearly-Changing Historical Land Use on DSM2 Simulation of Historical Delta Conditions **– Lan Liang (DWR)**

DWR's Delta Island Consumptive Use (DICU) model estimates Delta island agricultural diversions and return flows and assigns these flows and associated water quality concentrations to DWR Delta Simulation Model 2 (DSM2) nodes. DICU defines the Crop Evapotranspiration (ETc) as the total consumptive use in the agriculture fields. ETc is directly related to land use categories. The current use of the DICU model assumes one of two land use sets by water year type: critical and non-critical. Estimated historical yearly land use has been developed and implemented in the DICU model. Its influence on estimated Delta agriculture diversions and returns and DSM2-simulated Delta hydrodynamics and water quality are presented.

Statewide Water Analysis Network (SWAN) - **Rich Juricich (DWR)**

SWAN serves as the technical advisory group for the California Water Plan to assist DWR with applying collaborative methods to facilitate consensus in the development of existing and new analytical tools and technologies.

Water Sustainability Indicators Framework **- Rich Juricich (DWR)** **0.2 MB**

Describes a framework underdevelopment by DWR and its partners to help monitor the progress to meeting water sustainability objectives.

Integrated Water Management Economic Assessments - **Rich Juricich (DWR)**

DWR's Economic Analysis Section provides high quality, timely, cost-effective responses to DWR's internal economic analysis needs.

Water Planning Information Exchange - **Rich Juricich (DWR)**

A federated system for sharing water resources information, which allows data managers to maintain control of their data and serve it to the public through a central web portal.

California Statewide Data Program - **Rich Juricich (DWR)**

DWR's program for collecting several types of water resources data and making it available to the public.

Water Plan Update 2013 - Rich Juricich (DWR)

A summary of the major enhancements underway for Update 2013 of the California Water Plan.

Impact of Groundwater Banking and Extraction Program on Stream-Aquifer Interaction in North American GW Subbasin – Ali Taghavi (RMC), Robert Swartz (Sacramento Groundwater Authority), and Mesut Cayar (RMC)

The Sacramento Integrated Water Resources Model (SacIWRM) is an analytical tool that has been used in the Sacramento region since 1992. Recently updated in 2008, the model is used by water managers and decision makers in Sacramento County to evaluate the impacts and benefits of water resource projects on the groundwater system and on stream-aquifer interaction. For this study, the SacIWRM was utilized to estimate the change in stream-aquifer interaction along the American River, Sacramento River, and throughout the Sacramento Valley resulting from the extraction of banked groundwater in Northern Sacramento County.

To simulate the effects of the extraction of banked groundwater, a SacIWRM model scenario was developed where municipal groundwater production was increased above baseline levels by an additional 16,000 ac-ft for a single dry year. The change in stream-aquifer interaction due to extraction of banked groundwater was estimated by comparing the model scenario with the baseline model. Losses in stream flow to groundwater were considered both for the entire simulation period and only for the periods when the Sacramento Delta was in shortage conditions. To determine the sensitivity of the stream-aquifer interaction due to varying hydrology, three versions of the model scenario were developed with the extraction occurring in different years:

- extraction in 1976 (followed by a critically dry year, then average years),
- extraction in 1987 (followed by several dry years), and
- extraction in 1994 (followed by several wet years).

Simulation results show that there was an increase in stream flow loss to groundwater by 6% – 8% of the additional amount extracted (up to 1,350 ac-ft) for a 5-year period following the extraction of the banked groundwater. Stream flow losses varied by approximately 2% of the amount extracted depending on the hydrology of the subsequent years after extraction occurs. On average, 69% of the total stream flow loss occurred in the lower American River, 23% occurred in the Sacramento River, 3% occurred in other simulated streams and rivers, and an estimated 5% occurred in streams and rivers outside the model area.

Integrated Regional Water Management Tool: HydroDMS - Jeanna Long, Saquib Najmus, Ali Taghavi, Yamin Noor, and Mesut Cayar (RMC)

Integrated Regional Water Management (IRWM) is a collaborative process that crosses jurisdictional boundaries, involves multiple agencies, stakeholders, and groups and attempts to address the issues and different perspectives of all the entities involved through mutually beneficial solutions. The success of the IRWM depends on transparency of data sharing and analysis due to the intensive involvement of multiple stakeholders with multiple perspectives in the IRWM process. In order to facilitate the transparency needs, web-based tools have been recently developed to support the collaborative efforts to manage all aspects of water resources in a region. The Hydrologic Database Management System (HydroDMS) is a comprehensive web-based data management tool that stores water resources and hydrologic data in a relational database management system that may be analyzed and viewed in a map-based Google or ArcGIS interface. The HydroDMS is built upon a state-of-the art system architecture that combines the power of GIS with web technology. It provides a consistent, common database that streamlines reporting and compliance and fosters public outreach and education through a number of interfaces that are tailored to the public users, technical staff, and decision makers. While hiding the complexity of the database and system architecture, the system provides a suite of easy-to-use comprehensive tools that mimic the user's workflow process while they enter and validate water related data and perform complex analysis. It allows data storage, data sharing, data analysis, and reporting in a cost effective manner among all users and stakeholders. The HydroDMS can also store and display input and output of hydrologic models.

***State Water Project Chloride Modeling Analysis* – Sevim Onsoy (Kennedy/Jenks), Les Chau (Kennedy/Jenks), Matt Baillie (Kennedy/Jenks), Lynn Takaichi (Kennedy/Jenks), and Dirk Marks (Castaic Lake Water Agency)**

A spreadsheet-based mass balance model was developed to simulate flow and chloride concentration along the California Aqueduct from the Banks Pumping Plant in the Delta to the end of the West Branch at Castaic Lake. The primary objective of the modeling analysis is to forecast chloride concentrations at Castaic Lake resulting from projected SWP and contractor operations under the recent pumping constraints affecting the SWP operations. The modeling results are intended to assist the Santa Clarita Valley Sanitation District (SCVSD) develop a compliance solution to the Upper Santa Clara River chloride TMDL as about half the waste water treated by the SCVSD originates from the imported water conveyed through Castaic Lake. Of particular concern are the impacts on projected chloride levels at Castaic Lake corresponding to dry hydrologic conditions such as those from the 1987-1992 drought period.

The model domain from Banks Pumping Plant to Castaic Lake was divided into four systems - Delta, San Luis, San Joaquin, and West Branch - to account for monthly inflows and outflows along the California Aqueduct, including SWP and CVP deliveries, groundwater banking operations, and natural conditions. Inflow concentrations were based on available data and outflow concentrations were calculated by the model. A historical model was developed first and calibrated to measured historical records of 1990 to 2010, compiled from DWR and various other sources. The calibrated model was then used as the basis to forecast chloride concentrations in Castaic Lake, based on future projections of SWP/CVP water deliveries and reservoir operations (CalSim II model outputs used in the DWR's 2009 SWP Delivery Reliability Report) and projections of groundwater pump-ins.

Under the future hydrologic conditions similar to the 1987-1992 drought, the model forecasts chloride levels in Castaic Lake mostly from 60-70 mg/L, with the highest near 80 mg/L. The model forecast is lower than the historical range of 100 to 130 mg/L observed in Castaic Lake during the 1987-1992 drought period.

Session 18. San Joaquin River Restoration Program Modeling 1.6 MB

***Daily Friant and San Joaquin River Model (SJRRW)* – Todd Vandegrift (Reclamation)**

A daily operations model was developed in RiverWare, a versatile hydrologic modeling software package. The model simulates the hydrology along the San Joaquin River restoration reaches from Millerton Lake to the confluence with the Merced River, as well as along the Chowchilla and Eastside Bypasses. Daily Friant Dam operations and releases are modeled as well as downstream routing, losses, and operations (bifurcations, diversions, etc.). Daily inflows are identical to those used in the Daily Disaggregation Tool and match CalSim II. Monthly diversions and some downstream inflows are taken from CalSim II results, with monthly to daily flow patterning applied where appropriate. Daily Friant releases are modeled independently from CalSim II, including restoration release flow schedules and flood control, and therefore more realistic daily results are produced than the Daily Disaggregation Tool, which interpolates CalSim II monthly releases for a majority of its daily operations and thus doesn't capture the variability of daily operations. The model also simulates the operational challenges of forecast error and the effects that it would have on restoration allocations and flow scheduling, snowmelt flood control operations, and short term operations. The model results include Millerton Lake parameters such as storage, pool elevation, and releases, and downstream flows throughout the restoration reaches on a daily timescale.

***Groundwater Flow Model for Evaluation of Hydrologic Effects of the San Joaquin River Restoration* – Jonathan Traum and Steven Philips (USGS)** 4 MB

The USGS, in cooperation with the USBR, has developed a preliminary groundwater flow model (SJRRPGW) to help evaluate shallow groundwater issues for the San Joaquin River Restoration Program (SJRRP). The SJRRPGW was constructed using the USGS-MODFLOW2005 based Farm Process and is based on the framework of the USGS Central Valley Hydrologic Model (CVHM). In addition to groundwater flow, the SJRRPGW simulates the water supply and demand components of irrigated agriculture and simulates the surface-water flow and stream-aquifer interaction of the San Joaquin River. The aquifer sediment texture data used in the regional CVHM were refined to better represent the natural heterogeneity of aquifer-system materials at the scale of the SJRRPGW.

The SJRRPGW was calibrated for 1961 to 2003 using groundwater-level observations from 133 wells and streamflow observations from 19 gages. The simulated groundwater-level altitudes and trends (including seasonal fluctuations) and the simulated surface-water flow magnitudes and trends reasonably match measured data. The simulated San Joaquin River seepage-loss rates are generally consistent with rates estimated by previous studies. The preliminary calibrated model will be used to help understand the potential effects of restoration flows on agricultural drainage and the relative benefits of proposed SJRRP actions for reducing negative effects.

2D Habitat Modeling **– Daniel Dombroski, Blair Greimann, and Elaina Gordon (Reclamation)** **1.4 MB**

Quantitatively predicting potential habitat is critical in guiding the science, policy, and economics of river restoration projects. The characteristics of productive habitat for a given species are often well understood in a qualitative sense; however, using this conceptual framework to quantitatively assess habitat under varying hydraulic and geomorphic conditions often presents a greater challenge. We present methodology for predicting the areal extent, distribution, and quality of habitat within a river channel and surrounding floodplain. The approach is based on two-dimensional (2D) hydraulic modeling of the river system; knowledge of the local hydrology and habitat suitability criteria are used to complete the assessment.

We demonstrate the utility of the approach using case studies from the San Joaquin River Restoration Project where hydraulic modeling was performed in support of Salmon habitat assessment. The approach is general in concept, however, and can be applied to assess habitat for other species and flow environments. It is predicted that the approach will be useful in coordinating the efforts of engineers and biologists in informing policy and management decisions.

The Emigrating Salmonid Habitat Estimation (ESHE 1.0) Model: Estimating Habitat Area Requirements for Emigrating Central Valley Chinook Salmon **0.9 MB**
Joe Merz (Cramer Fish Sciences)

Cramer Fish Sciences developed the Emigrating Salmonid Habitat Estimation (ESHE 1.0) Model for estimating habitat area requirements for juvenile California Central Valley Chinook salmon (*Oncorhynchus tschawytscha*) (fry and smolts) as they emigrate from natal streams through the Sacramento-San Joaquin River system. The model is developed around the assumption that juvenile salmon carrying capacity of a given stream reach is a function of available area of suitable habitat and average fish territory size. ESHE models the rearing and emigration of individual daily cohorts of juvenile Chinook salmon, and tracks their average growth, territory size, and ultimately the amount of suitable habitat required to sustain the number of juvenile salmon present within a model reach, on a given day throughout the rearing and emigration period. The ESHE Model also allows user-modified inputs, and provides measures of uncertainty about estimates of required suitable habitat. The ESHE Model provides project managers a method to quantify and prioritize large-scale river system projects, in the context of restoring healthy salmon populations.

Session 19. Ecological and Water Quality Modeling

3-Dimensional Hydrodynamic, Sediment Transport, and Water Quality Model Framework to Support Resource Management Planning for the Sacramento San Joaquin Delta

Andrew Stoddard (Dynamic Solutions), Silong Lu (Dynamic Solutions), Paul Craig (Dynamic Solutions), Christopher Wallen (Dynamic Solutions), Zhijun Liu (Dynamic Solutions), William McAnally (Dynamic Solutions) and Eugene Maak (U.S. Army Corps of Engineers) **2.9 MB**

The California Delta is a critical natural resource for the region, the State of California, and the nation. The Delta, an integral part of the largest west coast estuary that connects freshwater streams from the Sacramento River and the San Joaquin River watersheds with the Pacific Ocean, is a unique estuarine resource that provides important ecosystem services to support water supply, recreation, fish and wildlife, tourism, aesthetics and the natural beauty of a rural environment. The restoration and maintenance of the ecological resources of the Delta and the availability of an abundant clean water supply to support agriculture and the people of the State of California are the two primary goals driving state, Federal and local planning efforts to attain sustainable resource management for the Delta. Surface water computer models are needed to meet these two goals to provide a scientifically credible framework to understand both the effectiveness and the consequences of natural events/conditions and resource management efforts to preserve the natural ecosystem while maximizing water quality, protecting water supplies and ensuring public safety for human inhabitants.

An advanced surface water computer model framework for the Delta has recently been developed by the U.S. Army Corps of Engineers, Sacramento District to represent the complex cause-effect interactions of upstream inputs from the Sacramento and San Joaquin Rivers, pollutant loading from wastewater facilities and agricultural canals, irrigation withdrawals and pumping stations and tidal forcing that interact to control hydrodynamic circulation, salinity, water temperature, sediment transport, organic carbon and nutrient cycles, dissolved oxygen, eutrophication and light attenuation. The model framework, based on the public domain Environmental Fluid Dynamics Code (EFDC), has achieved a unique pinnacle in surface water models developed for the Delta because the coupled hydrodynamic, sediment transport, water quality and sediment flux models are linked – for the first time ever -– with ecological models to describe the interaction of flows, salinity and water quality on fisheries and other critical ecological resources of the Delta. The 3-dimensional EFDC model domain, constructed with ~20,000 grid cells, extends over 1,300 square miles from Verona and the Yolo Bypass on the Sacramento River and Vernalis on the San Joaquin River through the Delta into Suisun Bay and Carquinez Strait.

An overview of key data sources and methods used to develop open water and flow boundary conditions will be presented. Model results will be presented to demonstrate calibration and validation of the model at key station locations within the Delta for tidal stage, flow, water temperature, salinity, suspended solids, organic carbon, nutrients, algal biomass and dissolved oxygen. The Delta EFDC model will provide the US Army Corps of Engineers and other Federal, state/local agencies and Stakeholders with an advanced model framework for evaluations of the consequences of natural events/conditions (e.g., floods, sea level rise) and the effectiveness of alternative resource management strategies that may be implemented to sustain the rich resources of the Delta.

Development, Calibration, and Application of a Lower Trophic Level Food Web Model for the Low Salinity Zone (LSZ) of the San Francisco Estuary **1.3 MB**

Shaye Sable (Dynamic Solutions), Kenneth Rose (Louisiana State University), Wim Kimmerer (SFSU), Steve Bartell (Cardno-Entrix), and Eugene Maak (U.S. Army Corps of Engineers)

A version of the comprehensive aquatic systems model (CASM) was developed, and coupled with the Environmental Fluid Dynamics Code (EFDC) model, to simulate daily growth processes and food web interactions over one year among lower trophic level (LTL) populations in the low salinity zone (LSZ) of the San Francisco Estuary. The LTL food web is comprised of two phytoplankton populations and nine consumer groups that include multiple populations of particle-feeding zooplankton, a predatory copepod, *Corbula* clams, mysids, and pelagic fish. Daily population growth is determined by bioenergetics-based equations, and EFDC-generated temperature, salinity, depth, and concentrations of nutrients, suspended sediments, and particulate organic matter (POC) differentially modify maximum photosynthesis and consumption of the populations. Daily predicted biomasses were calibrated to biomass data collected by the Interagency Ecological Program using an automated program called PEST. PEST adjusted bioenergetic parameters of the populations to best fit the predicted and the observed biomasses. The calibrated CASM was run in selected EFDC cells to evaluate food web responses due to the variation in the daily physical-chemical conditions. Suspended sediments and POC concentration varied within the EFDC cells and affected phytoplankton production via light regulation on photosynthesis. Changing phytoplankton production caused differences in consumer growth and shifted energy cycling within the food web. The CASM can evaluate the effects of water quality and restoration measures on production and distribution of the LTL populations, which can then be used to evaluate changes in food supply for important fish species (e.g., delta smelt) of the San Francisco Estuary.

Keno Reservoir Water Quality Modeling: CE-QUAL-W2 **4.5 MB**
Mike Deas (Watercourse Engineering), Annett Sullivan (USGS), I.E. Sogutlugil (Watercourse Engineering) and Stewart Rounds (USGS)

A hydrodynamic, water temperature, and water-quality model was constructed for a 20-mile reach of the Klamath River downstream of Upper Klamath Lake, from Link River to Keno Dam, for calendar years 2006-09. The two-dimensional, laterally averaged model CE-QUAL-W2 was used to simulate water velocity, ice cover, water temperature, specific conductance, dissolved and suspended solids, dissolved oxygen, total nitrogen, ammonia, nitrate, total phosphorus, orthophosphate, dissolved and particulate organic matter, and three algal groups. The Link-Keno model successfully simulated the most important spatial and temporal patterns in the measured data for this 4-year time period. The model calibration process provided critical insights into water-quality processes and the nature of those inputs and processes that drive water quality in this reach. The model was used not only to reproduce and better understand water-quality conditions that occurred in 2006-09, but also to test several load-reduction scenarios that have implications for future water-resources management in the river basin.

***Integrated Water Operations and Multi-species, Multi-performance Indicator Ecosystem Effects Analysis: The Ecological Flows Tool (EFT)* – Clint Alexander (ESSA Technologies Ltd.)**

As demonstrated in recent EIR/S applications for the North-of-the-Delta Offstream Storage Investigation and the Bay Delta Conservation Plan, the Ecological Flows Tool (EFT) clearly communicates the trade-offs for representative performance indicators of *multiple* focal species. EFT currently supports two eco-regions: (1) SacEFT (www.dfg.ca.gov/ERP/signature_sacriverecoflows.asp) for characterizing the ecological consequences of management-related changes in flow and temperature regime and channel restoration activities on the middle and upper Sacramento River and (2) DeltaEFT for the San Francisco Delta. SacEFT integrates flow management, water temperatures, channel migration and gravel augmentation with representative performance indicators based around five focal species: Chinook salmon, steelhead, green sturgeon, bank swallows, and Fremont cottonwood. TNC and ESSA Technologies are currently completing version 1 of the Delta Ecological Flows Tool (DeltaEFT) this spring. TNC's effort to extend EFT to the Delta has emphasized detailed reviews of pre-existing biophysical relationships (e.g., DRERIP, BDCP, SWRCB, POD research) as well as support from expert-led workshops to prioritize, vet and customize indicators. Delta flow management scenarios (inflow regimes, conveyance alternatives, gate operations, export pumping rates, sea-level rise) are evaluated in DeltaEFT by linking physical variables to important Delta habitat conditions and focal species targets such as: Brazilian waterweed suppression, invasive overbite clam suppression, invasive Asiatic clam suppression, Chinook/steelhead (multiple run types) smolt development & growth, smolt predation mortality, smolt temperature stress, an index of delta smelt habitat suitability, delta smelt entrainment risk, and tidal wetland inundated area and salinity/inundation regimes.

In addition to enabling rapid comparative scenario evaluation, EFT provides guidance on both target flows (to maximize the related ecological benefits) and avoidance flows (to reduce negative consequences), bracketing the range of discharges to be evaluated experimentally. This presentation summarizes example results from recent applications of EFT and describes next steps and collaboration opportunities.

The presentation also illustrates how EFT's emphasis on simple trade-off visualization (traffic light roll-ups) helps to bridge gaps between managers and technical specialists, to catalyze exploration of new alternatives and promote the development of flexibility in the water management system.

Session 22. Joint CWEMF and IEP – Applied Hydrodynamic Modeling and Forecast Tools

Forecasting Turbidity in the Sacramento-San Joaquin Delta **– John DeGeorge (RMA)**

With funding from the Metropolitan Water District of Southern California (MWD), Resource Management Associates (RMA) has finished its third year forecasting Delta turbidity during the winter wet season. The goal of this collaborative effort between RMA, 34North, DWR, Systech Engineering and MWD is to provide decision support to the Delta Smelt Working Group and to Delta operations to anticipate and potentially control turbidity at Delta compliance locations. RMA's forecasting efforts have now covered three very different Water Year conditions, from WY2011's wet conditions to the very dry conditions in WY2012. For WY2012, we streamlined and extended previous forecasting protocols and expanded the scope of the collaborative effort. In this presentation, we give an overview of RMA's forecasting efforts using our two-dimensional turbidity model and adult delta smelt behavioral model, and present the results of our interactions with 34North. Weekly forecasting results for turbidity, flow, and adult delta smelt particle tracking and are now publically available on the Bay-Delta-Live website.

Investigating the Retention of Planktonic Organisms in the Low-Salinity Zone using a Particle Tracking Model **3.5 MB**
Edward Gross (RMA), Wim Kimmerer (SFSU), and Michael MacWilliams (Delta Modeling)

A major challenge for estuarine plankton is to maintain populations within an estuary against tidal mixing and continuous seaward movement due to river flow. The Entrapment Zone study in 1994-1996 examined how vertical movements of plankton might result in retention in the Low-Salinity Zone of the San Francisco Estuary, generally in Suisun Bay. Copepods and larval fish appeared to move vertically in synchrony with the tidal currents, a pattern that should aid in retention of these organisms. However, retention calculated with observed vertical velocity profiles in the Suisun Bay channel was negligible, implying a need to analyze the entire three-dimensional flow field. We are conducting this investigation using the UnTRIM three-dimensional hydrodynamic model and the Fish-PTM particle tracking model. Particles can be assigned behaviors including passive drifting, tidal or diel vertical migration, or constant downward swimming. We first determined the tidal patterns of vertical distribution of particles that resulted from each behavior, then selected behaviors that gave similar vertical profiles of abundance to those from the Entrapment Zone study. We then determined the degree of retention resulting from the selected behaviors of particles released in a pattern in salinity space similar to that of the copepod *Eurytemora affinis*. The distribution of passively drifting particles spread rapidly both seaward and landward from this region, and shifted seaward with the net flow. Any downward movement, either tidally synchronized or continuous, reduced or eliminated seaward movement of particles due to the net flow. Thus, the detailed, time-varying three-dimensional flow field determines how these behaviors play out in the estuary. By inference, the spatial distributions of any organisms that move vertically in the water column will result in horizontal patterns of distribution that would be difficult to predict without the use of a particle tracking model operating at a suitably fine spatial scale.

Climate Change Information for Ecological Modeling **– Jamie Anderson (DWR)** **1.2 MB**

California's future climate is expected to change with increasing air temperatures, rising sea levels and changing precipitation patterns and amounts. Accounting for these projected changes and the large uncertainties associated with them is challenging for water resources and ecological planning. This talk will present available climate change projection information for California. Efforts to provide guidance in how to use the climate change information will also be discussed.