

Aceituno¹, K.M., T. Adelsbach¹, C. Eagles-Smith², J. Henderson¹

¹U.S. Fish and Wildlife Service, Environmental Contaminants Division, 2800 Cottage Way, W-2605, Sacramento, CA 95825

²U.S. Geological Survey, Davis Field Station, One Shields Ave., Davis, CA 95616
kevin_aceituno@fws.gov

Using Forage Fish to Assess Mercury Bioaccumulation in Aquatic Systems

Historic mining activity has led to a legacy of mercury contamination in the San Francisco Estuary. The most toxic form of mercury, methylmercury, is of primary concern due to its bioaccumulative potential in aquatic food-webs. Forage fish occupying low trophic positions represent a critical step in methylmercury bioaccumulation in fish, wildlife and humans. Temporal and spatial variations in mercury bioavailability effect bioaccumulation patterns in these fish, making them useful bio-monitoring tools in aquatic systems. Our goal was to use forage fish sampled from the Don Edwards San Francisco Bay National Wildlife Refuge to assess trends in mercury bioaccumulation in the aquatic food-web. We examined total mercury (THg) concentrations for five species of fish, Mississippi silverside (*Menidia audens*), topsmelt (*Atherinops affinis*), longjaw mudsucker (*Gillichthys mirabilis*), northern anchovy (*Engraulis mordax*) and rainwater killifish (*Lucania parva*). To compare THg among site and species, we used analysis of covariance with species and site as categorical predictors and standard length as a continuous predictor. Results indicate THg differed among species and among sites. THg concentrations were also compared to San Francisco Bay TMDL fish tissue objectives determined to protect human health and aquatic wildlife. Mean THg concentrations for all species exceeded the aquatic wildlife objective (0.03 ppm THg, wet weight) applied to fish 30-50 mm in length. The human health target (0.20 ppm THg, wet weight) applies to sport fish 600 mm in length, however, mean THg concentrations in northern anchovies and Mississippi silversides exceeded this value. Our preliminary findings suggest that life history strategies and developmental patterns are important factors affecting mercury bioaccumulation. Understanding these factors is essential to accurate assessment of mercury bioaccumulation in aquatic food-webs.

CALFED Statement of Relevance

Our results indicate that life history traits and developmental patterns of forage fish have an impact on the dynamics of mercury in aquatic food-webs.

Albertson, L.K.* , S.C. Zeug, B.J. Cardinale, H.S. Lenihan, M.A. Wydzga, L. Harrison, T. Dunne
UC Santa Barbara, Ecology, Evolution and Marine Biology, Santa Barbara, CA 93106
albertson@lifesci.ucsb.edu

Geomorphic Constraints on the Restoration of Macroinvertebrate Assemblages in the Merced River, CA

Many river restoration projects in California focus on creating ideal benthic habitat for adult spawning Chinook salmon. However, the habitat characteristics needed to support the base of food-webs that sustain juvenile salmon have received comparably little attention. Following a 2.25km restoration of the Robinson reach in the central valleys Merced River, we document a significant difference in the community of invertebrates that represents the primary source of food for fish. Although total invertebrate abundance is similar between the restored reach ($2,504 \pm 255$ individuals/m²) and an upstream reference channel ($3,488 \pm 428$ individuals/m²) that was not restored, the invertebrate assemblage shifts from 56 % dominance by sessile, filter-feeding caddisflies (*Hydropsychidae*) in the reference section to 51% dominance by highly-mobile, grazing mayflies (*Heptageniidae*) in the restored section. We hypothesize that this distinct shift is driven by a fundamental difference in the magnitude and spatial pattern of riverbed mobility in the restored and unrestored sections. To test this hypothesis, we perform two studies. First, we conduct a field experiment in which we directly manipulate bed stability in both the reference and restored channels by placing rocks in 35cm dia. by 17.5cm high mesh baskets, burying the baskets flush into the river substrata, and then manually disturbing the rocks after an 8-wk colonization period with frequencies that approximate background mobility of stream particles. Second, we integrate a spatially explicit 2D hydraulic model with particle size data to characterize the critical shear-stress required to move tracers ranging in size from 22.6 to 128mm in both the restored and unrestored reaches. We then sample invertebrate communities immediately before, and several dates following a large spring flood in areas of the channel that span a large gradient in mobility. Thus, we not only assess whether shifts in invertebrate assemblages can be mimicked experimentally, but also compare the resistance and resilience of the dominant invertebrate taxa to bed mobility imposed by a flood.

CALFED Statement of Relevance

Many river restoration projects in California create ideal benthic habitat for adult spawning Chinook salmon. However, the habitat characteristics needed to support the base of food-webs that sustain juvenile salmon have received comparably little attention. This study addresses restoration of the food-web that supports the critically important juvenile Chinook life-stage.

Ammann¹, A.J., P.T. Sandstrom², E.D. Chapman², C. Michel¹, A.P. Klimley², S.L. Lindley¹, R.B. MacFarlane¹

¹NOAA Fisheries, Southwest Fisheries Science Center, Santa Cruz, CA 95060

²University of California Davis, One Shields Ave Davis, CA 95616

arnold.ammann@noaa.gov

The Range of Detection of Coded Ultrasonic Beacons by Automated Monitors in Varying Aquatic Environments

Automated monitors, moored at fixed sites in rivers, lakes, and bays, are now commonly used to detect the passage of fish carrying individually coded ultrasonic beacons and to record behavioral and environmental information from them. This technology can provide major insights into the behavior, movements, and survival of aquatic animals.

Optimization of the performance of this technology requires cognizance of how the ultrasonic range of tags of varying specifications vary in these different environments. We performed benchmark tests to ascertain the range of detection between monitor and coded beacons in a reservoir (Comanche) where latters' ranges were expected to be greatest because the (1) tags and monitors in a linear array at successive distances were in acoustic free field that permitted spherical spreading of the ultrasonic signal, (2) the water was calm and devoid of waves that generate noise that masks the beacons' signals at greater distances, and (3) water flow was negligible so that both the tags and monitors were vertical in the water and the ultrasound was propagated directly between the two. Detection ranges were determined for one commercially available monitor (VR02, Vemco Lmtd., Halifax) with respect to three ultrasonic transmitters (V7, V9, and V16) with increasing diameters to their signal generating piezo-electric transducers (PZT). The smaller 7- and 9-mm diameter beacons, used on Chinook and steelhead smolts, have less power and generate signals with their PZT vibrating off resonance, and hence their transmission range is less than the 16 mm-diameter beacons, which are used with larger bony fishes and sharks and are resonant at 69 kHz. Similar range tests were performed under varying wind and current conditions in a bay (San Francisco), in a wide channel with slow flowing water (Cross-Delta, Sacramento River), in a narrow channel with slow-flowing water (Knight's landing, Sacramento River), and in a run of a fast-flowing water (Colusa, Sacramento River). The ranges of the beacons varied substantially between these different environments. An attempt is made to explain these differences on the basis of the magnitude of the ambient noise, which was recorded during some tests, and the inclination of the tags and monitors due to strong flows, which was recorded by an inclinometer during other tests. We urge that users of this automated tag-detecting system conduct site-specific tests of detection range based on the variability in the ranges observed in this study.

CALFED Statement of Relevance

These results are germane to the tagging of nearly 1000 salmon smolts per year and their detection by an array of 200 monitors in the Sacramento River, Delta, and San Francisco Estuary.

Anderson¹, F.E., Z. Song², R.L. Snyder³

¹U.S. Geological Survey, 6000 J St. - Placer Hall, Sacramento, CA 95819-6129

²College of Agronomy and Biotechnology, China Agricultural University /Key Laboratory of Crop Cultivation and Farming System, Ministry of Agriculture, Beijing 100094, China

³University of California Davis, Department of Land, Air and Water Resources, One Shields Avenue, Davis CA 95616

fanders@usgs.gov

Estimating Evapotranspiration Rates using GIS and the SIMETAW Model for an Agricultural Watershed

Recent advancements in micrometeorology have allowed accurate and reliable measurements of evapotranspiration (ET), using techniques such as eddy covariance, Bowen ratio, surface renewal, and lysimeters. Due to cost and accessibility, these techniques are usually limited to a single location or a single crop type. This research presents a method to increase the scale of ET measurements from single locations to an entire watershed by using crop coefficients (K_c), obtained from single crop ET studies, and monthly climate data. The scale was increased by using Geographic Information System (GIS) maps, generated from field observations made during the winter and summer of 2006, and the Simulation of Evapotranspiration of Applied Water (SIMETAW) model. This model estimates reference evapotranspiration (E_{T0}) using monthly climate data and general soil characteristics, which is then combined with K_c values to estimate crop evapotranspiration (E_{Tc}). E_{Tc} estimates were made for the Willow Slough watershed, located near Woodland California, which contains several widely studied crops, with known K_c values, such as alfalfa, rice, and tomatoes. However, roughly a third of the watershed contains natural grass rangelands, a plant community with limited ET information. The USGS, in conjunction with the University of California, Davis (UCD), began measuring ET for natural grass rangelands in August of 2006, to provide K_c values for this plant community. The objectives of this study are to: (1) determine ET for the various crops grown in the watershed, (2) estimate monthly and yearly water requirements, and (3) to model climatically different years and land use changes.

CALFED Statement of Relevance

The presentation relates to modeling results for water supply and reliability on the watershed scale. Focusing on how watershed atmospheric hydrodynamics may respond to changes in climate and land use.

Anderson, J.D., H. Yin, E. Reyes, F. Chung
California Department of Water Resources, 1416 Ninth Street, Room 215-17,
Sacramento, CA 95814
jamiea@water.ca.gov

Climate Change Impacts on Water Project Operations and the Delta

Problem Statement: Future projections for warming air temperatures, changes in precipitation patterns and snow levels, and increased sea levels are expected to impact management of California's water resources. California's water supply may be vulnerable to these changes since it relies on winter snowfall for much of its summer water supply. About two-thirds of Californians and millions of acres of farmland rely on water from the state and federal water projects. Much of that water flows through the Sacramento-San Joaquin Delta which is considered the hub of the water supply system. Shifts in precipitation and runoff patterns due to climate change could lead to modified reservoir operations and changes to Delta inflows and exports. Rising sea levels could lead to salinity intrusion into the Delta, which could require additional freshwater releases from upstream reservoirs to maintain water quality standards. Increased water levels could threaten Delta levee stability. Approach: Eighteen climate change scenarios were considered as recommended by the Governor's Climate Action Team. Climate projections were generated by six global climate models (GCM) under two assumed greenhouse gas emission scenarios. The GCM outputs were translated to the regional level using two downscaling techniques. Reservoir inflows were then estimated for each scenario. Sea level rise was also considered in some of the scenarios. Changes in State Water Project and Central Valley Project operations were then analyzed using the CalSimII model. Subsequent changes in Delta flows, water level, and water quality were then assessed using the Delta Simulation Model 2 (DSM2). Results: Climate change impacts assessment for SWP and CVP operations will be presented. The focus will be on project deliveries and end-of-year storage. Effects of climate change on Delta inflows and exports will also be discussed. Impacts on Delta water quality focus on compliance with water quality standards. Effects of sea level rise will also be presented.

CALFED Statement of Relevance

Quantifying potential impacts of climate change on water project operations and Delta flows, water level, and water quality are relevant to the CALFED objectives of water supply reliability, water quality, and levee system integrity.

Anderson, M.L.

CA Dept of Water Resources, 3310 El Camino Ave, Rm. 200, Sacramento, CA
95821

manderso@water.ca.gov

A Tale of Two Tails

Problem Statement: Forecasting and planning efforts related to California water and the CALFED system are based on the notion of mean conditions. Difficulties arise in the forecasting and planning process when observed conditions lie in the extremes. Climate change is expected to result in larger and more frequent extremes. The question arises of how frequently do observations fall into the extremes and is the rate of extreme observations increasing? Approach: Using observed data from the 20th century for California watersheds in the CALFED sphere of influence, analyses will be carried out to quantify the change in extreme event observations. Observed quantities tested will include precipitation, temperature, snow water equivalent in Sierra Nevada snowpack, and runoff. Visualization of changes to the observed distribution will be created as well. Possible implications associated with future climate change projections will be investigated. Results: Changes in the distribution of observations of precipitation, temperature, snowpack, and runoff over the past 100 years are presented as point of reference to discuss potential future changes over the next century. The implications of observed distributions made up of extreme events on the forecasting and planning process will be discussed.

CALFED Statement of Relevance

These results are relevant to the CALFED objective of water supply reliability.

Archbald, G.*, K.E. Boyer
San Francisco State University, Romberg Tiburon Center for Environmental
Studies, 3600 Judah Street, San Francisco, CA 94122
gavinarchbald@yahoo.com

Evaluating the Potential for Spread of an Invasive Forb, *Limonium ramosissimum*, in San Francisco Bay Salt Marshes

Invasive species threaten San Francisco Bay's remaining salt marsh plant communities and the success of marsh restoration efforts. In 2006 and 2007, Algerian sea lavender (*Limonium ramosissimum*), a salt tolerant invasive forb prevalent in southern California marshes, was discovered in several restored and disturbed marshes in San Francisco Bay. While this suggests the plant may threaten future marsh restoration sites, the extent to which *Limonium* has invaded, the elevational range of greatest potential impact, and the probability of viable seeds spreading to new areas is unknown. To address these questions, we located and mapped existing invasive *Limonium* populations in San Francisco Bay. Mapping results show eight populations of *Limonium* are clustered on the southwest edge of the Bay, separated by a maximum of 8.6 km, and invasion intensity ranges from several plants to several hundred square meters. The largest populations are centrally located, suggesting spread is occurring north and south along the Bay's western edge. Three of these invaded marshes are being surveyed to determine where, along an elevation gradient, *Limonium* might compete most aggressively with native marsh plants. We found the invasive is present primarily in the mid to high marsh and is commonly interspersed with *Sarcocornia pacifica*, *Jaumea carnosa*, *Distichlis spicata* and *Grindelia stricta*. Near total monocultures occur in the high marsh where *Limonium* grows on average 8 cm taller and produces 22 more flowers per plant than in mid marsh elevations, suggesting rare species growing at high marsh elevations are at risk. Currently, we are investigating the plant's dispersal potential by testing whether seed germination decreases with exposure to a range of salinities over days or weeks. The results of these studies will help determine whether future restored marshes are at risk of early colonization by *Limonium* and where invasions are likely to occur.

CALFED Statement of Relevance

By assessing the risk a potentially aggressive new invasive species, *Limonium ramosissimum*, poses to San Francisco Bay salt marshes, this research will provide critical information needed for agencies to prioritize eradication and control of non-native species in the Bay-Delta system.

Baxa¹, D.V., P.W. Lehman², S.J. Teh¹

¹School of Veterinary Medicine, Department of Anatomy, Physiology and Cell Biology, UC Davis, One Shields Avenue, Vet Med - APC, Davis, CA 95616

²CA Dept Water Resources, 3251 S Street, Sacramento, CA 95816

dvbaxa@ucdavis.edu

Assessment of Microcystis Toxicity in the San Francisco Estuary with a Molecular MCYD Marker

Microcystis toxins are viewed as one of several stressors that may potentially impact the overall health of fish populations in the San Francisco – San Joaquin Delta (SFE) through direct toxicity or mediated effects to the food web. Earlier studies have shown that hepatotoxic microcystin demethyl microcystin-LR and microcystin-LR are dominant in algal blooms previously observed in the estuary. As variations in the toxicity of blooms are due, in part, to changes in the relative proportion of toxic strains, a detection tool is needed but is currently lacking to identify and quantify the strains that contribute to bloom toxicity in the SFE. Our current study aims to address this gap by developing and applying PCR-based techniques to determine the distribution and estimate the proportion of toxic *Microcystis* based on the presence of a microcystin toxin synthetase gene *mcyD*. We employed both conventional and real-time quantitative PCR (qPCR) to analyze algal samples collected from several locations in the SFE during the onset, bloom, and post blooming of cyanobacteria between July and September of 2007. Our initial findings showed that algal populations were mainly composed of *Microcystis* spp. The proportion of toxic strains was determined by qPCR which showed significant variations, ranging from 400 – 4 M *mcyD* gene copy numbers/ μ g DNA, among the different stations examined at various times. These PCR-based techniques will be applied to future studies that aim to: 1) monitor and assess the distribution and abundance of toxic *Microcystis* and other toxic cyanobacteria in the SFE; 2) examine the effects of principal environmental factors on *Microcystis* toxicity and 3) determine potential relationships between *Microcystis* toxicity, trophic transfer and pelagic fish population dynamics in the Delta.

CALFED Statement of Relevance

The potential role of *Microcystis* toxins as one of several stressors affecting fish populations that are currently experiencing significant declines in the SFE is of particular concern to the IEP POD Management Team. The molecular tool will assist the team in identifying the potential relationships between *Microcystis* toxicity, trophic transfer, copepods and pelagic fish population dynamics in the Delta.

Beggel^{1,2}, S.* , I. Werner¹, R. Connon¹, J. Geist²

¹University of California, Davis, One Shields Avenue, Davis, CA 95616

²Technische Universitaet Muenchen, Muehlenweg 22, 85354 Freising, Germany

sbeggel@ucdavis.edu

Lethal and Sublethal Endpoints in Larval Fathead Minnow (*Pimephales promelas*): A Comparison of Commercial Pesticide Formulations versus Pure Active Ingredients

Residues of a great number of insecticides used in agricultural and urban areas can be found in surface water bodies throughout California at concentrations potentially hazardous to aquatic ecosystem. Toxicity thresholds such as LC/EC50 for aquatic species are generally determined using the pure chemical ingredient of these insecticides, whereas a significant proportion of available insecticide formulations consist of so called “inert” ingredients. These ingredients serve several functions, acting as solvents, surfactants or preservatives and may therefore increase the toxicity of the active ingredient. We chose a pyrethroid, bifenthrin, and the phenylpyrazole fipronil and compared the pure insecticide with one of the commercially available formulations, Talstar® and Termidor®. Mortality, swimming performance and growth in larval fathead minnow (*Pimephales promelas*) were used as toxicological endpoints to test the hypothesis that the toxicity of pure active ingredient differs from the toxicity of their respective insecticide formulation.

CALFED Statement of Relevance

This research compares the toxicity of two insecticides widely used in California as active ingredient and commercial formulation. It also establishes the quantitative relationship of standard acute toxicity endpoints and ecologically relevant sublethal effects in a surrogate fish species, which will provide important information for environmental risk models.

Bergman, P.S., B.J. Cavallo, C.R. Turner
Cramer Fish Sciences, 126 East Street, Auburn, CA 95603
pbergman@fishsciences.net

Fish Life Cycle Modeling: An Interactive Object-oriented Approach

The abundance and health of fish populations are influenced by a myriad of environmental and anthropogenic effects at each life stage. Increasingly, fisheries managers are in need of tools allowing population analysis of cumulative effects, while making it possible to estimate the relative contribution of specific water project effects, recovery actions, and even stochastic events (i.e. poor ocean conditions). We describe the development and application of an interactive object-oriented simulation tool (the IOS model) to analyze the complex life cycle of fish populations and associated factors affecting their survival. We developed the IOS model utilizing graphic-based simulation software which allows modeling of complex systems with mathematical accuracy, while creating a tool that is transparent and easily explainable to decision-makers and stakeholders. With IOS, the model is depicted graphically in a nested hierarchy which allows the user to view or describe the model at any level of detail. For example, the top level hierarchy can start with a geographic overview, then stream reaches, and within those reaches are nested in successive order: reach, life stage, functions within life stage, and input data for functions. While the IOS approach is transparent and easy to understand, it is also quantitatively complex and uses underlying mathematical relationships to drive the population life cycle. IOS allows explicit modeling of uncertainty in model parameters and inputs and performs powerful sensitivity analyses to determine major factors affecting fish population dynamics. We have already had success modeling the life cycle of winter-run Chinook in the Sacramento River and are currently creating models for Sacramento River spring-run Chinook and juvenile fish passage through the California Delta.

CALFED Statement of Relevance

The Interactive Object-oriented Simulation (IOS) model is a new tool to assist conservation efforts of native fishes and help water managers effectively balance ecosystem and water supply needs.

Betchart, W.B.

Consulting Water Resources Engineer, 17050 Montebello Road, Cupertino, CA
95014

Betchart@earthlink.net

Climate Change -- Seasonal Shift of Runoff

Regional scale results from global climate models provide simulations of California streamflows from 1950 to 2100. DWR's Delta Risk Management Strategy was able to obtain and use these simulation results to characterize future changes in water availability for water supply and Delta recovery from levee breaches. The example of the Feather River (inflow to Oroville Reservoir) is used. Analysis of the simulation results from the SRESa2 scenario / GFDL model by using a regression approach demonstrates the progression of shifting annual percentage of inflows from late spring and summer to winter.

CALFED Statement of Relevance

The shifting seasonal pattern of runoff due to warming is expected to lessen water supply reliability due to less spring/summer runoff. This will also mean less water availability for Delta recovery from levee breach events.

Borglin, S.E., W.T. Stringfellow, J.S. Hanlon, M. Brunnell, J. Graham
University of the Pacific, 123 Montecito Crescent, Walnut Creek, CA 94597
seborglin@lbl.gov

Source Tracking of Algae Seed as Part of a Large-Scale Ecosystem Study of Algae Biokinetics as a Function of Non-Point Source Discharge

The State of California is instituting a total maximum daily load (TMDL) requirement for oxygen demand on the San Joaquin River (SJR) in Central California that includes algal biomass. The TMDL is driven by the low levels of dissolved oxygen in the Stockton deep water ship channel which is a barrier to fish migration to the upstream SJR. Previous studies have identified algal biomass as the most significant oxygen-demanding substance in the upstream SJR DO TMDL Project study-area. An ecosystem-scale study has been undertaken to improve both the understanding of algal seed sources and algal growth in the SJR. Significant algal concentrations are found in the upstream tributaries but the loads into the river are relatively small, and most of the algal biomass measured downstream is produced when inoculated algae grow in the main stem of the SJR. Mitigating seed sources would lower the initial inoculation and inhibit overall growth downstream. Bulk parameters such as nutrients, organic carbon, and chlorophyll indicate loads but are not sufficiently specific to evaluate seed source. Phospholipid fatty acid analysis (PLFA) was performed on samples collected in the main stem of the SJR as well as the major tributaries from 2005-2007. PLFA analysis enables the detection of community specific phospholipids and provides a fingerprinting of the bulk algal community structure. The overall community in the system is predominantly diatoms with lower detection of green algae and dinoflagellates

CALFED Statement of Relevance

Understanding algal growth and seed sources in the San Joaquin River supports efforts by CalFed to restore the San Joaquin River and to develop a dissolved oxygen TMDL for the upstream San Joaquin.

Boyer¹, K.E., L.K. Reynolds², S. Wyllie-Echeverria³, B. Ort¹, S. Cohen¹

¹Romberg Tiburon Center/SFSU, 3152 Paradise Drive, Tiburon, CA 94920

²University of Virginia, 291 McCormick Rd, Charlottesville, VA 22904

³Friday Harbor Labs, University of Washington, 620 University Road, Friday Harbor, WA 98250

katboyer@sfsu.edu

Restoring Eelgrass to San Francisco Bay: A Mesocosm Comparison of Donor Specific Seedling Recruitment and Genetic Diversity

In San Francisco Bay, past attempts to restore eelgrass (*Zostera marina*) have had limited success; however, previous trials have not included seeding techniques, which are commonly used in other regions. Flowering rates are relatively high in the bay and there is at least one annual bed that relies on recruitment from seed each year. Here, we describe a mesocosm experiment that assessed the potential to restore eelgrass to San Francisco Bay using seed. We measured seedling recruitment, clonal spread, and genetic diversity of restored populations from one annual and two perennial donor populations seeded in mesocosms using a modification of a new buoy-deployed seeding technique. The experiment included inoculation of half of the tanks with small cores of sediment collected from the donor sites. Seeds from all three donor populations produced seedlings in the mesocosms followed by clonal spread through rhizomes during the summer months. Inoculation with donor bed sediments led to a significant increase in seedling recruitment and clonal spread for all donors. Mesocosm recruits from the annual population had significantly higher genetic diversity; while initial recruitment from the annual donor was lowest, clonal spread and thus final shoot densities were highest for this donor, suggesting that genetic diversity may play a role in establishing robust eelgrass patches following seedling recruitment. These results suggest that 1) seeding holds promise for restoration in San Francisco Bay, 2) donor choice, including genetic diversity of the donor, may matter to success of restored eelgrass, and 3) inoculation with small amounts of donor site sediment may increase eelgrass recruitment and clonal spread, perhaps through inclusion of beneficial microbes. Applicability of these results is currently being field-tested at restoration sites within San Francisco Bay. This work meets the goals and objectives of the CALFED program by providing new insights into the processes governing a key species and habitat in the estuary and information that should aid in successful ecosystem restoration and management.

CALFED Statement of Relevance

This work meets the goals and objectives of the CALFED program by providing new insights into the processes governing a key species and habitat in the estuary and information that should aid in successful ecosystem restoration and management.

Boyer¹, K.E., S. Wyllie-Echeverria², S. Cohen¹, B. Ort¹, L. Carr¹, S. Kiriakopolos¹, L. Reynolds³, N. Cosentino-Manning⁴, A. Doherty⁵

¹Romberg Tiburon Center/SFSU, 3152 Paradise Drive, Tiburon, CA 94920

²University of Washington, 620 University Road, Friday Harbor, WA 98250

³University of Virginia, 291 McCormick Road, Charlottesville, VA 22904

⁴NOAA Fisheries Restoration Center, 777 Sonoma Ave., Santa Rosa, CA 95404

⁵California Coastal Conservancy, 1330 Broadway, 11th floor, Oakland, CA 94612

katboyer@sfsu.edu

Multiple Approaches toward Successful Restoration of Eelgrass (*Zostera marina*) in San Francisco Bay

Biophysical modeling suggests that eelgrass (*Zostera marina*), a flowering plant that inhabits 3000 acres of shallow habitat in San Francisco Bay, could be restored to hundreds, if not thousands, of additional acres if propagules are delivered to appropriate sites. As previous restoration attempts have had limited success, we have developed a multi-faceted approach to explore constraints and maximize the potential for successful restoration of this important foundation species. Through surveys of extant eelgrass beds we have assessed characteristics including plant densities, genetic diversity, and epifaunal community structure to aid in choices of donor material for restoration and develop goals for restored habitat attributes. Through mesocosm and field experiments, we have tested seeding and transplanting techniques, compared success of different donor material sources (including maintenance of genetic diversity), and tested restoration site suitability, including evaluating the role of planting depth in restoring eelgrass at different sites. This poster summarizes our work to date and discusses application of our approach for other groups charged with the restoration of seagrass populations in urbanized estuaries. The outcome of these studies will be incorporated into the Subtidal Habitat Goals Project for San Francisco Bay, a comprehensive and long-term vision for research, restoration and management of habitats below mean high tide.

CALFED Statement of Relevance

This work meets the goals and objectives of the CALFED program by providing new insights into the processes governing a key species and habitat in the estuary and developing guidelines and tools to promote successful ecosystem restoration and management.

Boyer¹, K.E., S. Wyllie-Echeverria², L.K. Reynolds³, B. Ort¹, L. Carr¹, S. Cohen¹

¹Romberg Tiburon Center/SFSU, 3152 Paradise Drive, Tiburon, CA 94920

²University of Washington, 620 University Road, Friday Harbor, WA 98250

³University of Virginia, 291 McCormick Rd., Charlottesville, VA 22904

katboyer@sfsu.edu

Field Experiments to Evaluate Eelgrass (*Zostera marina*) Restoration Techniques, Donor Selection, and Maintenance of Genetic Diversity

Evidence suggests that San Francisco Bay may be becoming more habitable for the seagrass, *Zostera marina* (eelgrass), and that suitable restoration efforts might be used to increase eelgrass acreage and thus the vital habitat it provides. Seeding techniques, while not previously used to restore seagrasses in California, hold promise for San Francisco Bay as flowering rates are relatively high and seedlings are known to contribute to the persistence of extant beds; further, seeds should maximize genetic diversity of restored populations. We conducted experiments at three unvegetated sites in the bay identified by biophysical modeling as favorable habitat for eelgrass. We compared a new seeding method, buoy-deployed seeding, to hand-broadcasting seeds and transplanting whole plants using a frame system. We used one annual and two perennial populations as sources of donor material. Our greatest success was with buoy-deployed seeding, which led to seedling establishment at all sites. At one site seedlings did not persist into the first summer; however at the other two sites, recruited seedlings spread into sizable patches within the first growing season and continued to persist and spread in the second (current) growing season, also producing flowering shoots that are now contributing additional seedlings. The two perennial donor populations produced similar numbers of clonal patches and total densities, significantly more so than the annual population. Restored plants showed minimal, non-significant decreases in genetic diversity compared to their donor populations. These findings suggest that buoy-deployed seeding can be an effective restoration technique for establishing eelgrass in San Francisco Bay while conserving genetic diversity present in donor populations.

CALFED Statement of Relevance

This project meets CALFED program goals by making important advances in development and refinement of procedures to insure successful restoration of a key species and habitat in the estuary.

Brander, S.M.* , G.N. Cherr
UC Davis, Department of Environmental Toxicology, Bodega Bay Marine Lab,
Bodega Bay, CA 94923
sbrander@ucdavis.edu

Endocrine Disruption in the Sacramento-San Joaquin Delta: The Response of a Resident Fish Species

Endocrine disrupting compounds (EDCs) are widespread in the environment and are known to damage the reproductive systems of fishes. Deleterious effects of EDCs include the production of female reproductive proteins and malformed or tumorous testes in adult male fish, reduced egg production in adult females, and altered mating behavior in both sexes. Recent findings suggest that these effects may extend beyond individual fish to the entire population, resulting in skewed population sex ratios, and ultimately population decline. Preliminary data from the CalFed project "Identifying Causes of Feminization of Chinook Salmon in the Sacramento and San Joaquin River System" indicate that water samples from a number of locations in and near the Sacramento-San Joaquin (SSJ) watershed produced estrogenic responses in adult male rainbow trout. However, rainbow trout are not found throughout the entire estuary and thus may not be representative of threatened and endangered native estuarine species (e.g., Delta smelt, longfin smelt) that are found across a range of salinities in the SSJ watershed. My work complements this project by utilizing a ubiquitous euryhaline resident fish species (*Menidia beryllina*) as an indicator of exposure to reproductive contaminants. I plan to investigate whether specific sites within the SSJ Delta cause male *Menidia beryllina* to express choriogenin, an egg coat protein normally found only in females and which is a well-established biomarker of endocrine disruption. Initial tests confirm that commercially available salmonid antibodies successfully cross-react with *M. beryllina* choriogenin, which will permit rapid assessment of *M. beryllina* samples collected during the summer of 2008. Via collaboration with the USFWS, *M. beryllina* will be collected at regularly surveyed sites and will be assessed for choriogenin expression. This initial sampling will establish the pattern of EDC distribution throughout the SSJ Delta and will be followed by an outplanting experiment at impacted sites in 2009.

CALFED Statement of Relevance

The sublethal impact of endocrine disrupting compounds in aquatic ecosystems is often overlooked. Ecosystems in the SSJ Delta cannot be improved upon or protected with a successful outcome until these contaminant impacts are understood.

Brandes¹, P.L., R.W. Perry², M. Marshall¹

¹U.S. Fish and Wildlife Service, 4001 N. Wilson Way, Stockton, CA 95205

²University of Washington, School of Aquatic Fisheries Sciences, Box 355020, Seattle, WA 98195

Pat_Brandes@fws.gov

Use of Acoustic Tag Technology to Estimate Relative Juvenile Chinook Salmon Survival and the Proportion of Salmon Migrating into the Interior Sacramento-San Joaquin Delta

Coded wire tag (CWT) studies have demonstrated that survival in the Sacramento – San Joaquin River Delta is lower for marked juvenile salmon released into the interior Delta (Georgiana Slough) than for those released on the main-stem Sacramento River (Ryde). The objectives of this study were to confirm that relative survival is lower in the interior Delta and estimate the proportion of salmon migrating into the interior Delta with the DCC gates open and closed using acoustically tagged, late-fall run, juvenile Chinook salmon. Tagged fish were detected by receivers placed throughout the Delta to determine movement patterns and river segment survival rates. Sample sizes for the first year of the study (2006-2007) were low, but suggested that: (1) survival to Chipps Island was lower in the interior Delta than in the main-stem Sacramento River; (2) fewer juvenile salmon migrated into the interior Delta from the Sacramento River when the DCC gates were closed, and; (3) more juvenile salmon migrated into and survival was higher in Steamboat and Sutter Sloughs when the DCC gates were closed. Sample sizes were increased in the second year of the study to improve precision and determine if preliminary conclusions from the first year were confirmed. Estimates of the proportion of salmon diverted into the interior Delta support the hypothesis that closing the DCC will decrease the number of juvenile salmon that enter the interior Delta. These studies also infer that closing the DCC will improve juvenile salmon survival through the Delta. Closing the DCC is a management action that has been used to improve the survival of juvenile salmon migrating through the Delta. Acoustic tag studies provide a way to confirm the hypothesis that closing the DCC will result in improved survival of juvenile salmon migrating through the Delta from the Sacramento River.

CALFED Statement of Relevance

Closing the DCC is a management action that has been used to improve the survival of juvenile salmon migrating through the Delta. Acoustic tag studies provide a way to confirm the hypothesis that closing the DCC will result in improved survival of juvenile salmon migrating through the Delta.

Bremner¹, A.M., W.N. Brostoff¹, P.E. LaCivita¹, T. Keegan², D. Woodbury³

¹U.S. Army Corps of Engineers, 1455 Market Street, 15th Floor, San Francisco, CA 94103

²ECORP Consulting, Inc., 2525 Warren Dr. Rocklin, CA 95677

³National Marine Fisheries Service, 777 Sonoma Ave. RM 325, Santa Rosa, CA 95404

allison.m.bremner@usace.army.mil

Juvenile Salmonid Outmigration Trends in Relation to Dredging Activity Sites in the San Francisco Estuary

Information on the temporal and spatial distribution of Federally-listed juvenile Chinook salmon and steelhead in San Francisco Bay is needed for assessing potential impacts to these species from dredging activities. Currently, work windows are used that limit dredging activities to periods of time when listed salmonids are thought to be absent in the bay. Through the use of hydroacoustic telemetry we hope to increase our knowledge of juvenile salmonid migratory behavior to better manage dredging operations. Through a collaborative multi-agency effort, Chinook salmon and steelhead smolts implanted with ultrasonic tags are being released each year during the winter months of 2007-2009. As the smolts move from the Sacramento River, through the Estuary, and under the Golden Gate Bridge during their outmigration, they are detected by strategically-located hydrophones placed to better define juvenile salmonid migratory routes, transit times, and distribution relative to dredging and dredged material placement sites, thus providing the information needed to make management decisions. Data from the 2007 field season revealed that the tagged smolts: utilized deeper channels more often than shallow areas during outmigration; traversed the San Francisco Estuary from the release point in Rio Vista, CA to the Golden Gate in an average of 20 days and 41 days for Chinook salmon and steelhead, respectively; and were detected at dredging and dredged material placement sites. This project is coordinated with complementary research conducted by ECORP Consulting, Inc. for the Bay Planning Coalition. This study was designed and funded in collaboration with the San Francisco Bay Region Long Term Management Strategy for the Placement of Dredged Material and the CALFED grant recipients at the NOAA Fisheries Salmon Ecology Laboratory in Santa Cruz and the University of California Davis Department of Fish, Wildlife, and Conservation Biology.

CALFED Statement of Relevance

This project is one part of a multi-agency/research institute project which has the common goal to gain knowledge about the migratory behavior of native species so the new information can be used to protect habitat for the native species in the future.

Briggs, A.L.* , S. Cohen, W. Kimmerer
Romberg Tiburon Center, San Francisco State University, 3150 Paradise Drive,
Tiburon, CA 94920
allegre@sfsu.edu

An Introduced Copepod in SF estuary: Genetic Diversity in a Recent Invasion

The introduced predatory copepod *Tortanus dextrilobatus* was identified in the San Francisco Estuary (SF) in 1993 and within a year had become abundant. The SF population was probably introduced via ballast water of cargo ships. The known range of the species is limited to coastal waters of southern China and introduced populations in South Korea and the SF Estuary. Objectives of this study were to answer questions about the source and demographic history of the introduced population, particularly the effective size of the founding population. We characterized genetic variation of the mitochondrial gene cytochrome oxidase c subunit I (COI) by sequencing DNA from individual copepods from SF, Korea, and Xiamen, China. In contrast to expectations, no haplotypes (mitochondrial genotypes) were shared among the three populations so we cannot identify the source of the SF population. In addition, the Asia and SF populations are genetically divergent, suggesting that the source region has yet to be determined, and may lie outside of the known species range. All three populations showed evidence of previous expansion in abundance, suggesting a global cause unrelated to recent introductions, such as sea-level rise during the retreat of glaciation. Haplotype and nucleotide diversities of the SF population were similar to those of the native population, suggesting that the source of the SF population was a single introduction of a large number of individuals or multiple introductions from the same or closely-related populations. Because the species has not been introduced to other estuaries in the Pacific coast of North America, the first scenario is the most parsimonious. This introduction occurred before mid-ocean exchange of ballast was required. To more effectively control species invasions, we need more genetic studies to supplement, or contradict, information on sources of introduced species based on morphology and distribution.

CALFED Statement of Relevance

This study is related to the CALFED goal of ecosystem restoration, with the goal of prevention of species introductions. This study highlights the need for genetic studies to identify vector sources that may be unknown by conventional methods.

Brostoff, W.N., J. BurtonEvans, F. Tabatabai
U.S. Army Corps of Engineers, San Francisco Dist., Environmental Planning A,
San Francisco, CA 94103
William.N.Brostoff@usace.army.mil

Delta LTMS: A Long Term Management Strategy for Dredged Delta Sediments

The Delta Long Term Management Strategy (Delta LTMS) is a multiagency effort developing ways to plan, coordinate, and manage dredging and dredged material placement (dredging activities). The Delta LTMS goals are to: Support and maintain Delta channel functions for navigation, flood control, water conveyance, and recreation. Maintain and stabilize Delta levees that protect land-based activities, water conveyance, and terrestrial ecosystems. Protect and enhance water quality for Delta water supply and ecosystem function. The U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, California Department of Water Resources, California Bay-Delta Authority, the Central Valley Regional Water Quality Control Board and other agencies and stakeholders are participants Delta LTMS. The Delta LTMS is developing a database of sediment quality which will aid in planning dredging and dredged material placement. Working groups have been established to streamline permitting for dredging operations, examine protocols for sediment testing, and to develop alternatives for sediment placement, including beneficial uses such as wetlands restoration and levee stability. A regional dredged material sediment management plan will be developed. Additionally, it is anticipated that in the future, the Delta LTMS will be involved with research on possible adverse effects of dredging on sensitive species such as salmonids and green sturgeon.

CALFED Statement of Relevance

The Delta LTMS addresses resource management issues in all four areas of the CALFED Program, water supply reliability, water quality, levee systems, and ecosystem restoration, as well as related navigation and recreation issues in the Sacramento-San Joaquin River Delta.

Brown, M.R.

U.S. Fish and Wildlife Service, Red Bluff Office, Red Bluff, CA 96080

Matt.Brown@fws.gov

Did a Large-scale Stream Restoration Project Increase Concentrations of Mercury in Clear Creek?

Lower Clear Creek is undergoing habitat restoration from the effects of gold mining, gravel mining, dams and diversions. Restoration activities have the potential to increase the bioavailability of mercury left over from gold mining by placing or disturbing materials in the floodplain or stream channel. Monitoring suggests a pattern of increasing downstream concentration of mercury which may be due to 1) restoration actions increasing the availability of mercury; 2) gravel processing plants releasing contaminated water; 3) non-point source mercury leaching from widespread mine tailings; or 4) increasing amounts of fine sediments in the stream channel as the creek decreases in gradient. Our study focused on the potential for a large-scale multiphase stream channel and floodplain restoration project to increase the concentration of mercury in Clear Creek. We also considered the effect of water from gravel processing plants released into the project area. Concurrent with project construction, physical remediation was attempted to reduce the amount of water and mercury coming from the gravel processing plants. We measured total mercury in water samples during the two largest storms in the first winter post-construction. Sampling occurred at stations on Clear Creek above and below the project area and stations on the tributaries that flow into Clear Creek in this reach. Water flowing through tributaries in the project had mercury concentrations averaging 29% lower than in Clear Creek. As tributaries flowed through the project, mercury concentrations sometimes increased or decreased but never exceeded the concentrations in Clear Creek. Low discharges, turbidities and mercury concentrations from gravel processing plants suggest that remediation was successful. During the second storm, mercury concentrations in Clear Creek did not increase downstream suggesting that remediation reduced a significant source of mercury or that there were seasonal differences in mercury availability. The study should be replicated during higher flow years.

CALFED Statement of Relevance

The study evaluated the potential for a CALFED funded restoration project to increase mercury contamination. Mercury contamination and habitat restoration are high priority issues for CALFED. Clear Creek is a high priority watershed for CALFED. This information may inform similar CALFED-funded projects and improve future projects.

Brown, R.T., S. Jesse
ICF Jones & Stokes, 630 K street Suite 400, Sacramento, CA 95814
rbrown@jsanet.com

Evaluation of Fish Protection from the Head of Old River Barrier

The effectiveness of installing the head of Old River barrier for reducing the entrainment of migrating San Joaquin River (SJR) fall-run Chinook salmon was evaluated. Estimating the fraction of the fish that might be protected by just one of the VAMP actions is difficult, because single-action conditions have seldom been observed. The goal of this Reclamation study was to develop a simple model that would estimate the fraction of SJR salmon salvaged at CVP and SWP pumps, and the overall survival fraction to Chipps Island. This evaluation compared the daily patterns of salmon abundance in the SJR at the Mossdale trawl to the observed daily salvage of salmon at the CVP and SWP pumping plants. The daily Mossdale fish abundance and the estimated flow diversions and fish preferences were combined to calculate the number of fish expected at the CVP and the SWP salvage. The comparison of the Mossdale abundance and the CVP and SWP salvage for the 1996–2005 period provided a method to estimate the expected salvage fraction for the full range of San Joaquin River flows and CVP and SWP exports, with and without the head of Old River barrier. Both the reduced exports and the head of Old River barrier will reduce the fraction of fish salvaged. The overall comparison of survival to Chipps Island for juvenile SJR salmon is more uncertain than the calculation of the fraction of juvenile salmon reaching CVP and SWP salvage.

CALFED Statement of Relevance

Identifying the portion of the protection that is achieved by the barrier installation included a comprehensive evaluation of fish movement and behavior during migration conditions. This study contributes to the adaptive management of SJR flows, barrier installation and exports during the VAMP period and supports the likely benefits from a permanent gate.

Brusati¹, E.D., D.W. Johnson¹, J.M. DiTomaso²

¹California Invasive Plant Council, 1442-A Walnut St. #462, Berkeley, CA 94709

²Dept. of Plant Sciences, UC Davis, MS 4, One Shields Ave., Davis, CA 95616

edbrusati@cal-ipc.org

Follow the Weeds: Assessing the Risk of Spread for Invasive Plants

Invasive plants are a top threat to California's biodiversity, ecosystem services, agricultural production and human health. Risk assessment -- the evaluation of current and potential future impacts -- is a critical component of invasive plant management and policy, and is essential to implementation of state and federal plans. In an era of reduced budgets, land managers need to know where to focus their work to produce the most effective ecosystem restoration. Predictive models can help early detection by showing where invasive plants may spread and predicting the effects of changing conditions under global climate change. We collected data and developed maps to determine the current range and predicted spread of 36 invasive plants. This presentation will focus on species invading the Bay-Delta watershed, including *Dittrichia graveolens* (stinkwort), *Sesbania punicea* (red sesbania) and *Tamarix parviflora* (smallflower tamarisk). We surveyed county Weed Management Areas for data on current extent and population status (stable, increasing, decreasing due to control). To predict future spread, we researched native and introduced ranges of these plants globally and applied information through the climate-based modeling software Climex. Comparing climatic characteristics from each plants' existing range with those from California regions enabled us to extrapolate the potential success of that plant here. We then applied two climate-change assumptions to determine how climate change will affect predicted range. Our predictions show that some species that currently have limited extent in riparian areas have the potential to spread to a large portion of the state. These results are especially troubling for *S. punicea*, which is sold as an ornamental plant. This project takes a global perspective by examining worldwide ranges of the study species. Its regional results will help land managers in California focus their ecosystem restoration programs. Final results will be disseminated through the Cal-IPC webpage in late 2008.

CALFED Statement of Relevance

This project relates to the theme of global climate change as well as CalFed's program objective in ecosystem restoration. It provides land managers with information to guide their ecosystem restoration programs by showing which invasive species are already nearby and which have the most potential to spread.

Callaway¹, J.C., V.T. Parker², L.M. Schile³

¹University of San Francisco, Dept. of Env. Science, San Francisco, CA 94117

²San Francisco State University, San Francisco, CA

³University of California, Berkeley, CA

callaway@usfca.edu

Sediment Dynamics at the Newly Restored Island Ponds, South San Francisco Bay

Sediment accumulation is a critical factor driving the development of restored tidal marshes as they build elevation to a point suitable for vegetation establishment. This issue is particularly important for highly subsided tidal wetland restoration sites (including South San Francisco Bay salt ponds) that may be up to 200 cm below target elevations for vegetation establishment. We are evaluating sediment dynamics at the Island Ponds, the first salt ponds to be restored through the South San Francisco Bay Salt Pond Restoration Project. We are measuring sediment accretion within Pond A21, using the sediment pin method (PVC pipes set 3 meters into the sediment). The dense gypsum layer (up to 25 cm) and the lack of vegetation preclude the use of other methods. For short-term, mass-based accumulation rates, we are using a modification of the filter paper method, with sample discs that are deployed over a two-week tidal period. There has been substantial sediment accumulation within Pond A21 since breaching in March 2006, with approximately 12-14 cm of sediment accumulating over the first year in most of the southern half of the pond, and even greater accumulation in particular locations. Rates at higher locations are variable but lower; however, even at these locations sediment accumulation is orders of magnitude higher than in most natural tidal wetlands. Short-term, mass-based measurements of accumulation reflect similar spatial variability across the pond and show that substantial sediment accumulation has occurred throughout most of the year. These results give an indication of the potential for sediment accumulation during the critical initial restoration period for subsided tidal marshes.

CALFED Statement of Relevance

Results from this research are of direct interest for understanding the early development of restored tidal wetlands within the Bay-Delta, especially sites that are highly subsided and need to accumulate substantial sediment prior to vegetation establishment.

Carr¹, L.A., K.E. Boyer¹, A.J. Brooks²

¹San Francisco State University- Romberg Tiburon Center, 3152 Paradise Dr., Tiburon, CA 94920

²UC Santa Barbara- Marine Science Institute, Santa Barbara CA 93106

lindseyac@gmail.com

Epifaunal Community Structure in San Francisco Bay Eelgrass (*Zostera marina*) Beds: Implications for Restoration

Epifaunal species play key roles in the functioning of seagrass communities, as they have important positive effects on the plants through grazing epiphytes that compete for light. Additionally, these small herbivorous crustaceans are an important link in the food chain from primary producers to higher-order consumers. However, epifaunal species are not functionally redundant and their relative effects on important seagrass ecosystem processes vary substantially. In San Francisco Bay, experimental tests of eelgrass (*Zostera marina*) restoration are underway using both seedling and whole shoot transplant techniques. As restored beds develop, one goal is to establish the functions of natural eelgrass beds, including epifaunal grazing and trophic support; however, there is almost no data on epifaunal abundance and community structure in extant beds to aid in setting goals for the restoration sites. The objective of this study was to elucidate the seasonal dynamics of the epifaunal communities in five extant eelgrass beds, including differences between flowering and vegetative shoots. We found that epifaunal density varied significantly among seasons, sites and shoot type. Densities per shoot were as high as 5000, with a 10-fold difference among sites, and were 5x higher on average on flowering shoots than on vegetative shoots. Approximately 85% of the total abundance was from introduced species, but cluster analyses showed that composition of these species varied by season, site and shoot type. These data suggest that the epifaunal community that establishes through importing of shoots to restoration sites could depend on the donor site, the season of shoot collection, and the restoration method used (flowering versus vegetative shoots). These data help to define a range of epifaunal densities to aim for at restoration sites; however, as epifauna were overwhelmingly non-native, and all of the introduced have been present for >50 years, setting a restoration site goal of a high proportion of native species lacks merit, and future work should consider functional roles rather than species origins.

CALFED Statement of Relevance

This work meets the goals and objectives of the CALFED program by providing new insight into the ecological communities and functioning of an important habitat in the estuary, and information that could inform further conservation and restoration efforts.

Carroll¹, S.E., R. Spent¹, B. Turner², A. Hutzel³, L. Wycoff⁴

¹Ducks Unlimited, 3074 Gold Canal Drive, Rancho Cordova, CA 95670

²California Wildlife Conservation Board, 1807 13th Street, Suite 103, Sacramento, CA 95811

³California Coastal Conservancy, 1330 Broadway, Ste 1100, Oakland, CA 94612

⁴California Department of Fish and Game, 7329 Silverado Trail, Napa, CA 94558
scarroll@ducks.org

Lessons from the First Phase of Salt Pond Restoration in the North Bay

In 1994, the State of California purchased nearly 10,000 acres of commercial salt ponds along the Napa River to be included as part of the California Department of Fish and Game's Napa-Sonoma Marshes Wildlife Area, identified as the Napa River Unit. The objective for this property was conversion of the salt ponds into a mosaic of naturally self-sustaining and managed habitats to support populations of plants, fish, and wildlife, including endangered species, migratory waterfowl, shorebirds, and anadromous and resident fishes. Other important benefits included improved water quality and enhanced public use with wildlife-compatible recreation opportunities. To achieve these goals, project proponents undertook an eight-year planning and permitting process to determine the most feasible restoration approach. The planning process was completed in 2004. The construction activities associated with the restoration of the Napa River Unit Phase 1 were completed in September 2006 in Ponds 3, 4, and 5 and February 2008 in Ponds 1, 1A, and 2. Construction included such activities as breaching and lowering levees, replacement & removal of water control structures, armoring of necessary levees, and excavation of historic tidal channels. The restoration methods consisted of both proven techniques as well as some innovative approaches. This project is unique for both its overall size, one of the largest single tidal wetland restoration projects in the United States for its time; and for the scale at which construction techniques were applied. The Phase 1 construction activities of the Napa River Unit Restoration improved approximately 5,300 acres within the Wildlife Area. In addition to the construction activities, the Napa River Unit Restoration Project included physical and biological monitoring to assist the Department of Fish and Game with adaptive management decisions and to benefit planning for future restoration efforts as this project continues along its restoration trajectory. Full restoration relies on natural sedimentation. Vegetation colonization of the deeper ponds may take upwards of 50 years, creating valuable interim habitat for diving ducks. Vegetation recovery is already visible in more shallow areas and the benefits to the human and wildlife inhabitants of the San Francisco Bay Estuary are already being seen.

CALFED Statement of Relevance

This project was among the first and the largest salt pond restoration projects in the nation, restoring 3,429 acres, and enhancing 1,680 acres in a tidal marsh, managed pond mosaic. This project will have tremendous benefits for wildlife, water quality and overall ecosystem health.

Casler¹, B.R., K. Lehmann¹, R. Weil²

¹Analytical Environmental Services, 1801 7th Street, Suite 100, Sacramento, CA 95811

²City of American Canyon, 205 Wetlands Edge Rd, American Canyon, CA 94503
bcasler@analyticalcorp.com

City of American Canyon North Slough Wetland Restoration Project

The Napa River and its associated marshes and sloughs have been greatly altered to accommodate agricultural and urban development. A multitude of levees constructed in the twentieth century have had a negative impact on flood dynamics and processes. Continued urban growth and its associated infrastructure in the vicinity threaten to sever the ecological linkages among remaining natural habitats in the northern San Francisco Bay region. The City of American Canyon has led an effort in coordination with California Department of Fish and Game (CDFG) to restore 519 acres of tidal wetlands along the east bank of the Napa River. The project goals include improving water circulation and tidal influence to the area by breaching several levees. This action is intended to restore ecological conditions favoring tidal marsh habitat that can sustain a wide range of ecological functions and wildlife resources. The project would establish habitats for sensitive species identified in the CALFED Ecosystem Restoration Program. All targeted levees were successfully breached by November, 2005. Vegetation sampling before levee breaching and subsequent sampling and monitoring post levee breaching will help determine project success. Initial monitoring results two years after the breaches indicate that several salt marsh plant species are becoming established. Four more years of monitoring will be conducted to document marsh restoration and project success.

CALFED Statement of Relevance

The project was funded by CALFED and is consistent with their mission to restore ecological health and improve water management for the beneficial use of the entire Bay-Delta System. Successful implementation of this project will also enhance the biological linkage to the adjacent CDFG Napa-Sonoma Marsh Wildlife Area.

Chapman¹, E.D., P.T. Sandstrom¹, A.J. Ammann², C. Michel², A.P. Klimley¹, R.B. MacFarlane², S.L. Lindley²

¹University of California Davis, One Shields Ave., Davis, CA 95616

²NOAA, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060

edchapman@ucdavis.edu

Diel Migrations of Salmon Smolts in the Sacramento River, Delta, and San Francisco Bay Estuary

We have been able to track fine scale movements of chinook salmon, *Oncorhynchus tshawytscha*, and steelhead trout, *Oncorhynchus mykiss*, in the Central Valley of California through the use of ultrasonic telemetry. Miniature, ultrasonic coded beacons were implanted within the peritoneum of 500 fish during January of 2007 and released at four locations throughout the Sacramento River and Delta. These fish have been detected by an array of monitors established throughout the watershed extending from Redding to the Golden Gate Bridge in the San Francisco Bay. The detections of chinook over the following months (January, February, and March) exhibited a diel pattern of migration, that is there are few detections during daytime and many during nighttime. This is likely because individuals remain within a confined area during the day moving little, and then become active at night swimming extensively downstream. Furthermore, the difference between the ratio of more frequent nighttime detections to less frequent daytime detections of chinook smolts decreases in the Delta and San Francisco Bay Estuary. Steelhead, which reside upriver longer, do not exhibit the same diel pattern to detections at any point during their out migration. There may be other environmental cues that stimulate migrations of steelhead such as rainfall events (see Sandstrom et al. poster), but it does not appear to be related to day length.

CALFED Statement of Relevance

Late Fall Chinook smolts are exhibiting diel patterns of migration which may help managers determine the use of water in the Sacramento River. These fish are traveling at night in the upper river and by limiting the use of pumps during the day we may be able to reduce mortality.

Christiansen, N.A., L. Martin
San Francisco Bay NERR, 3150 Paradise Dr, Tiburon, CA 94920
nicsen@sfsu.edu

Water-quality Monitoring in the San Francisco Bay National Estuarine Research Reserve

To enhance the understanding of estuarine ecosystem function and health and to create a countrywide protocol for data collection and analysis, the National Estuarine Research Reserve (NERR) system developed the System-Wide Monitoring Program (SWMP) in 1995. The SWMP systematically gathers water-quality, meteorological, and biological data over a range of spatial and temporal scales at each of the reserves. The goal of the SWMP is to track long-term changes and short-term variability in the nation's estuarine systems and to make these important datasets available to the public. SWMP data has been used to facilitate research and teaching, assist in land management decisions, and increase public interest. These interactions enhance stewardship awareness and lead to a more comprehensive appreciation and understanding of estuaries. Since 2005, the San Francisco Bay NERR has been analyzing nutrient loads and collecting water-quality data at 15 minute intervals from China Camp State Park in San Rafael. Recently we have created additional monitoring stations, including another station near China Camp, in Gallinas Creek, and two stations in Rush Ranch Open Space Preserve in Suisun Bay. Due to their relatively undisturbed histories, both areas serve as reference sites. In this poster we describe San Francisco Bay NERR's water-quality monitoring program, highlight the latest developments, summarize the data, and provide links to relevant datasets.

CALFED Statement of Relevance

By providing consistent, long-term water-quality, meteorological, and nutrient data for San Francisco Bay, we contribute to the growing database that supports the comprehensive understanding the estuarine ecosystem. Both NERR sites are rare representatives of historically intact marshes and watersheds, therefore the datasets provide important baseline information for restoration and research activities in the Bay.

Clemento¹, A.J.* , J. Garza², E. Anderson²

¹UC Santa Cruz Ocean Sciences/NOAA Fisheries, 110 Shaffer Road, Santa Cruz, CA 95060

²NOAA Fisheries, 110 Shaffer Road, Santa Cruz, CA 95060

anthony.clemento@noaa.gov

Validation of a New Method for Population Assessment of Pacific Salmonids

The goal of the proposed research project is to evaluate a novel method of efficient genetic tagging through an experiment with Chinook salmon (*Oncorhynchus tshawytscha*) from California's Central Valley. Current management of the California Chinook fishery relies heavily on population data derived from coded wire tags (CWTs). The CWT program is limited by its ability to tag only a small percentage of hatchery production and subsequently, by extremely low tag recovery rates. This problem is exacerbated by the need to store, transport and process adult heads and by recent developments which necessitate secondary tags to indicate CWT fish. Utilizing a new methodology for large-scale parentage inference, collection of genetic information from the parental breeding generation can be used to "tag" the offspring cohort. At a hatchery or weir, the entire breeding population can be sampled, and the entire next generation tagged. Subsequent non-lethal sampling of fish during their seaward migration, in fisheries and upon return to spawn (either at hatcheries or instream) is followed by parentage assignment with high confidence, allowing accurate pedigree reconstruction and identification of stock and cohort of origin. This parentage-based tagging (PBT) method can also be used to identify family groups and, therefore, to estimate heritability and eventually map genes involved in the inheritance of physical traits (e.g. size, growth, age-at-return) to their chromosomal locations. Such data can provide a predictive framework for assessing the effects of different management and conservation actions. We are currently developing molecular assays for use in PBT and have isolated single nucleotide polymorphisms (SNPs) using published salmonid sequence data. Sampling has been implemented at one of the largest hatcheries in California. I am evaluating the relative costs and benefits of the PBT method with traditional CWT, and laying the statistical foundation for future investigation of inheritance of salmon life history traits.

CALFED Statement of Relevance

The Central Valley is the primary source of Chinook to California's ocean salmon fishery. The 2008 collapse of Central Valley Chinook cohorts, and the subsequent fishery closure, highlights the need for a more comprehensive PBT-based tagging strategy, so that limited sampling can still be implemented to yield valuable population data.

Clipperton, N.W., D.W. Kratville
Department of Fish and Game, Water Branch, 830 S Street, Sacramento, CA
95811
nclipperton@dfg.ca.gov

***Shedding Light on the Shallows: Evidence from Multiple Estuaries
Illustrates the Benefits of Tidal Marsh to Native Fish***

In the early years of CALFED, emphasis was on shallow water habitat restoration as the means to improve ecological conditions in the Delta. The definition of shallow water habitat included a diversity of habitats including bay edge, sloughs, flooded islands, river channels, and wetlands. Certain shallow water habitats in the Delta were later shown to provide little value to native species, and in many cases were benefiting non-natives, including submerged aquatic vegetation (SAV) and non-native predatory fish. This has raised questions as to the value of shallow water in general. The majority of the Delta was historically a vast expanse of tidal marsh. In many estuaries on all coasts of North America, tidal marsh has been shown to have obvious water quality benefits and has been clearly shown to be extremely valuable for native fishes. On the Pacific coast, many native fish spawn and rear in tidal marshes. Fish with access to marsh surfaces and channels have been shown to have improved foraging success, greater stomach fullness, and increased growth rates compared to fish without access. Small tidal marsh channels and marsh plains may also provide refuge from predators. Of aquatic habitats in the upper San Francisco estuary, tidal marsh channels have the highest phytoplankton concentrations and support the greatest zooplankton growth rates. Exchange of this productivity with adjacent habitats through tidal circulation may improve food availability in adjacent open water habitats. In order to benefit native species, tidal marsh restoration must be designed to use local hydrology and geomorphology to mimic a native marsh. Marshes should be designed to have an extensive system of dendritic channels including shallow, intertidal channels with high velocity flows that maintain the channels and prevent the establishment of SAV. If restoration of tidal marsh follows proven design criteria developed in the San Francisco Bay, it has the potential to provide numerous benefits to native fish species.

CALFED Statement of Relevance

Provides new direction for CALFED ecosystem restoration in the Delta to contribute to the recovery of native fish species.

Cocherell, D.E., A. Klimley, J.J. Cech Jr.
UC Davis, One Shields Ave., Davis, CA 95616
decocherell@ucdavis.edu

Temperature Preference Studies of Juvenile Green Sturgeon *Acipenser medirostris*, using a Large, Annular Laboratory Apparatus

Little information is known of the behavioral preferences of anadromous green sturgeon *Acipenser medirostris* inhabiting the Bay-Delta ecosystem. Traditional preference apparatuses for fishes have had significant drawbacks, limiting their usefulness in studies of active or moderately active fishes. To effectively determine sturgeons' environmental preferences, we constructed a 3-m-diameter, annular chamber of clear, acrylic plastic. A smaller version (1-m-diameter) of this annular apparatus has proved effective in recent thermal studies. This annular design decreases the possible, confounding variables of differential light intensities, water depths, and cover found in other chambers. Our annular chamber has constant water depths and velocities, uniform light intensities, and stable vertical and horizontal temperature gradients for the experimental fish. Temperatures in the Sacramento River and Delta, regions frequented by juvenile sturgeon, typically range between 8-23° C, seasonally. Our objective is to experimentally demonstrate (via frequency of occurrence histograms) the temperature preferences of age-0 and age-1 green sturgeon acclimated to temperatures in this relevant seasonal range, mimicking Sacramento River and Delta environmental conditions. In determining green sturgeon temperature preferences, life history models can be improved to make more accurate occurrence predictions of wild, age-0 and age-1 green sturgeon in the Sacramento River-Delta-San Francisco Bay system. Research funded by CALFED and the California Department of Fish and Game.

CALFED Statement of Relevance

By including green sturgeon temperature preferences into life history models, natural resource managers can improve occurrence predictions of wild, age-0 and age-1 green sturgeon in the Sacramento River-Delta-San Francisco Bay system.

Cochrane, L.A.* , V. Parker
San Francisco State University, Biology Department, 1600 Holloway Ave, San
Francisco, CA 94132
LAURA10@sfsu.edu

Seed Bank Diversity of Oxbow Lakes on the Sacramento River

This project aims to assess the effects of the invasive species *Ludwigia peploides* ssp. *montevidensis* on seed bank diversity and formation in oxbow lakes on the middle Sacramento River. Oxbow lakes are dynamic off-channel wetlands that provide critical habitat for a myriad of organisms and naturally vary in their histories and degree of connectivity to the main stem of the river. These differences shift their functional hydrology, potential for flooding, and other characteristics. We sampled for soil seed banks in the bottom of a subset of these lakes along functional gradients of connectivity and invasion. Ten soil cores approximately 5 cm diameter x 5 cm depth were collected from each site. Cores were homogenized, split into two equal parts and spread evenly in 25 cm x 25 cm flats and then subjected to one of two watering treatments: saturated or submerged. Seed bank characteristics were determined using the seedling emergence method. We have found moderate diversity of terrestrial species in the saturated treatment but generally low seed density. In the submerged treatment, emergence and diversity of aquatic species are quite low, comparable to findings of field surveys previously conducted. Preliminary findings indicate that *L. peploides* is inhibiting seed bank formation and suggest that *L. peploides* is displacing native species, either by crowding, shading, or other effects. Anoxic water and low aquatic plant diversity in many of our sites indicates unfavorable water quality may be limiting these systems. Management practices must take into consideration the significant negative effects of *L. peploides* on native seed banks and on the ecosystem as a whole.

CALFED Statement of Relevance

Water policy and resource management efforts require an understanding of how invasive species will impact wetland dynamics, affect water quality and influence restoration efforts. Oxbow lakes are linked to Bay-Delta wetlands and insight as to how these systems might change is critical to future management.

Cohen¹, S.C., B. Ort¹, K.B. Boyer¹, S.W. Wyllie-Echeverria²

¹Romberg Tiburon Center, Biology Department, and San Francisco State University, 3150 Paradise Drive, Tiburon, CA 94920

²Friday Harbor Labs, University of Washington, 620 University Road, Friday Harbor, WA 98250

sarahcoh@sfsu.edu

Seagrass Restoration Genetics: Genetic Diversity in Experimental and Natural Populations in San Francisco Bay, California

Seagrass populations in San Francisco Bay exist as a series of fragmented units that are genetically and geographically distinct. This arrangement presents restoration challenges. A multi-faceted restoration approach funded by NOAA and the California Coastal Conservancy has incorporated genetic characterization of sources and restoration sites to evaluate seed-based restoration. Genetic diversity was sampled in an annual population and several perennial populations. First generation offspring in mesocosms continued to reflect the genetic composition of their donor populations, remaining genetically distinct from each other, but not from their source. However, offspring in a restoration site may be genetically distinct from their source and tend to lose differentiation from each other. Nonetheless, genetic diversity remains high in mesocosm and field trials in the first generation, based on 7 microsatellite loci. In sum, initial follow up of seeding suggests it is an effective method for supplying population genetic diversity that is critical to seagrass population resilience. To resolve questions regarding selection between donor and restored populations and overall diversity, we recommend increased sampling and longer term genetic monitoring of source and restoration populations to gain a baseline and the collection of experimental data to characterize temporal variation. This research aids ecosystem restoration planners in the choice of appropriate donor material that will be most likely to maximize genetic diversity, and by inference, biomass and resilience in the face of inevitable disturbances to populations of this critical foundation species.

CALFED Statement of Relevance

This research aids ecosystem restoration planners in the choice of appropriate donor material that will be most likely to maximize genetic diversity, and by inference, biomass and resilience in the face of inevitable disturbances to populations of this critical foundation species.

Coleman, B.K., M. Roos, K. Kao, M. Mierzwa, F. Chung
Department of Water Resources, 3310 El Camino Ave, Suite 200, Sacramento,
CA 95821
bcoleman@water.ca.gov

Calculating Historical Sea Level Trends in California

Problem Statement: Sea level rise is a key issue for managing both California's water resources and protecting its various local coastal communities. While it is desirable to establish common rates of sea level rise for all planning activities in areas like the Sacramento-San Joaquin Delta, it is important to understand the variation in sea level change at California's other coastal communities in order to better plan for the consequences of sea level rise. Approach: Several California coastal tidal stations, including La Jolla, Golden Gate, and Crescent City, with long periods of recorded gage data were used to analyze the long-term sea level change trends throughout the State. Both centered and backward-looking 19-year means for each station were used to isolate the effect of long-period astronomical variations in local gage data and to illustrate the sensitivity of sea level trends on the averaging method. These local rates were also compared with established global mean sea level rise estimates. Results: Based on the historical trend analysis of the centered 19-year mean, Golden Gate (San Francisco) and La Jolla (San Diego) both showed gradual rises in level. In contrast, Crescent City showed a long-term decrease.

CALFED Statement of Relevance

Relevance: An improved understanding of the basic methodology used to evaluate historical local sea level change is crucial to aiding public understanding of the more complex issues related to projecting future sea level rise trends. This poster meets CALFED's objectives by linking to posters focused on projecting the impacts of sea level rise on water supply reliability, water quality, and levee stability in the Bay-Delta.

Collins, E.M., R.G. Titus

California Department of Fish & Game, 8175 Alpine Ave. Suite F, Sacramento, CA 95826

ecollins@dfg.ca.gov

Steelhead Smolt Emigration: The First Year of Acoustic Monitoring Through the Lower American River and Sacramento San-Joaquin Delta System

Little is known about smolt emigration, including timing and survival, of wild juvenile steelhead on the lower American River. Work to date by the California Department of Fish and Game suggests that most wild steelhead in the lower American River smolt at age 1. However, very little is known about what months of the year these fish smolt, how far they travel, how long the migration takes, and when and where the fish experience relatively high mortality. More specific questions include: Do some smolts go to the ocean while others stay in the Sacramento-San Joaquin Delta (Delta) system? Do some never leave and become resident fish, or “rainbow trout?” This information is very important for our basic understanding of steelhead ecology and has been unattainable to date through standard river sampling methods such as rotary screw traps. We initiated a monitoring study in early 2008 to address these questions using acoustic tag technology. Our study takes advantage of a network of hydrophones already in place on the Sacramento River and throughout the Delta and San Francisco Bay. In addition, we have added four hydrophones over the course of the lower American River. Our target was to tag 100 smolts with V9-1L Vemco tags between January and April 2008, but we only succeeded in tagging 13 steelhead smolts. As of May 2008, eight smolts have moved downstream past our lowermost hydrophone, two have not been detected on any of the hydrophones, and three have not moved from the area in which they were first tagged and released. We will resume tagging steelhead pre-smolts in September 2008 to provide opportunity to monitor for a potential late fall-early winter emigration of fast growing young-of-year steelhead from the lower American River.

CALFED Statement of Relevance

Acoustic technology is being used on the lower American River in order to answer questions regarding juvenile steelhead life-histories. This information is very important for our basic understanding of steelhead ecology and for management of this Central Valley population, currently listed as threatened under the Endangered Species Act (ESA).

Connon¹, R.E., J. Geist², L. Dabronzo¹, E. Tung¹, I. Werner¹

¹UC Davis, School of Veterinary Medicine: Anatomy, Physiology and Cell Biology, One Shields Avenue, Davis, CA 95616

²Technische Universität München, Fish Biology Unit, Department of Animal Science, D-85350 Freising, Germany

reconnon@ucdavis.edu

Tissue-Specific Transcription of Stress-Responsive Genes in Striped Bass (*Morone saxatilis*), Following Exposure to Water Samples from the San Francisco Estuary, California, USA

Striped bass (*Morone saxatilis*) are pelagic, euryhaline, predatory fish of Atlantic origin. Popular as a sport fish, they are economically important and have been introduced to areas outside their natural distribution range, such as the San-Francisco Bay Area. Over the last few years abundance indices in the upper San Francisco Estuary have shown precipitous declines. A multitude of factors, including over-fishing, degradation and loss of habitat, invasion of exotic species, flow modification, and pollution have been attributed to the decline of species. Toxic contaminants from agricultural, industrial, urban and mining activities, acting individually or synergistically are one of several factors potentially affecting pelagic productivity. In this study, we tested the effects of 7-d laboratory exposure to water samples from seven sites of interest in the San Francisco Estuary on several molecular biomarkers. Real-time quantitative PCR was used to determine tissue-specific transcription changes, measuring cellular stress responses in proteotoxicity (hsp70, hsp90), phase I detoxification mechanism (CYP1A1), metal-binding (metallothionein), estrogenic (vitellogenin), immune-function and pathogen-defense (TGF- β , Mx-protein, nRAMP). Parameters, such as length and weight, swimming behavior and mortality were also recorded. Here we present changes in expression of these molecular biomarkers in liver, spleen, white muscle, anterior kidney, brain and gills after 7-day exposures of 90-day old striped bass. We compare transcription levels between sites tissues, and control fish, and explore potential causative factors to the decline in numbers of this species.

CALFED Statement of Relevance

Striped bass (*Morone saxatilis*) are an economically important sport fish which have dramatically declined in abundance. This research uses molecular biomarkers to investigate the effect of stressors present in ambient water samples, a probable cause in their population decline.

Cosentino-Manning¹, N.K., K. Merkel², S. Wyllie-Echeverria³, M. Fonseca⁴, J. Kentworthy⁴, C. Addison⁴, M. Jacobi⁵, J. Jensen⁶

¹NOAA Fisheries Restoration Center, 777 Sonoma Ave Suite 219-A, Santa Rosa, CA 95404

²Merkel and Associates

³University of Washington

⁴NOAA NCCOS, Applied Spatial Ecology

⁵NOAA Assessment and Restoration Division

⁶Caltrans

natalie.c-manning@noaa.gov

Research to Guide Eelgrass (*Zostera marina*) Restoration in San Francisco Bay: Mapping, Monitoring, and Recovery Rates

Historically (before 2003), there have been few attempts at eelgrass restoration in San Francisco Bay and these efforts have met with little success. Protecting and restoring productive eelgrass beds is a high priority for the National Oceanic and Atmospheric Administration (NOAA); however, little is known about which factors govern eelgrass restoration success within the Bay. In 2003, two research efforts began to document the current status of eelgrass and the limiting factors that control eelgrass restoration: the Bay-wide Eelgrass Research Project (funded by the California Department of Transportation, CALTRANS) and NOAA's National Ocean Service (NOS) Eelgrass Pilot Recovery Project (funded as a partnership with NOAA Fisheries, NMFS). Through sidescan sonar, the Bay-wide Eelgrass Research Project has resulted in maps that define the distribution and density of eelgrass coverage, finding much greater acreage than previously known as well as additional beds. Through biophysical modeling that considered many physical attributes that could influence eelgrass success, additional maps were created that predict regions favorable to eelgrass and that are now being used in restoration planning. Monitoring of eelgrass densities and distributions has led to the development of a monitoring protocol for San Francisco Bay. As part of the mapping project, an eelgrass recovery project was initiated at several sites within the Bay. The recovery project is providing recovery rate data for planning of restoration projects and computation of interim loss resource services for computing restoration ratios and to assess recovery times after an injury. Moreover, the recovery project has identified both annual and perennial growth forms of eelgrass over large areas of the Bay. This fact is important since an unusually high prevalence of annuals would dramatically alter options for restoration and expectations for management, as all studies to date are based on perennial growth strategies.

CALFED Statement of Relevance

Biophysical modeling suggests that eelgrass (*Zostera marina*), a flowering plant that inhabits 3000 acres of shallow habitat in San Francisco Bay, could be restored to hundreds, if not thousands, of additional acres. As previous restoration attempts have had limited success, we have developed a multi-faceted approach to explore constraints and maximize the potential for successful restoration of this important foundation species and its associated community. Through surveys of extant eelgrass beds we are assessing characteristics including plant densities, genetic diversity, and epifaunal community structure to aid in choices of donor material for restoration and develop goals for restored habitat attributes. Through mesocosm and field experiments, we are testing seeding and transplanting techniques, comparing success of different donor material sources (examining recruitment, clonal spread, flowering rates, and maintenance of genetic diversity in restored populations), and testing restoration site suitability, including evaluation of the role of planting depth in restoring eelgrass at different sites. This poster cluster meets the goals and objectives of the CALFED program by providing new insights into the processes governing a key species and habitat in the estuary and developing guidelines and tools to promote successful ecosystem restoration and management.

Cramer, S.P.

Cramer Fish Sciences, 600 NW Fariss Road, Gresham, OR 97030

stevec@fishsciences.net

The Rainbow x Steelhead Interaction: Strengthening Population Viability

Federal fisheries agencies have chosen a policy to treat resident and anadromous *O. mykiss* within the same basin as distinct ESU's or DPS's under the Endangered Species Act. In spite of the policy, there is clear evidence that the two ecotypes often interbreed, and share the same stream networks to spawn and rear. Parentage and breeding studies indicate that the tendency for either anadromy or residency is an inherited trait among *O. mykiss*, and expression of the trait is also influenced by environmental circumstances. We used life-cycle modeling of resident rainbow and anadromous steelhead populations to simulate how the interaction of one type with the other influenced the population viability of either type. The model included the response of inherited traits to natural selection by environmental factors that influenced carrying capacity, migration, and survival. Both resident and anadromous parents can produce offspring of either type, but the ability to survive in saltwater is greater for fish from anadromous parents. On the other hand, resident rainbow experience higher parr-to-adult survival, are less fecund, but have higher rates of repeat spawning. Consistent with observations in the Sacramento Basin and elsewhere, the simulations showed residency will predominate in river reaches with cool, dependable flow through the summer, while anadromy will predominate in areas where summer carrying capacity is sharply reduced by low flow and high temperature. These population responses are adaptive, enabling *O. mykiss* to thrive in a wide range of habitats and environmental circumstances. Predicted viability of the population over the long term for either ecotype was much higher when the contributions of both ecotypes to each other were accounted for.

CALFED Statement of Relevance

Species and Communities - Science that advances monitoring, understanding and management of steelhead (ESA listed) and their ecological functions and requirements in the Bay-Delta and its watershed.

Curtis¹, M.J., D.E. Rider¹, R.E. O'Dell², V.P. Claassen¹, S. Lorenzato
¹UC Davis, 2144 Plant and Environmental Sciences Building, Davis, CA 95616
²Bureau of Land Management, Hollister, CA
vpclaassen@ucdavis.edu

Evaluation of Infiltration beneath Annual versus Perennial Grass Communities

We examined differences in surface soil hydrology between annual and perennial grasslands, in an effort to determine the extent to which each one of these vegetation types would facilitate rapid surface infiltration, so as to reduce peak flood flows and to recharge shallow aquifers. Rainfall simulations were used to evaluate surface saturated hydraulic conductivity on seven sites in central and northern California. At each site, paired plots consisting of monocultures of either annual or perennial grasses were identified. Our data indicate that perennial grasslands have a significantly greater surface saturated hydraulic conductivity, or infiltration, than annual grasslands. The average increase in infiltration between all paired sites was 63 %. Soil bulk density and penetrometer resistance were also lower in perennial grasslands compared to annual grasslands. These data indicate that management of grasslands for perennial grasses rather than annual species will increase surface infiltration, which can be expected to reduce peak flood flows and recharge shallow aquifers to a greater degree than the current annual grasses that dominate California grasslands.

CALFED Statement of Relevance

Increased soil infiltration reduces overland flow and reduces spikes in stormwater runoff. Native perennial species have deeper roots and greater infiltration than the current communities of invasive annual grasses that cover much of California's foothills and central valley. This study quantifies benefits of this infiltration capacity for stormwater attenuation.

Dailey, B.A.*, V. Parker
San Francisco State University, 1600 Holloway Ave, San Francisco, CA 94132
bianca97@comcast.net

Effects of Salinity on Germination in a Brackish-freshwater System in Response to Climate Change

We are investigating the effects of increased salinity on germination for brackish-fresh water marsh vegetation because salinity will increase in the brackish marsh zones in response to climate change. We set up a seed bank experiment to further understand the effects of rising salinities on germination for these systems. Soil cores were collected from Browns Island (fresh/brackish marsh in CA) along transects from channel sites inland. They were then divided amongst three different treatments of varying salinity levels (0, 3 & 10 ppt.) and germination was recorded based on distance from channel and salinity treatment level. We find that far more germination was observed for the control treatment (0 ppt.). As salinity levels increased, germination numbers decreased. Germination numbers for the control treatment were recorded highest at the furthest distance from the channel while for the 2 saline treatments germination was found to peak at the 75 m mark. Increased salinity acts as a germination inhibitor for many brackish-fresh water species. Faced with the threat of rising sea levels, fresh-brackish systems are expected to see a decrease in germination from this flora because of rising salinities. While all wetland species germination are inhibited to some degree by salinity, a prolonged shift in salinity, such as expected due to rising sea level, could result in a full ecosystem conversion from a high diversity fresh-brackish marsh to a low species diversity salt marsh.

CALFED Statement of Relevance

Wetlands policy and reserve management efforts require an understanding of how climate change will impact wetland dynamics and will influence restoration efforts.

Dale¹, L.L., N. Miller¹, C. Brush², S. Vicuna³, T. Kadir², E. Dogrul², F. Chung²
¹Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720
²Department of Water Resources, 1416 Ninth Street, Sacramento, CA 95814
³University of California Berkeley
lldale@lbl.gov

Drought Analysis of the California Central Valley Surface-Groundwater-Conveyance System

Problem Statement: This study quantifies the impacts of long-term droughts - an analogue for climate change related snowpack reduction - and to illustrate the potential for subsurface storage to limit adverse impacts on water supply in the Central Valley. This includes how groundwater pumping compensates for reductions in surface inflow, changes in water table elevations, and potential for system recovery. This study also includes estimates of the impacts of changes in groundwater levels and surface supplies on crop acreage and crop water demands.

CALFED Statement of Relevance

These results are relevant to the CALFED objectives of understanding water supply reliability and ecosystem restoration.

Dallas¹, K.L.* , P.L. Barnard²

¹Department of Earth and Planetary Sciences, UC Santa Cruz, 1156 High Street, Santa Cruz, CA 95060

²United States Geological Survey, Coastal and Marine Geology Team, Pacific Science Center, 400 Natural Bridges Drive, Santa Cruz, CA 95060

katedallas@gmail.com

Impact of Sand and Gravel Removal From San Francisco Bay

San Francisco Bay is among the most anthropogenically-altered estuaries in the entire United States, but the effect of human activities on sediment transport to the coastal ocean has not been quantified. Since the discovery of gold in 1848 the bay floor has been continuously altered by a range of activities, including infill by hydraulic mining debris, mining of fill for bay development, dredging of harbors and waterways, and mining of sand and gravel for use as construction aggregate. In order to assess the impact of these activities on the regional sediment budget, historical records are compiled to quantitatively assess the total volume of material removed from the system. Long-term effects on the amount of sediment delivered to the coastal ocean are analyzed through comparison of hydrographic surveys of the San Francisco Bar, a huge, 120 km² ebb tidal delta at the mouth of the Golden Gate. Survey data from 1855, 1873, 1900, 1955, and 2005 are compiled to create bathymetric models and compared to quantify net sedimentation volumes and rates of sediment deposition and erosion. Modifications in the volume of sediment transported through the Golden Gate are crucial to quantify because it supplies sand to coastal beaches, which are valued for their beauty, critical habitat, and protection they provide to low-lying infrastructure. This system-wide approach is unique to the region and emphasizes the often overlooked connection between San Francisco Bay and the coastal ocean. Results are key to understanding sediment transport within the system and are beneficial to a variety of state and federal agencies responsible for sediment management within the bay.

CALFED Statement of Relevance

Knowledge of system-wide processes affecting sediment delivery to the coastal ocean will enhance our ability to establish successful and sustainable sediment management practices inside San Francisco Bay.

De Riu, N., D.F. Deng, G.D. Moniello, S.S. Hung
Department of Animal Science, University of California, One Shields Avenue,
Davis, CA 95616
nderiu@ucdavis.edu

Growth Performances, Tissue Burden, HSP 70 Expression, and Caspas 3/7 Activity in Juvenile White Sturgeon Fed Diets with Graded Levels of L-selenomethionine

Selenium (Se) toxicity resulted from various anthropologic activities has become a primary concern in some environmental contaminant situations because of its bioaccumulation in the aquatic food chain. Effects of releasing subsurface agricultural drainage water from seleniferous soil of the Central Valley to the San Francisco Bay Delta in California to the native white sturgeon are not well understood. An 8-week trial was conducted to determine the growth performances, tissue Se burdens, HSP 70 expression, and caspas 3/7 activity in juvenile (30 g) white sturgeon fed graded level of Se. Twelve tanks of white sturgeon with 25 fish per tank were kept at 18°C and three replicate tanks of fish were fed one of four purified diets laden with 0, 20, 40, or 80 mg Se/kg diet. Selenium was added in the diets in the form of L-selenomethionine because it is an ecological reverent Se compound in the aquatic food chain. After the 8-week growth trail, there was no mortality in fish in all dietary treatment groups but a significant ($P < 0.05$) decrease in growth rate and feed efficiency, and a significant ($P < 0.05$) increase in Se concentration in the whole body, gill, kidney, heart, liver, and white muscle in fish fed diets with increasing levels of L-selenomethionine. Liver HSP 70 expression and caspas 3/7 activity were also significantly ($P < 0.05$) increased with increasing dietary L-selenomethionine. Results in this trail suggested that even at the lowest added concentration (20 mg Se/kg diet), an ecologically reverent concentration, L-selenomethionine is toxic to juvenile white sturgeon.

CALFED Statement of Relevance

Selenium toxicity is a primary concern in some environmental contaminant situations because it is bioaccumulated in aquatic food chain. Effects of releasing subsurface agricultural drainage water from seleniferous soil of the Central Valley to the San Francisco Bay Delta in California to the native white sturgeon are not well understood.

De Rosa, L.D., A.J. Thuman, H. Li, T.W. Gallagher
HydroQual, Inc., 1200 MacArthur Blvd, Mahwah, NJ 07430
lderosa@hydroqual.com

San Joaquin River Deep Water Ship Channel - A Hydrodynamic and Water Quality Model to Assess Alternative Management Strategies for Dissolved Oxygen Impairment

Organic carbon enrichment and low dissolved oxygen (DO) has led to water column impairment in the San Joaquin River Deep Water Ship Channel (SJR DWSC). Under funding from the CALFED Ecological Restoration Program and as part of the development of a DO TMDL in the SJR DWSC, a 3-dimensional hydrodynamic and water quality model was developed and calibrated to explore adaptive management strategies that address DO violations. The calibrated model computes eutrophication (nutrient-algae-DO) and sediment interactions and takes into account the upstream loads, Stockton RWCF discharge and the changing DWSC geometry. The model has been specifically tailored to compute light dependent algal growth based on modeled total suspended solids (TSS) concentrations. The 3D model surface velocities are greater than bottom velocities reflecting bottom shear stresses and the model is able to compute surface to bottom water quality over the tidal cycle. Adaptive management model simulations to project impacts on DO in the DWSC were made. Unit responses were made to quantify contributions of oxygen demands from upstream carbon loads, instream algal growth and decay, the Stockton RWCF ammonia load, and sediment oxygen demand (SOD). Projections were done to simulate DO conditions that would result under various flow scenarios, some of which simulate managing flow in the DWSC by changing upstream agricultural diversions via barrier operations during low-flow summer periods. The CA Department of Water Resources (DWR) has installed an aeration device to inject oxygen into the DWSC to aid in improving DO conditions. Model projections were made to simulate DO in the DWSC under operation of the aeration device.

CALFED Statement of Relevance

This work was funded by CBDA's CALFED Ecological Restoration Program and supports the programs goals of protecting and restoring water quality in the Sacramento-San Joaquin Delta.

DeVore, K.L., W. Patterson, L. Konde, I. Oshima, G. Ewing
California Department of Fish and Game, 4949 Viewridge Road, San Diego, CA
92123
kdevore@dfg.ca.gov

Lake Davis Pike Project (GPS Treatment Tracks)

In September 2007, the California Department of Fish and Game (DFG) completed a chemical treatment project to eradicate the invasive northern pike from Lake Davis and its tributary streams. Unlike an eradication effort in 1997, the 2007 project included significant use of GIS and GPS to improve the likelihood of success. GIS and GPS proved to be powerful tools critical to the successful implementation of a project of this scope and complexity. GIS provided the means to create needed map-reference products and facilitate geographic analyses. GPS provided necessary tools for surveys, navigation, and tracking. Both technologies were utilized to produce status maps that were invaluable in conducting the 2007 treatment.

CALFED Statement of Relevance

When nonnative species spread quickly and threaten the abundance and diversity of native plants and animals, they are considered invasive. Northern pike (*Esox lucius*), an extremely aggressive predatory fish, can seriously affect aquatic ecosystems by eating fish such as trout and salmon. Pike have adversely affected both trout fishing and the local economy at Lake Davis in California.

Deng, D.F., S. Acuna, B. Bradd, X. Deng, N. Ikemiyagi, W. Bennett, J. Lindberg, S. Teh
UC Davis, Aquatic Toxicology Program, Davis, CA 95616
ddeng@ucdavis.edu

Does Size Really Matter in Adult Smelt's Reproductive Performance?

The objective of this study was to test the effect of size of female delta smelt (*Hypomesus transpacificus*) on reproductive performance. Two size classes of 1 year old F1 hatchery smelt with average body weight and length of larger females (n=6) of 4.79 g and 82.3 mm and smaller females (n=6) of 2.36 g and 65.2 mm were tested. Fish gametes were manually expressed with in vitro fertilization; embryos and hatchlings were maintained at 16 0C. Reproductive performance including fecundity, fertility, hatchability and embryo and larval sizes were measured. RNA/DNA ratio of newly hatched and 7 days old larval smelt will be determined to estimate their growth. The newly hatched larval smelt were also exposed to increasing temperature challenge (16 to 24 0C for 4 hours). Results showed that the larger females had higher fecundity, fertility and hatchability than the smaller females. There are no differences in condition factor, gonadosomatic and hepasomatic indices between adult smelts of different sizes and expression of heat shock protein (hsp70) between larvae from larger or smaller adult smelt. Analysis of RNA/DNA ratio and measurements of developing smelt are work in progress and will be presented.

CALFED Statement of Relevance

Our study has important implications for the primary CALFED objectives. Restoration and water conveyance measures intending to benefit delta smelt could be measurably improved by targeting larger females that clearly have the capability to produce more and higher quality offspring.

Dettinger¹, M.D., D. Cayan, H. Hidalgo²

¹USGS, Scripps Institution of Oceanography, UCSD, La Jolla, CA 92093

²Scripps Institution of Oceanography, La Jolla, CA

mddettin@usgs.gov

CASCADE Climate Change Scenarios—Methods and Availability

The first link in the chain that the CASCaDE project is developing of physical and ecosystem models of the Bay-Delta-watershed system is the connection to climate-change simulations by models of the global climate. Four simulated climate-change scenarios are being evaluated, with two from the Geophysical Fluid Dynamics Laboratory's GFDL CM2.1 climate model (a model that is highly sensitive to greenhouse-gas increases) and two from the National Center for Atmospheric Research's Parallel Climate Model (which is less sensitive). Simulations from these two climate models under projections of accelerating emissions of greenhouse gases (A2) and gradually slowing emissions (B1) have been downscaled for use in other CASCaDE models using the new constructed analogues method. Downscaling was primarily to a 12-km grid that spans the conterminous US, including California and the Bay-Delta-watershed region. Daily temperatures (maximum and minimum) and precipitation are available on this grid for the period 1950-2100, through <http://cascade.wr.usgs.gov>

CALFED Statement of Relevance

This poster will mark the release of the downscaled climate scenarios to the CALFED community for use in other studies, thus facilitating investigations of potential effects of climate change on the Bay-Delta system by other groups and agencies and allowing for intercomparability of results across studies.

Deverel, S.J., T. Tesfay, J. Fio
HydroFocus, Inc., 2727 Del Rio Place, Davis, CA 95618
sdeverel@hydrofocus.com

Subsurface Processes Affecting Solute Mobility, Willow Slough Watershed, Yolo County, California

There are concerns about the influence of agricultural activities on the transport of drinking water constituents of concern in central Valley watersheds and the Sacramento River. We investigated the subsurface behavior of dissolved organic carbon and nitrogen related to agricultural activities in the Willow Slough Watershed in Yolo County, a representative Sacramento Valley agricultural watershed. To understand the subsurface flow system and solute mobility, we collected and evaluated physical and chemical data in the unsaturated-zone and saturated zones during 2006 - 2008. Shallow groundwater generally flowed to Willow Slough. Wet conditions during winter and early spring resulted in groundwater flow to the slough throughout 2006. Dry conditions during 2007 resulted in late summer slough water losses to the groundwater system. Groundwater contributes nitrate at the rate of about 2 kg/day-mile to the slough. Shallow groundwater flows slowly in the heterogeneous, predominantly fine-grained deposits and age dating showed that groundwater near the slough recharged 20 to 30 years ago. Therefore, today's land management practices will affect nitrate movement (or lack of) to Willow Slough in future decades. Nitrogen and oxygen isotopes and oxidation-reduction potential measurements indicate that denitrification affects groundwater and unsaturated-zone nitrate concentrations. Unsaturated-zone chemical data shows the influence of fertilization practices and crop. For example for a forage crop, nitrate-N concentrations in the unsaturated zone were low (less than 3 mg/L). In contrast, for corn, concentrations ranged from 5 to 40 mg/L. Fertilization rates for the two crops were similar (about 192 and 227 kg/A-year for corn and forage, respectively) but applied once at the beginning of and four times during the growing season for corn and forage, respectively. Geostatistical analysis coupled with groundwater flow and solute transport modeling is facilitating evaluation of processes affecting groundwater flow and solute movement.

CALFED Statement of Relevance

The presentation provide useful information about factors affecting surface water quality in agricultural watersheds contributing to the Delta.

DiGiorgio¹, C.L., D. Gonzalez², S. San Julian², A. Conner²

¹Department of Water Resources, MWQI Program, PO Box 942836,
Sacramento, CA 94236

²Department of Water Resources, 1450 Riverbank Road, West Sacramento, CA
95605

caroldi@water.ca.gov

Nutrient Dynamics of an Actively Farmed Delta Peat Island

In the Delta, nutrient dynamics have always been important. From an ecological standpoint, recent studies suggest that urban ammonia and phosphate contributions may be responsible for overall changes in Delta algal growth patterns and assemblages. From a drinking water perspective, attention is turning to the carcinogenic precursors associated with nitrogenous products. Given the level of importance to both drinking water and ecological health, understanding the sources and loads of nutrients in the Delta is paramount to understanding how the Delta functions. Traditionally nutrient point sources are the most easily studied (for example wastewater treatment plant inputs), however, due to the difficulties of access, or lack of actual pumping measurements, quantifying nutrient loads produced by in-Delta agriculture have been lacking. This study addressed this gap. From October 2005 to June 2007, samples were collected weekly for nitrate, nitrate + nitrite, ammonia, Total Kjeldahl nitrogen, total phosphate, and dissolved orthophosphate, along with 15 minute continuous flow data from the 2 pumps that drain Staten Island. Staten Island is a 9200 acre actively farmed peat island located in the central/north Delta. Based on nutrient concentrations, and flow, nutrient loads discharged into the receiving water were calculated. With respect to flow, total summer volumes discharged off the island were similar or higher to volumes discharged during the winter. Seasonally, nutrient concentrations were higher in the winter than in the summer. Seasonal concentration differences were due to differences in source water. The greatest seasonal loads were generally discharged during the winter, however for orthophosphate the greatest loads were discharged during the summer. Preliminary calculations suggest that during the 2006 water year, approximately 50,000 kg, total nitrogen and 2,000 kg, total phosphate were discharged off the island. These loads were used to extrapolate peat island nutrient load contributions and compared to existing literature values.

CALFED Statement of Relevance

This study quantifies the nutrient loads discharged off an actively farmed Delta island. These results help fill a critical data gap in our understanding of the contributions made by farmed Delta islands to the overall nutrient load in the Delta.

Dobb¹, D.E., K.E. King¹, S.J. Loughney¹, B.R. Mabey², M.S. Smith¹, S.L. Lunceford¹

¹TechLaw, Inc., 7411 Beach Dr. East, Port Orchard, WA 98366

²TechLaw, Inc., 90 New Montgomery St. #1010, San Francisco, CA 94105

ddobb@techlawinc.com

Development of a Mercury Source Protocol for the State of Utah

Problem Statement: From where is mercury coming? What is the ultimate source of the mercury showing up in Utah's fish population and presenting a human health concern? Can the sources be identified? If the sources can be identified, what can be done to reduce or eliminate the sources of mercury? Approach: TechLaw developed a protocol describing methodology(s) that: 1) efficiently characterize mercury contamination, 2) determine likely source(s) in a water body, and 3) identify receptor pathways of exposure. Initiating the process at the site of a fish advisory, this approach works backward by utilizing mercury studies pertaining to local conditions in addition to potential environmental reactions and localized mercury species that identify potential sources. Results: The holistic watershed approach is designed for phased implementation to capitalize on data obtained from previous steps for subsequent informed decision making. Significant amounts of analytical data existed that needed to be reviewed and summarized before moving forward. Conclusions: The process provides enough detail for personnel to assess a generic setting for potential Hg sources that starts with a conceptual site model, then ventures forward in a stepwise fashion to develop an applicable field design that includes: Development of a local mercury exposure baseline; Phased multi-media sampling plan that dictates the next sampling step; Adequate biological sample collection that represents various rates of Hg bioaccumulation; Using invertebrate and fish tissue sampling results to infer potential higher trophic level exposure; Incorporating variations in aquatic ecosystems into the conceptual site model; Carefully considering stream sampling that is consistent with the conceptual model and purpose of the study, i.e., whether purpose is to target eco or human receptors; and Identifying numerous sediment and surface sampling methods that correspond to study purpose and geological setting.

CALFED Statement of Relevance

- 1) Enable California to address fish advisories.
- 2) Mitigate or control the problem.
- 3) Minimize costs.
- 4) Maximize resources.

Dobroski, N.A., C. Scianni, D.B. Gehringer, M.B. Falkner
California State Lands Commission, 100 Howe Avenue, Suite 100 South,
Sacramento, CA 95825
dobrosn@slc.ca.gov

Implementing Performance Standards for the Discharge of Ballast Water

Ballast water is a major vector for the dispersal of nonindigenous species (NIS) in marine and aquatic habitats. In an effort to curb these species introductions, the California State Lands Commission (Commission) Marine Invasive Species Program (MISP) has recently established performance standards for the discharge of ballast water. The performance standards set limits for organism concentration as a function of organism size class. The standards will be implemented on a graduated time schedule beginning January 1, 2010, with a final standard of zero detectable living organisms in ballast water discharge by 2020. An important step associated with the implementation of performance standards has been the evaluation of available treatment technologies to meet those standards. In its December 2007 report to the legislature, the MISP determined that no single technology is yet able to meet California's performance standards, and only 11 of 28 treatment systems reviewed had results available of testing onboard vessels. A major hindrance to the review of treatment system efficacy was a lack of standardized methods used to verify system performance. As a result of the conclusions drawn from this report, the MISP has developed a standardized set of testing guidelines for use by technology developers in assessing system compliance with California's ballast water performance standards and water quality objectives. Additionally, the MISP is in the process of developing protocols for use by Commission inspectors to verify vessel compliance with the performance standards. These testing guidelines and verification protocols will work in tandem to educate technology developers about California's standards and ensure that all discharging vessels will meet the required standards. California's proactive approach to ballast water management will limit the introduction of NIS in the San Francisco Bay-Delta and other California waterways and serves as a model for effective regional, science-based management of a global challenge.

CALFED Statement of Relevance

California's proactive approach to ballast water management will limit the introduction of NIS in the San Francisco Bay-Delta and other California waterways and serves as a model for effective regional, science-based management of a global challenge.

Dodd, A.M.

CALFED Science Fellow, 1660 Hookton Road, Loleta, CA 95551

amd2@humboldt.edu

Using Passive Particle Simulations and Field Data to Gain Insight into Juvenile Chinook Salmon Behavior for Model Development of Fish Migration in the North Delta

This research addresses a major management issue in the Delta: understanding how juvenile salmon move through the Delta as a means of improving water management actions. How juvenile salmon move through the Delta affects their probability of successfully migrating to the ocean in a variety of ways. Time spent in different regions of the Delta affects growth potential and predation, alters their exposure to entrainment in diversion pumps, and affects the time to out-migrate. The ability to predict juvenile salmon movement will benefit management decisions in the Delta with an increased understanding of how changes in flow, either from natural or anthropogenic causes, affect the probability of success of juvenile salmon reaching the ocean. One of the largest potential influences on flows and fish migration pathways in the north Delta is DCC gate operations. For example, opening the DCC channel gates adds a potential pathway for juvenile salmon to reach the central Delta which can potentially increase the time to travel to the ocean as well as their exposure to entrainment in the south Delta diversion pumps. The ability to predict juvenile salmon movement in the north Delta can assist managers in improving the efficiency of managing DCC operations. A model of fish behavior merged with particle transport can be used as a tool to evaluate how different flows and gate operations affect outmigration. The recommended model development strategy is to find the simplest model of fish movement that is consistent with available data. Under this strategy, alternative models of behavior are hypothesized and then tested by seeing which (by themselves or in combination) can best reproduce a variety of patterns observed in the real system. Models are designed using field data for both design and testing. Designing models to reproduce observed patterns guides the modeler to important processes that should be included in the model, relevant scales, and an appropriate level of detail. The resulting model is then tested by whether or not it can reproduce the observed patterns it was designed to address. The purpose of this work is to present insight into how model results can be used to evaluate affects on migration pathways and identify key behaviors that are missing. This is done through comparison of passive particle simulations to field observations over different flows and DCC gate operations.

CALFED Statement of Relevance

This research addresses a major management issue in the Delta: understanding how juvenile salmon move through the Delta as a means of improving water management actions.

Doroshov, S.I., J. Linares-Casenave, P.J. Allen, J.P. Van Eenennaam
University of California, Department of Animal Science, Davis, CA 95616
sidoroshov@ucdavis.edu

Gametogenesis in Cultured Green Sturgeon

Age and size at maturity and the breeding interval are important determinants of reproductive potential in sturgeons. Currently, there is no such information for the threatened green sturgeon. We studied gametogenesis and the reproductive cycle in captive populations of two year-classes (1999 & 2000) which originated from the Klamath River brood fish. Fish are sampled annually for gonad development and body size, and histological stages of gametogenesis are illustrated by photomicrographs and correlated with fish size and age. Gonadal sex differentiation was completed at age 6 months, considerably earlier than in white sturgeon. Proliferation of spermatogonia started at 2-3 years, and most males matured within 4-6 years, at fork length >125 cm and weight > 15 kg. Growth and differentiation of the ovarian follicle was slow, and vitellogenic growth (deposition of crystalline yolk) commenced at age 6 years. The first four females fully matured at age 8 years, at mean fork length 155 cm and weight 34 kg. These preliminary data revealed a sex-dimorphic rate of sexual maturation in green sturgeon and onset of maturity at an apparently similar to wild fish body size.

CALFED Statement of Relevance

Green sturgeon is a CALFED “at risk species” and this study provides the first detailed description of their reproductive cycle. This information will be valuable for future stock monitoring and assessment studies and provides insight into their unique life history strategy.

Downing-Kunz, M.A.*, M.T. Stacey
University of California, Berkeley, 202 O'Brien Hall, Berkeley, CA 94720
mokunz@berkeley.edu

Transport of Rafting Vegetation in the Sacramento-San Joaquin Delta

This research demonstrates a novel approach to measuring current-induced stresses on floating aquatic vegetation. Water hyacinth (*Eichhornia crassipes*) is a free-floating aquatic macrophyte that forms large mats transported by winds and currents. In the Sacramento River-San Joaquin River Delta (Delta), water hyacinth is found in sloughs and tributary rivers and causes a range of problems such as: blocking canals and waterways, closing marinas, fouling irrigation pumps, displacing native plants, reducing dissolved oxygen in the water, and depositing silt and organic matter more rapidly. Currently, water hyacinth growth is controlled predominantly by herbicide application. Using field-based experiments, this project seeks to improve management of water hyacinth and other non-native rafting vegetation in the Delta through the development of a mechanistic understanding of raft transport and dispersion. At several locations in the Delta, the motions of individual vegetation rafts were measured using a GPS-logging drifter. An Acoustic Doppler Velocimeter (ADV) was used to measure relative water velocities on the underside of the rafts for determining current-induced stresses. Additional measurements of local water and wind velocities were accomplished using an Acoustic Doppler Current Profiler (ADCP) and an anemometer. Field experiment data was used to develop tools and analysis techniques to study raft dynamics, including relative velocities and stresses. This research forms the basis for future development of a predictive model for vegetation raft transport and dispersion based on physical processes.

CALFED Statement of Relevance

This research specifically addresses CALFED's ecosystem restoration and water quality objectives because it considers non-native species that compromise the native ecosystem of the Delta. By investigating the dynamics governing aquatic vegetation transport, this project serves to improve understanding and management of water hyacinth and egeria in the Delta.

Drake, J.L.* , E.J. Carpenter
San Francisco State University, Romberg Tiburon Center for Environmental
Studies, Tiburon, CA 94920
jeana@sfsu.edu

Community Structure and Dynamics of Phytoplankton Blooms in a Brackish Coastal Lagoon

Rodeo Lagoon, the terminus of a wetland system in the Marin Headlands, is a brackish coastal lagoon which has experienced massive phytoplankton blooms for at least the last 30 years. These algal blooms may have detrimental effects on the two endangered species (Tidewater goby, *Eucyclogobius newberryi*; and California brown pelican, *Pelecanus occidentalis californicus*) that inhabit the lagoon and its fringing areas. The goal of this study was to determine 1) factors that promote or inhibit large phytoplankton blooms in the lagoon; and 2) potential negative impacts of the blooms on water quality. These goals were accomplished by measuring physical and nutrient parameters of the lagoon on a weekly basis. Also measured weekly were phytoplankton biomass, community composition, primary productivity, and rates of nitrogen fixation. Results indicate that several large (>500 µg /L chlorophyll a) algal blooms occurred during 2007, with abrupt shifts in dominant taxa. Between these shifts, periods of hypoxia were observed. Nitrogen fixation by the filamentous cyanobacterium *Nodularia spumigena* coincided with an initial increase of ammonium in the water column. Subsequent ammonium cycling in the lagoon system allowed water column concentrations to reach up to 200µM NH₄⁺. These results are important to the National Park Service, which administers Rodeo Lagoon as part of the Golden Gate National Recreation Area, in developing a management plan for the critical habitat in and around Rodeo Lagoon.

CALFED Statement of Relevance

This study examined the relationship between large phytoplankton blooms and wetland habitat for two endangered species.

Drauch¹, A.M.^{*}, J. Rodzen², B. May¹

¹University of California Davis, 2403 Meyer Hall, Davis, CA 95616

²California Department of Fish and Game, Rancho Cordova, CA

amdrauch@ucdavis.edu

Applying Genetic Techniques to Resolve Critical Uncertainties in White Sturgeon Ecology and Management

Several critical uncertainties about white sturgeon ecology may inhibit our ability to make informed management decisions for the species in California, including a lack of information about population structure, dispersal behavior, and recruitment success. To address some of these uncertainties, we will combine genetic and demographic data to examine the status of white sturgeon populations in California and across the species range. First, we will examine population structure of white sturgeon within and among the Sacramento, Columbia, Snake, Kootenai, and Fraser Rivers. Knowledge of the extent of genetic variation in this species may be used in wildlife forensics and law enforcement to identify the sources of poached materials. Second, we will use mixed stock analysis to evaluate dispersal of white sturgeon among large west coast estuaries. Exploitation of white sturgeon occurs primarily in estuaries and if white sturgeon from different spawning populations are found to mix in estuary habitats, interjurisdictional management may be warranted. Finally, we will examine the relationship between spawning stock size and recruitment in the Sacramento River by constructing full-sib progeny arrays of down-migrating juvenile white sturgeon. The ability to estimate the number of adults spawning each year will allow managers to better understand annual population trends and make more accurate projections of future white sturgeon abundance.

CALFED Statement of Relevance

Restoration of white sturgeon, a species of concern in the Delta, requires additional knowledge about important population characteristics such as gene flow, dispersal behavior, and recruitment dynamics. Genetic techniques can be used to examine these characteristics and provide crucial information for white sturgeon management in California.

Durand, J.R.*

UC Davis, WFCB/Center for Watershed Science, Davis, CA 95616

jrdurand@ucdavis.edu

Sources of Secondary Production and Loss in Suisun Bay and Marsh

Currently zooplankton populations are suppressed throughout the Estuary, in part because of invasive clams that are able to filter both phytoplankton and juvenile crustaceans at very high rates, competing directly with fish for food. However, some regions of the Estuary, such as Suisun Marsh and parts of the Delta, still retain very high levels of production. Under certain conditions these productive regions can export adult zooplankton, which are less vulnerable to predation by clams. We analyze zooplankton and fish productivity in Suisun Marsh in an effort to determine what factors control the quantity and quality of production. The study compares a number of different tidal sloughs that have dramatically different physical and biological characteristics. The factors that are to be examined include predation regimes, the physical structure of sloughs and adjacent floodplains, water quality including nitrogen concentration, primary production, and residence time and circulation of water. Our hypotheses are that differences in secondary production vary as a function of one or more of these factors; that predation rates are also controlled by these factors, especially among invasive predators; and that the restoration of shallow water habitat can supply increased zooplankton to POD fishes if these parameters are understood and taken into consideration. Finally, we hypothesize that across the Estuary, secondary production is becoming dominated by organisms that thrive in high nitrogen, low phytoplankton environments, creating a low energy, parallel food web that is not supportive of larger organisms such as fish.

CALFED Statement of Relevance

We examine the conditions required for successful restoration of shallow water productivity in an effort to: 1) remediate potentially unproductive sites, and 2) make predictions about the next wave of invasive organisms that might be expected to capitalize on such sites if left unrestored.

Durieux¹, E.D., T. Vaught², C. Chin¹, P. Fitzgerald¹, G. Whitman¹, R. Hoang¹, D.J. Ostrach¹

¹Pathobiology, Conservation & Population Biology Laboratory, John Muir Institute of the Environment, Center for Watershed Sciences, UC Davis, One Shields Ave, Davis, CA 95616

²Professional Aquaculture Services, 559 Cimarron Drive, Chico, CA 95973, USA
eddurieux@ucdavis.edu

Spawning of Striped Bass (*Morone saxatilis*): An Essential Tool for Evaluating the Effects of Multiple Stressors in the San Francisco Estuary

Along with other pelagic fishes in the San Francisco estuary, the striped bass (*Morone saxatilis*) population has suffered a significant decline in the past decades. Our research investigates how multiple stressors have contributed to this decline using a life cycle approach. A significant part of this project is based on striped bass spawning in captivity using domestic and river-collected broodstocks. This procedure enables us to: study habitat use and bioaccumulation of contaminants via otolith micro-geochemistry; analyse gametes and effects of maternal transfer of contaminants on larval development; perform larvae feeding trials using native and introduced copepods (in collaboration with other researchers) and produce juveniles for experimental purposes. Adult striped bass are collected during the spawning season on the Sacramento River between Knights Landing and Colusa using an electro-fishing boat with support from California Department of Fish and Game. Fish are transported to the UC Davis Putah Creek fish facility. Both domestic and river-collected fish are injected with Human Chorionic Gonadotropin to induce spawning in females and to increase sperm production in males. When the eggs become ripe sperm from 3-5 males/female is used for fertilization. Fertilized eggs are placed into upwelling hatching jars for incubation. Hatching occurs in approximately 48hrs and larvae are reared in 4 foot diameter tanks. Comparative developmental studies are then initiated. After exogenous feeding begins (5 days post-hatching), larvae are transferred to ponds where they feed on zooplankton. After 4-8 weeks, when they can be fed a commercial diet, juveniles are brought back to the campus fish facility for use in Ecotoxicology experiments. Striped bass collection and spawning are a vital component of our multidisciplinary research program. Results from these and future studies will help to provide a better understanding of the role of multiple stressors on fish populations in San Francisco estuary.

CALFED Statement of Relevance

Striped bass is an important sentinel species in the San Francisco Estuary. It is one of the four POD species of great interest to those managing the San Francisco Estuary and its watershed. The results of this study can help to better understand how multiple stressors and contaminants affect the health of this population and other local fish species which is essential for managing water quality and ecosystem restoration.

Dyda¹, R.Y., P.J. Hernes¹, R.G. Spencer¹, T. Ingrum¹, B.A. Pellerin², B.A. Bergamaschi²

¹University of California Davis, One Shields Avenue, Davis, CA 95616-5270

²USGS, 6000 J Street, Placer Hall, Sacramento, CA 95819-6129

rydyda@ucdavis.edu

Hydrologic Controls on the Sources and Dynamics of Dissolved Organic Matter in the Willow Slough Watershed in California (U.S.A.)

The WS watershed is a 415 km² agriculturally influenced watershed in the Sacramento River valley, California. Weekly sampling during 2006 shows that land management practices such as seasonal irrigation have a substantial impact on the composition and concentration of dissolved organic carbon (DOC), with average concentrations nearly doubling from winter baseflow to summer irrigation. Concomitant increases in carbon-normalized lignin yields indicate that DOC derived from vascular plants may account for this increase, as lignin is unique to vascular plants. Lignin phenols also provide useful insight to the composition, quality and degradation state of DOC. Lignin phenols can be used to differentiate between angiosperm and gymnosperm woody and nonwoody tissues, and unchanging syringyl to vanillyl and cinnamyl to vanillyl ratios suggest that the source of DOC remains constant throughout the year. In addition to supplying useful source information, dissolved lignin phenols undergo rapid photodegradation when exposed to adequate solar radiation, resulting in increases in the acidic components of lignin and decreases in the syringyl phenols. The acid to aldehyde ratios of both vanillyl and syringyl phenols suggest differing seasonal diagenetic pathways in winter baseflow DOC versus the rest of the year. Lignin phenol analyses can be costly and time consuming, limiting their use in complex riverine and marine systems that require intense sampling, whereas optical measurements provide a more rapid and cost-effective method for investigating DOC concentration and composition in these systems. In this study, chromophoric dissolved organic matter (CDOM) measurements at 350 nm were correlated with lignin concentrations, and specific UV absorbance and spectral slope (indicators of aromaticity and molecular weight) were correlated with carbon-normalized lignin yields, with r^2 values of 0.57 and 0.54, respectively. This suggests that optical measurements can be used to leverage molecular-level lignin analyses to achieve better spatial and temporal coverage.

CALFED Statement of Relevance

This research contributes to our understanding of the sources, pathways and fate of dissolved organic matter (DOM) through diverse hydrologic regimes as well as the transformation of DOC into disinfection byproducts such as trihalomethanes and provides insight to water quality, ecosystem health and human health.

Eckard¹, R.S., T.E. Kraus², P.J. Hernes¹, B.A. Bergamaschi²

¹University of California, Davis, Land Air and Water Resources, Davis, CA 95616

²US Geological Survey, California Water Science Center, Sacramento, CA

rseconsulting@gmail.com

Production and Decomposition of Fatty Acids in the California State Water Project: Insight into Organic Carbon Additions, Losses and Processing

California's State Water Project (SWP) stores and conveys organic carbon (OC) rich Sacramento-San Joaquin Delta water to supply agricultural and municipal demands across southern portions of the state. High OC concentrations in the Delta and SWP are a concern for drinking water because during disinfection treatment, OC reacts to form carcinogenic disinfection by-products (DBPs). However, the fate of organic carbon as it is transported through SWP canals and stored in SWP reservoirs is unknown. During transit and storage, primary production in the SWP can contribute additional OC, while bio- and photodegradation may significantly alter both its concentration and composition, and thereby affect its propensity to form DBPs. Fatty acids can be used to trace sources and process affecting OC because different types of fatty acids are uniquely produced by vascular plants, algae and bacteria. To examine processes affecting OC in the SWP, water samples were collected along the main stem of the California aqueduct as well as from two reservoirs – San Luis and Castaic – and fatty acid concentrations and compositions determined. Results from this study will help constrain the amount of algal and bacterial OC production occurring in SWP aqueducts and reservoirs, describe the potential for degradation of OC components during residence in the SWP system as evidenced by fatty acid decay, and shed light on the question of how much OC is being produced in the SWP system.

CALFED Statement of Relevance

Understanding processes affecting organic carbon additions, losses, and transformations as water travels through the California State Water Project will help identify management actions that may reduce the concentration of organic carbon and disinfection byproduct forming materials arriving at water treatment sites.

Ejeta, M.Z., J. Wang, T. Kadir, F. Chung, M. Anderson
California Department of Water Resources, 1416 Ninth Street, Sacramento, CA
95835

mejeta@water.ca.gov

Analysis of Simulated Historical Streamflow Data Based on General Circulation Modeling

The invalidity under climate change of the assumption of statistically stationary hydrological data has necessitated the development of data that incorporates the effect of climate change for water resources planning. A concerted effort is underway at various research institutions to generate streamflow data that is based on general circulation modeling. The dependability of model generated data for planning purposes requires a detailed analysis of this simulated data. Simulated streamflow data for two downscaling methodologies is available from these research institutions. Observed flow data corresponding to the simulated data is available from various agencies. Through a statistical analysis of extreme events, this paper examines simulated historical streamflow data that is based on the results of general circulation modeling. The analysis is done by comparing results from different models against one another as well as by comparing them with observed data for the 1950 – 1999 period. While the analysis of simulated historical streamflow may not necessarily guarantee the dependability of the corresponding projected streamflow, it can serve as a guide for obtaining a signal due to climate change at a future period compared to a historical period. Thus, the analysis of simulated streamflow data becomes relevant in the research for a new approach for developing hydrological data for water resources planning that incorporates climate change.

CALFED Statement of Relevance

The analysis highlights the use of model generated streamflow data to study the impact of climate change on water supply reliability.

Ejeta, M.Z., M. Roos, T. Kadir, M. Anderson, J. Galef, F. Chung, J. Anderson, M. Mierzwa, B. Coleman, K. Kao
California Department of Water Resources, 1416 Ninth Street, Sacramento, CA
95835
mejeta@water.ca.gov

Analysis of Historical Data for Climate Change Trend in California

This paper examines various long-term historical data to find out if there are more reasons to believe that a trend of climate change has started to occur in California. The analysis uses 1) temperature, snow, and precipitation data from a cross-section of locations throughout California; 2) natural runoff, also called unimpaired flow, data of over 100 years for eight river locations in the Sacramento and San Joaquin Valleys; 3) sea level change in the San Francisco Bay; and 4) paleoclimate data derived based on tree ring research. The data is available from various sources including the National Weather Service's Cooperative Observer Program (COOP), the California Cooperative Snow Surveys program, and the National Oceanic and Atmospheric Administration (NOAA). Potential evidence of climate change trend embedded in each data type as well as any correlations between these data are closely examined. The results of this analysis are used to gain more insight about the invalidity under climate change of the assumption of statistically stationary hydrological data. Because the invalidity of this assumption is bound to change the traditional approach of water resources planning, this analysis is relevant to the effort to develop a new approach for water resources planning that incorporates climate change.

CALFED Statement of Relevance

The analysis highlights the impact of climate change on water supply reliability, water quality, and levee system integrity.

Fisch¹, K.M.*, J. Lindberg², B. Baskerville-Bridges², B. May¹

¹Genomic Variation Laboratory, UC Davis, Department of Animal Science, One Shields Avenue, Davis, CA 95616

²Fish Conservation & Culture Lab, UC Davis, 5280 Bruns Rd., Byron, CA 94514
kmfisch@ucdavis.edu

Delta Smelt Refugial Population Development and Genetic Management

A refugial population for the threatened delta smelt has been initiated at the Fish Conservation & Culture Laboratory (FCCL), a satellite facility of University of California, Davis (UC Davis), in collaboration with the Genomic Variation Lab (GVL) at UC Davis, and the US Fish and Wildlife Service in response to a marked decline in delta smelt population abundance indices. To aid in the development of a breeding plan for the delta smelt refugial population, we are examining delta smelt population genetics throughout the Sacramento-San Joaquin Delta. The FCCL has developed successful rearing techniques for all life stages of delta smelt over the past decade, and initiated the refugial population this spring 2008. Wild-origin delta smelt, birth year 2006, were collected in the lower Sacramento River and serve as the broodstock for the refugial population. The current breeding plan aims to maximize genetic diversity in the refugial population, within the constraints of the existing aquaculture facilities. Single-pair crosses are combined in small groups to form multi-family groups (MFG). Genetic analysis of the parents and progeny (GVL, UC Davis) will aid in the design of a breeding plan by performing pedigree analysis, survival analysis, and population genetics studies of delta smelt. To date, approximately 200 single-pair crosses have been made. We determined diversity statistics and relatedness estimates for the founding population. These fish have low levels of relatedness and are genetically diverse, making them excellent specimens with which to initiate the refugial population in order to maintain genetic diversity. The results of this study will be used to develop and manage a delta smelt refugial population that preserves the genetic and phenotypic diversity of wild delta smelt. The results of the associated delta smelt population genetics studies will be instrumental in the management of this imperiled species.

CALFED Statement of Relevance

Development of a delta smelt refugial population provides a safeguard against species extinction of this endemic, threatened species in the Bay-Delta. Delta smelt population genetics and life history studies will increase species understanding for management, as delta management for native species is a necessary component of delta recovery.

Fleck¹, J.A., B.D. Downing¹, J. Saraceno¹, G. Gill², M. Stephenson³, B.A. Bergamaschi¹

¹US Geological Survey CWSC, 6000 J St, Sacramento, CA 95819

²Battelle Marine Sciences, Sequim, WA

³Department of Fish and Game, Moss Landing, CA

jafleck@usgs.gov

Linking Diurnal Trends in Methylmercury Concentration and Organic Matter Photo-reactivity in Wetlands of the Yolo Bypass, California

Aqueous concentrations of methylmercury (MeHg) are known to vary temporally and spatially due to a multitude of concurrent production and loss mechanisms. Diurnal trends in MeHg production, bacterial demethylation, photodemethylation, diffusion and advection transport processes have been identified; however, the magnitude and relative importance of each process is not well known, particularly in wetland systems. Variations in aqueous MeHg concentrations may be important both by impacting biotic accumulation factors at the base of the aquatic food chain and as a challenge to regulatory efforts to manage MeHg exports, such as the efforts to establish a MeHg TMDL in the Sacramento watershed and subwatersheds. To identify the possible diurnal variation in surface water MeHg concentrations in wetlands managed by the Yolo Bypass Wildlife Area, two agricultural wetlands (wild rice and white rice) were monitored over a 24-hour cycle using a combination of in situ optical sensors and traditional surface water grab samples. In the wild rice field, MeHg concentrations doubled from 1 ng/L to 2 ng/L over the nighttime hours and returned to 1 ng/L during the daylight hours, whereas the white rice field showed no significant variation in MeHg concentration (0.73 +/- 0.08 ng/L) throughout the diurnal cycle. Similar trends were observed when MeHg data was expressed as a percentage of total Hg, with both wetland fields exhibiting similar levels (20% MeHg) following the nighttime period. Field parameters (solar radiation, pH, dissolved oxygen, and temperature) measured in situ exhibited similarly large diurnal trends at each wetland, whereas optical proxies for dissolved organic matter composition mirrored the fluctuations in MeHg absolute concentration and %MeHg, with a strong diurnal trend in wild rice and none in white rice. The similar trends in organic matter composition proxies and MeHg measurements suggest a unique link between DOM photo-reactivity and photo-demethylation in these wetlands.

CALFED Statement of Relevance

Understanding the variability of MeHg concentrations over the diurnal cycle is essential for the proper application of regulatory efforts aimed at managing MeHg exports and may be important in terms of how MeHg is taken up by both phytoplankton and primary consumers.

Foster, S.Q., C.E. Phillips, T.S. Schraga, J.E. Cloern
U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025
safoster@usgs.gov

Lessons Learned from 40 Years of San Francisco Bay Water Quality Research

On April 3, 1968 scientists from the U.S. Geological Survey ventured onto the murky waters of San Francisco Bay to make their first measurements of water quality. Forty years later, the USGS studies continue (in partnership with the Regional Monitoring Program) as one of the world's longest sustained programs of research and observation in a coastal ecosystem. Regular monitoring includes monthly measurements of salinity, temperature, dissolved oxygen, chlorophyll a, nutrients, suspended particulate matter, light penetration and phytoplankton species composition. Sampling is designed to measure spatial and temporal variability along a 145 km transect between South San Francisco Bay and the lower Sacramento River. How has California's great estuary responded to changes over the last 40 years that include: growth of the state population from 19 to 37 million people; implementation of the 1972 Federal Clean Water Act; introductions of many dozens of alien species; hydrologic extremes from the record drought of 1976-77 to the record runoff of 1982-83; and progressive increases in water export and decreases in sediment supply from the large rivers? We have mined the data set from USGS cruises to highlight some notable events, trends, and lessons from four decades of learning by observation. As examples, we will show: historic values of the most seaward and landward X2 (place where bottom salinity = 2); South Bay as a hypersaline lagoon during the 1976-77 drought; remarkable and rapid shifts of salinity following major floods; occurrences of new phytoplankton blooms in the Bay after the 1998-1999 El Niño-La Niña transition; and trends of decreasing nutrients and increasing dissolved oxygen during this era of improved wastewater treatment. In an age of increasing public concern about climate change, natural resource supply and sustainability, it is easy to envision the ongoing significance of this sustained, rigorous program of observation and research.

CALFED Statement of Relevance

The USGS-RMP surveillance of San Francisco Bay is essential to advancing one of the CALFED Science Program's main objectives to monitor, understand and manage key water quality components and processes as they pertain to ecological integrity and public health.

Fregoso, T.A., B.E. Jaffe
US Geological Survey, 400 Natural Bridges Drive, Santa Cruz, CA 95060
tfregoso@usgs.gov

Sediment Deposition, Erosion, and Bathymetric Change in Central San Francisco Bay: 1855 -1979

Central San Francisco Bay (CSFB) is the hub of a dynamic estuarine system connecting the San Joaquin / Sacramento Delta, Suisun Bay, and San Pablo Bay to the open ocean and South San Francisco Bay. To understand the role that CSFB plays in sediment transport throughout the system, determining historical changes in patterns of sediment deposition and erosion from both natural and anthropogenic forces is vital. The first extensive hydrographic survey of CSFB was conducted in 1855. From 1855 to 1979, four additional comprehensive surveys, composed of approximately 600,000 soundings, were collected within CSFB. These surveys were used to create digital bathymetry models (DBM) of the bay using a Geographic Information Systems (GIS). These DBMs were then used to develop bathymetric change maps and to determine long-term change in deposition and erosion patterns and volumes. CSFB had a net gain in sediment from 1855 to 1979 of approximately 42 million cubic meters (mcm); however, within this timeframe there have been periods of both deposition and erosion. For instance, from 1855 to 1895 CSFB was erosional, losing roughly 2 mcm of sediment per year. Sedimentation patterns also varied spatially. The northern part of the bay was depositional during all change periods while the eastern region alternated between erosion and deposition. CSFB also was impacted by anthropogenic activities, such as dredging and dredge disposal, borrow pits, and sand mining. For example, bathymetric change at a borrow pit created near Bay Farm Island sometime between the 1947 and 1979 surveys indicates roughly 25 mcm of sediment was removed from the system. A firm understanding of the spatial and temporal distribution of sedimentation and erosion within CSFB will aid in the understanding of sediment transport pathways throughout the estuary and allow informed management of sediment-related issues such as sand mining and marsh restoration.

CALFED Statement of Relevance

Historical knowledge of the spatial and temporal distribution of sedimentation and erosion within Central San Francisco Bay will aid in the understanding of sediment transport pathways throughout San Francisco Bay Estuary. This will allow for informed management of sediment-related issues such as restoration planning.

Galef, J.K., T. Kadir, F. Chung
Department of Water Resources, 1416 Ninth Street, Sacramento, CA 95814
igalef@water.ca.gov

Climate Change Impacts on the Upper Feather River Basin and Oroville Inflow

Problem Statement: Climate change projections forecast warmer air temperatures and changing precipitation patterns, resulting in direct impact on snowmelt and runoff processes in the Feather River Basin of Northern California. Stream inflow variations to Lake Oroville can affect flood management operations, hydro power availability, water quality, and the health of downstream fisheries.. Approach: The Governor's Climate Action Team recommended the investigation of eighteen climate change scenarios generated by six global climate models (GCM) under two assumed greenhouse gas emission scenarios. The GCM outputs were translated to the regional level using two downscaling techniques. Daily precipitation and minimum and maximum temperature data from each scenario at the 1/8-degree resolution were further refined to 2-km resolution using PRISM data. Estimates for each of the 324 hydrologic response units making up the 8 sub-basins were then computed. Impacts on runoff, baseflow, and streamflow at different locations were assessed using applications of the PRMS model developed by the USGS. Results: Climate change impacts assessment for runoff, baseflow, and inflows to Oroville will be presented. A comparison will also be made to the inflow generated at Oroville by the VIC model for the same scenarios.

CALFED Statement of Relevance

Quantifying potential impacts of climate change on water supply for project operations are relevant to the CALFED objectives of water supply reliability and water quality.

Garcia, C.A., C.M. Messer

CA Department of Water Resources, 1416 Ninth Street, Sacramento, CA 95814

cgarcia@water.ca.gov

The Real Time Data and Forecasting Comprehensive Program

In 2006, the Real Time Data and Forecasting Comprehensive Program (RTDF-CP) was established as a means for collaboration between different water quality monitoring, modeling and operational groups within the Department of Water Resources. The RTDF-CP works on multiple water quality tasks that provide stakeholders with vital information on a continuous basis in a variety of formats. The comprehensive program includes groups from DWR's Operations and Maintenance Division, Division of Environmental Services and the Bay-Delta Office. For this comprehensive program, the Division of Operations and Maintenance Water Quality Section (WQS) is proud to collaborate with the Municipal Water Quality Investigations Branch of the Division of Environmental Services to conduct extensive monitoring and information dissemination activities. The WQS monitors water quality throughout the State Water Project (SWP) and provides data used to assess short and long-term trends, effects of emergency spills and pipeline ruptures, influence of operations and hydrology, and the general suitability of SWP water for drinking water purposes. MWQI monitors water quality as it related to drinking water throughout the Sacramento-San Joaquin Delta and provides data and information on various constituents such as organic carbon, boron and nutrients to source water and municipal water managers, water treatment plant operators, State Water Contractors and various other stakeholders. As efforts to improve environmental quality in the Sacramento-San Joaquin Delta increase and the demand for water supplies also increase, information on water quality such as that provided by this comprehensive program will prove vital for policy makers.

CALFED Statement of Relevance

This poster presentation will demonstrate the importance of the Time Data and Forecasting Comprehensive Program (RTDF-CP) to the California State Water Project water quality data dissemination activities to the State Water Contractors and other stakeholders.

Gardiner, R.J., R.E. Melcer, I. Woo, J.Y. Takekawa
US Geological Survey, San Francisco Bay Estuary Field Station, 505 Azuar Dr.,
Vallejo, CA 94510
rachelgardiner@yahoo.com

***Pre-restoration Monitoring of the Giacomini Restoration Project (Part I):
Avian Community Structure and Habitat Use***

Large scale loss of coastal wetlands has occurred in California over the past 100 years. The associated avian community has declined in diversity and abundance with this loss of habitat. The Point Reyes National Seashore (PRNS) acquired the Giacomini Ranch (228 ha) with the goal of restoring historic natural and hydrologic tidal and freshwater processes to the largest freshwater input to Tomales Bay. The response of the avian community was selected as one of the main indicators of restoration success. Baseline surveys of community structure and habitat use will provide useful information for the evaluation of restoration and management actions. In November 2004, USGS-WERC initiated seasonal avian census surveys and vegetation surveys at the Giacomini Ranch Restoration Project and two local reference marshes (which were chosen for their location within the Tomales Bay watershed and the presence of wetland habitat types that will likely be represented at project site as the restoration progresses). Through these pre-restoration surveys, we have characterized the avian community structure and habitat use at each site. We detected a total of 145 bird species at all five study areas from both area counts and VCP surveys, of which 25 species are of special concern and 12 species are CALFED MSCS focal species. Though avian composition varied by season, the Giacomini restoration sites typically had greater species richness and abundance; however, species were more evenly distributed in freshwater Olema Marsh and Inverness tidal marsh. Habitat use was analyzed by grouping bird species into guilds based on foraging characteristics. The Giacomini restoration sites were dominated by flocking ground gleaners (i.e. blackbirds), which reflected the dominance of pasture habitat. The reference marshes were dominated by surface divers, opportunists, dabblers, and deep probers, which reflected the dominance of tidal marsh, brackish, and open water areas. Habitat conversion from pasture into tidal wetland will significantly alter plant communities resulting in a change to avian species composition and habitat use.

CALFED Statement of Relevance

We provide a baseline of avian habitat use data from which managers can identify changes in bird community structure as restoration progresses. These data are relevant to the CALFED Ecosystem Restoration Objective to restore and protect habitats and ecosystem function with the goal of supporting sustainable populations of diverse species.

Goodwin, K.E.*, J.A. Harrison, D.J. Sobota
Washington State University Vancouver, School of Earth and Environmental
Sciences, 14204 NE Salmon Creek Ave., Vancouver, WA 98686
goodwin@vancouver.wsu.edu

A High Resolution Model of Dissolved Inorganic Nitrogen Transport in the Sacramento and San Joaquin Basins

Information on sources and sinks of nutrients transported in aquatic ecosystems is important for the management of water quality and ecosystem health. In California's Central Valley (CV) high levels of dissolved inorganic nitrogen (DIN) have been associated with low levels of dissolved oxygen in the lower San Joaquin River and related adverse impacts on fish and other aquatic organisms. We used a newly available hydrography database in conjunction with high-resolution N input data to develop and apply a spatially-explicit (~1 km spatial resolution) DIN transport model. We then used this model to estimate DIN input from land-based sources, losses in terrestrial and aquatic ecosystems, and downstream transfers of DIN. DIN sources in our model include manure and inorganic fertilizer used for agriculture, biological N₂ fixation, nitrogen deposition, and sewage outflow. DIN sinks include harvest and subsequent export of agricultural products, consumptive water use, and retention in aquatic systems. Preliminary model results suggest that most N applied to sub-watersheds of the Sacramento and San Joaquin Rivers (> 90%) is not transported downstream. Early model results also suggest that consumptive water use is an important determinant of DIN transport in the CV and that non-point N sources (fertilizer and manure) constitute a major source DIN in most major CV rivers.

CALFED Statement of Relevance

This work addresses two of the CALFED program objectives: Ecosystem Restoration and Water Quality. Model development and results highlight important features to DIN retention and allow for scenario runs to investigate the impacts of management decisions.

Greenberg, A.B., R. Schlipf, B. Wines, S. Lee, W. Bruhns
San Francisco Bay Water Board, 1515 Clay St., Suite 1400, Oakland, CA 94612
agreenberg@waterboards.ca.gov

Restoring Salt Ponds to Wetlands in the San Francisco Bay

The North and South Bay Salt Pond systems are two large projects designed to restore thousands of acres of wetland habitat lost in the San Francisco Bay Region over the past 200 years. The long term success rate for projects on this scale is unknown, and the main problem presented to managers is how to maintain existing habitat and create new habitat while protecting water quality. Managers must also consider risks to native ecosystems, recreational opportunities, and flood prone areas with large urban populations. Resource managers and scientists in the San Francisco Bay Region have developed goals for wetlands and related habitats to restore high functioning systems. In the decade since the release of the San Francisco Baylands Ecosystem Goals, thousands of acres of former wetlands have been purchased for restoration which involves, at the least, establishing the correct hydrology to be phased over many years, and to be monitored effectively for success. The North Bay Salt Pond Restoration project is being constructed and monitored and provides excellent habitat for birds and other wildlife. The South Bay Salt Pond Restoration Project is currently undergoing review by regulatory agencies, but the Initial Stewardship Plan for opening up ponds to tidal circulation has been largely successful in maintaining existing habitat for shorebirds and waterfowl. However, excessive algal growth in former salt ponds has resulted in low dissolved oxygen levels and some fish kills within these ponds. Various methods are being tried to prevent future water quality problems, such as increasing tidal marsh restored from former salt ponds while reconfiguring existing ponds to encourage bird use. Restoration is benefiting important species such as the salt marsh harvest mouse, California clapper rail, Chinook salmon and other species that share similar habitats. Regional and site specific monitoring are important to track potential water quality impacts (e.g., low dissolved oxygen, mercury bioavailability), to maintain healthy biological species, and to prevent the spread of contaminants and aggressive non-native plants and animals. San Francisco Bay salt pond restoration has important implications for the preservation of native species and habitat, and for protecting humans from storms and sea-level rise.

CALFED Statement of Relevance

San Francisco Bay salt pond restoration has important implications for the preservation of native species and habitat, and for protecting humans from storms and sea-level rise.

Greene¹, V.E.* , L.J. Sullivan¹, W.J. Kimmerer¹, J.K. Thompson²

¹Romberg Tiburon Center, SFSU, 3152 Paradise Drive, Tiburon, CA 94920

²U.S. Geological Survey, MS-496, 345 Middlefield Rd, Menlo Park, CA 94025

vegreene@gmail.com

Preliminary Findings of the Impact of the Overbite Clam on the Microzooplankton Community of the San Francisco Estuary

The non-native, overbite clam *Corbula amurensis* has irreversibly altered the San Francisco Estuary since its introduction in 1986. Feeding by *C. amurensis*, formerly *Potamocorbula* is widely believed to be the cause of a significant decline in plankton biomass because of the clam's high filtration rates. Previous studies have demonstrated consumption of phytoplankton, bacteria, and copepod nauplius larvae. However, no information is available on grazing on other microzooplankton, defined as heterotrophic eukaryotes <200 μm , which, in addition to copepod nauplii, includes rotifers, aloricate ciliates and tintinnid ciliates. Microzooplankton provide a key link in the pelagic foodweb by consuming small phytoplankton and bacteria, and in turn being eaten by mesozooplankton, including copepods. Copepods are the principal food source for most larval fish species. To understand how *C. amurensis* affects pelagic food webs, we need to know how rapidly and efficiently they clear the water, specifically focusing on what they are eating, and at what rate. One possible source of prey is tintinnid ciliates. From 1978 to 1981, before the clam was introduced, tintinnid ciliates (~190 μm) were reported in densities of 1000/L. We do not know the current abundance of these organisms. The primary objectives of this study are to quantify the current abundance of tintinnid ciliates in the Low Salinity Zone of the San Francisco Estuary (salinity < 5) and measure clearance rates of *C. amurensis* on tintinnids. Tintinnid abundance will be monitored monthly at US Geological Survey water stations. Preliminary feeding rates of *C. amurensis* on microplankton, including aloricate and tintinnid ciliates, ranged from 0.5 to 2.0L individual⁻¹ h⁻¹. This project will significantly advance the understanding of the microbial ecology of primary consumers such as tintinnid ciliates and their role in the trophic transfer of energy as a food source for *C. amurensis*.

CALFED Statement of Relevance

This project will significantly advance the understanding of the microbial ecology of primary consumers in the Low Salinity Zone, such as tintinnid ciliates, and their role in the trophic transfer of energy as a food source for *Corbula amurensis*.

Groves¹, D.G., D. Yates², D. Purkey³, B. Joyce⁴, A. Draper⁵

¹RAND Corporation, 371 60th Street, Oakland, CA 94618

²National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307

³Stockholm Environment Institute-US Center, 133 D St., Ste. F, Davis, CA 95616

⁴Stockholm Environment Institute, 11 Curtis Ave., Somerville, MA 02144

⁵MWH, 3321 Power Inn Road, Suite 300, Sacramento, CA 95826

groves@rand.org

Evaluating Climate Change and Management Strategies for the California Water Plan

The California Water Plan (CWP) Update 2009 is making a major effort to incorporate climate change into its analyses of future water conditions in California. One key analytic objective of the CWP is to evaluate the performance of regional and statewide water management response packages against a large set of future scenarios reflecting climate change and other uncertainties. This presentation will describe how the Water Evaluation and Planning (WEAP) model will be used as an engine for this analysis at two scales: (1) California wide, defined by the State's hydrologic regions and (2) for the Sacramento and San Joaquin River Hydrologic Regions, disaggregated at the planning level. To evaluate a wide range of future climate impacts on the California water system, downscaled monthly weather time series, corresponding to individual global circulation model climate projections will be used as model inputs. WEAP's built-in rainfall-runoff and soil moisture algorithms will then translate these plausible sequences of weather parameters into projected hydrologic flows and evapotranspiration-driven irrigation demands. The presentation will present interim results and describe the decision-analytic framework to be used to evaluate the response packages against the climate scenarios.

CALFED Statement of Relevance

This presentation will describe on-going climate impacts and adaptation research for the California Water Plan Update 2009. The work seeks to inform water resources planning at the state, regional, and local level in California.

Hanlon, J.S., W.T. Stringfellow
University of the Pacific, 3601 Pacific Ave., Stockton, CA 95211
jhanlon@pacific.edu

Rapid Determination of Preferential Flow Paths through Wetland Pond Systems

Wetland pond systems have been proposed as a best management practice (BMP) for improving the quality of agricultural drainage water before discharge into receiving waters. Monitoring the effectiveness of wetlands for the removal of sediments, nutrients, and other water quality constituents presents a considerable challenge due to the number drainage outfalls, seasonal variability of input water quality and quantity, and heavy sediment loads. The goal of this study was to develop a rapid method for determining the preferential flow path through a permanent wetland receiving agricultural drainage by tracking changes in multiple water quality parameters. This method of wetland characterization is useful for the rapid assessment of mixing efficiency without the use of dye tracers. Data was gathered from multiple points across the wetland pond using a YSI Sonde 6600 to measure water quality. Depth and location were acquired from a Garmin 188C GPS equipped with sonar. Water velocity and direction were collected from a Sontek Argonaut SL Doppler meter. The equipment was carried aboard a 12' boat and rowed to various points, taking measurements along the way. Software was written bringing data from these instruments together to be viewed in real-time and recorded. The gathered data was plotted on a geo-referenced aerial image of the pond using ArcGIS software. This experiment showed that there was significant short-circuiting of the agricultural drainage through the wetland. When visualized as interpolated surfaces, several water quality parameters confirmed the water in the northeast corner of the wetland, the entrance, and the exit were all similar to each other and distinct from the rest of the pond. More traditional methods for discerning flow paths, using velocity and direction data, were unable to map this preferential flow path due to the relatively small pond currents and surface winds altering the motion of the boat.

CALFED Statement of Relevance

This technique could see increased application for monitoring the effectiveness of pond systems that are utilized as a best management practice for irrigation reuse and the improvement of water quality. Many ponds can be assessed in a fairly quick manner or multiple assessments made in a rapidly changing system.

Heady, W.N.*

Ecology and Evolutionary Biology Department, UC Santa Cruz, Long Marine Laboratory, Santa Cruz, CA 95060

heady@biology.ucsc.edu

Salmonid and Aquatic Macroinvertebrate Ecological Responses to Restored Side Channel Habitat in the Mokelumne River, CA: Just Add Water

The lower Mokelumne River (LMR) includes approximately 54km of regulated river between Camanche Dam, a complete barrier to anadromous fish, and the Bay-Delta. Since 1927, approximately 190,000m² of side channels have been eliminated in the 14.5km extent of remaining salmonid spawning habitat (Edwards et al. 2004). Historically, side channels provided high-quality rearing habitat for juvenile Chinook salmon and steelhead. In 2005, the East Bay Municipal Utilities District (EBMUD) engineered 1,915m² of side channel habitat in the LMR, constructed to flow at dam releases above 14.5m³sec⁻¹. EBMUD monitored the side channels to determine if they provided juvenile salmonid rearing habitat; i.e. 1) appropriate physical habitat characteristics, 2) aquatic macroinvertebrate prey, and 3) evidence of juvenile salmonid habitat and prey use. To quantify these three criteria, structural characteristics, water depth and flow, benthic and drift invertebrate prey species composition and abundance, and habitat use and diet samples were collected on a monthly basis. Side channels provided appropriate structural characteristics, water depth and flow for rearing juvenile salmonids. Aquatic macroinvertebrates rapidly colonized the side channel habitat with abundance and taxonomic richness increasing over the monitoring period. Benthic and drift community assemblages provided preferred salmonid diet items. Juvenile salmonids were found in the side channels at high densities with full stomachs. Restored side channel habitats like these provide beneficial rearing habitat for salmonids. These efforts help to restore spatial and temporal habitat heterogeneity in degraded systems with a suite of ecological benefits. Lateral increase of rearing habitat may be of great benefit to sensitive species in degraded systems linearly limited by complete barriers such as dams. While creation of such habitats are paramount to sustained natural salmonid production in highly managed streams, system managers must also take hydrograph manipulation into account to realize the full benefits of such projects.

CALFED Statement of Relevance

This study elucidates benefits of side channel restoration, the necessity of monitoring ecological responses to restoration, and a next step in Bay-Delta tributary management; pro-active flow management to return spatial and temporal variability to regulated rivers, activate side channel rearing habitat, and benefit declining salmonid species protected under the endangered species act.

Henneberry¹, Y.K.* , D.E. Mourad¹, T.A. Doane¹, T. Kraus², P.A. Bachand³, R. Fujii², W.R. Horwath¹

¹UC Davis, One Shields Ave, Davis, CA 95616

²United States Geological Survey, 6000 J St., Placer Hall, Sacramento, CA

³Bachand and Associates

yumberry@ucdavis.edu

Investigating Dissolved Organic Carbon Stabilization by Metal Based Floc in a Wetland Environment

This study is part of a larger project designed to investigate the feasibility of using metal-based coagulants to remove dissolved organic carbon (DOC) from island drainage water in the San Joaquin Delta and subsequently retaining the metal-DOC precipitate (floc) in wetlands to promote sediment accretion in the area. Dissolved organic carbon is a constituent of concern, as some forms of DOC can be converted to carcinogenic compounds during drinking water treatment. The focus of this work is to assess floc stability over time and to determine if the floc can be permanently sequestered as part of wetland sediment. Drainage water collected seasonally from Twitchell Island was coagulated with ferric sulfate and polyaluminum chloride at optimal and 50%-optimal dosage levels. Floc was incubated in the laboratory under anaerobic conditions for six weeks under various conditions including different DOC concentrations, microbial inoculants, and addition of nutrients. Preliminary results indicate the floc is a stable system; little to no DOC was released from the floc into the water column under incubations with native microbial inoculate. In addition, floc incubated with previously coagulated water appeared to remove additional DOC from the water column. Future work will involve field and laboratory studies using ¹³C labeled plant material to examine the effects of fresh plant matter and the effects of peat soil DOC on floc stability, in order to elucidate mechanisms behind carbon stabilization by metal-based floc.

CALFED Statement of Relevance

Investigating ways to reduce harmful disinfection by products through the use of metal-based coagulants addresses two of CALFED's four objectives, which will improve water quality and water supply in the region. Construction of wetlands as floc retention ponds, which are aimed at mitigating land subsidence, addresses the objectives of increasing both levee stability and wetland acreage in the area.

Hladik, M.L., J.L. Orlando, K.M. Kuivila
U.S Geological Survey, 6000 J Street, Sacramento, CA 95819
mhladik@usgs.gov

Standardized Sampling Protocol for Pyrethroids in Water

The loss of pyrethroid insecticides during sampling can confound the interpretation of analytical and toxicity test results. Sampling method, container material and water composition have a significant influence on the association of pyrethroids to container walls, which can be as high as 50%. Any sampling method involving transfer through multiple containers increases the potential for pyrethroid loss. This “loose-association” with container walls can be reversed through agitation. While sampling with pumps or autosamplers, no pyrethroids were lost as long as the water was continuously moving through the system. When sampling with containers, the material influenced the amount of loss: glass < plastic < Teflon. Additionally, pyrethroids were easier to re-suspend from the glass container walls. Since the amount of wall-association is proportional to the surface area to volume ratio of the sample, taking larger field samples (greater than 3 L) reduced pyrethroid losses to less than 10 percent. The amount of wall-association cannot be easily predicted because of the dependence on water composition; samples with higher dissolved organic carbon or suspended sediment concentrations have lower percent loss. Standardized sampling protocols are critical to yield accurate pyrethroid concentrations for assessment of potential effects.

CALFED Statement of Relevance

Standardized methods for pyrethroid sampling will ensure that any pyrethroid data collected will be representative and meaningful to the understanding of water and sediment quality.

Hobbs¹, J.A., J. Rosenfield²

¹UC Berkeley, 513 McCone Hall, Berkeley, CA 94720

²UC Davis, 1 Shields Ave, Davis, CA 95617

hobbsja@gmail.com

Exploring Longfin Smelt Life History Variation using Otolith Geochemistry

Problem Statement: Longfin smelt (LFS) have declined substantially in the San Francisco Estuary. This species requires protection and targeted management; yet little is known about its behavior and ecological tolerances. In an effort to better understand the behavior and ecology of this population, the Interagency Ecological Program and the Pelagic Organism Decline (POD) team initiated a review of data from several long-term community monitoring programs. Analyses of historical patterns in density and distribution suggested that many LFS migrate out of brackish water for some part of their life cycle. Approach: We employed laser-ablation sampling of LFS otoliths to determine whether any otolith tissue was deposited in a marine environment. By sampling across the otolith growth-axis, we can determine the duration of marine residence. Results: Preliminary results revealed a sharp increase in Sr/Ba and $87\text{Sr}:86\text{Sr}$ ratios, suggesting a major change in habitat utilization, consistent with a migration from fresh waters to marine environments. We also observed several life-history contingents, with some fish migrating to the marine environment after the first year of life, a brackish water group, with similar migration timing, a resident low-salinity group and an early migratory group. The duration of marine/brackish residency varied from a few months to greater than 2 years. Conclusion: As this study continues, we hope to determine what fraction of the LFS population uses the marine/brackish vs low-salinity environment and the effect of this marine migration on life history parameters. This technique can provide the direct observation regarding the habitat suitability of the low-salinity “Bay Suisun” hypothesis for the Pelagic Organism Decline.

CALFED Statement of Relevance

This research provides new insights into the population structure of the longfin smelt and will provide key life-history information for the petition to list the San Francisco Bay longfin smelt as threatened under the endangered species act.

Hrodey, P.J.

US Fish and Wildlife Service, 4001 North Wilson Way, Stockton, CA 95205

pete_hrodey@fws.gov

Liberty Island 10 Years after the Flood: The USFWS's Involvement Then and Now

Tidally influenced, freshwater marsh habitat is an important component for the early life stages of many fishes found within the Sacramento – San Joaquin River Delta. Identifying these areas, understanding how they develop, and how fish use them are important factors to consider in the management of these newly formed habitat complexes. Liberty Island is a former artificial island which has been undergoing passive restoration since 1997. The Stockton office of the U.S. Fish and Wildlife Service has been involved with monitoring the fish communities using Liberty Island since the early 2000's. The purpose of this presentation is to briefly summarize the CALFED funded monitoring activities completed by our office as well as introduce and discuss the CALFED funded Breach III study. Our previous results have shown significant temporal differences in habitat use by native and non-native fish species of varying life stages. Our future work is aimed at understanding the habitat use and diet of different life stages of fish using Liberty Island under varying flow regimes. Sharing past results and future plans of these studies will help to inform researchers in the Cache Slough and Yolo Bypass areas of our activities and may initiate future collaborations. Amid possible changes in water development, land-use activities, and levee deterioration this once limited habitat may become more available to native fish species. This may be particularly important for threatened or endangered species such as Chinook salmon *Oncorhynchus tshawytscha* and Delta smelt *Hypomesus transpacificus*.

CALFED Statement of Relevance

Ecosystem Restoration: Tidally influenced, freshwater marsh habitat is an important component for the early life stages of many fishes found within the Sacramento – San Joaquin River Delta. Identifying these areas, understanding how they develop, and how fish use them are important factors to consider in the management of these habitat complexes.

Hutchinson, R.A., J.H. Viers, J.F. Quinn
Information Center for the Environment, UC Davis, One Shields Ave., Davis, CA
95616
rahutchinson@ucdavis.edu

Non-Chemical Control of Perennial Pepperweed: Tarping as a Viable Eradication Method?

Perennial pepperweed (*Lepidium latifolium*), a known invader of riparian habitats, has become a dominant species along the edges of the organic rice fields at the Cosumnes River Preserve. The extensive network of organic rice farms doubles as habitat for migratory birds, including the sandhill crane (*Grus canadensis*). Established perennial pepperweed patches in and adjacent to organic agricultural areas at the preserve are in close proximity to cars, humans, animals and water and harbor the potential to spread to adjacent sensitive riparian habitat via viable seed or plant propagules during flood events. In our effort to control the expansion of pepperweed at the Cosumnes River Preserve, we tested the implementation of tarping or solarization as a non-chemical control method while monitoring non-target vegetation response. We hypothesized that by tarping existing populations for two consecutive growing seasons we could eradicate perennial pepperweed non-chemically while creating a mix of more favorable species. As tarping is reported to have limited success in controlling perennial species, we used two different treatment strategies in combination with tarping: 1. Mow and 2. Mow and Rototill. Predictably, the mow and tarp treatment was relatively ineffective, with only about 60% of trial plots considered >90% eradicated and the remaining 40% increasing in pepperweed stems. Mow, rototill in combination with tarping was successful in about 80% of plots, with only 11% of plots increasing in stems. Additionally, the non-target vegetation results indicated similar responses to both types of treatments, with significantly lower cover of both native and nonnative species post treatment than control plots ($p < 0.0001$). Our results support the use of tarping for the control of perennial pepperweed if used in combination with a mow and rototill treatment and minimal post treatment monitoring and eradication.

CALFED Statement of Relevance

Perennial pepperweed is a serious threat to riparian communities throughout the delta.

Ingram, J.F., S.K. Brewer

US Fish and Wildlife Service, 4001 North Wilson Way, Stockton, CA 95205

jack_ingram@fws.gov

Spatial and Temporal Habitat Use by Juvenile Fishes on Liberty Island, Sacramento-San Joaquin Delta

Loss of nursery habitat, including freshwater marshes, is a major factor related to decreased survival of fishes in altered riverine-estuarine systems. Liberty Island was an agricultural island formed by levees, but due to levee breaches in 1997 has undergone passive restoration to a mix of tidally-influenced freshwater marsh and submerged, relatively shallow-water habitat. The objective of this study was to document the spatial and temporal patterns in use of submerged portions of Liberty Island by juvenile fishes. Sampling conducted over a 1-yr period using Kodiak trawls resulted in the collection of 21 fish species; seven species were numerically dominant, including two native species. We used Wilcoxon-Mann-Whitney tests to assess whether mean catch-per-unit-effort (CPUE) of dominant species was significantly different on the east versus west side of the island. Mean CPUE of only one species, striped bass *Morone saxatilis*, was significantly greater on the east compared to the west side of the island (CPUE: 96 versus 36, respectively). Inter-annual patterns showed a bimodal distribution in abundances between native and non-native fishes. Discriminant function analyses was used to classify presence versus absence of the seven dominant species; more than half (57%) of the models created showed temperature was the most significant variable to classifying species presence. Temperatures used by these species relate to spawning patterns with native fishes being more abundant during early portions of the year and non-native juveniles dominating our catch later in the year. Information on habitat use by native and non-native fishes may be used as guidance for habitat-restoration efforts, and to predict changes in juvenile abundances that may occur with ongoing passive tidal marsh restoration in the Delta.

CALFED Statement of Relevance

Ecosystem Restoration: Information on habitat use by native and non-native fishes may be used as guidance for habitat-restoration efforts, and to predict changes in juvenile abundances that may occur with ongoing passive tidal marsh restoration in the Delta.

Israel, J.A., B. May

University of California, Davis, Department of Animal Science, Davis, CA 95616

jaisrael@ucdavis.edu

Intraannual Genetic Analysis of Green Sturgeon in the Upper Sacramento River: What Can We Learn?

Though green sturgeons (*Acipenser medirostris*) spend the majority of their life in the marine environment, critical processes like spawning and recruitment occur in the upper Sacramento River. Very little information is known about these biotic and abiotic drivers of these processes in Sacramento River green sturgeon. The lack of spawning and recruitment are significant threats in the population viability of other North American sturgeon species and further research into these processes in green sturgeon may yield insight into the population dynamics and viability of the species. Collaborative pilot studies this year between UC Davis, Bureau of Reclamation, and U.S. Fish and Wildlife Service this year have yielded important information about the migration of adults, location of spawning (presence of eggs) and rearing (presence of larvae and juveniles) areas, and methods for collecting larvae and juvenile sturgeons. Tissue samples were collected from adults, eggs, and young green sturgeon in the Upper Sacramento to evaluate the intraannual genetic variation among fishes collected from different life history stages in the same river. The relatedness among different groups of fishes in the Sacramento River are considered in light of the spatial and temporal variation of biotic and abiotic drivers like the availability of spawners, water temperature, and flow. Genetic results of the number of green sturgeon spawners in a section of the Sacramento River, derived from a “capture-recapture” method, was estimated from collections of eggs and juveniles and compared to estimates from 2001 to 2007.

CALFED Statement of Relevance

Green sturgeon in the Sacramento River are the only reproducing population in the threatened Southern DPS of green sturgeon, are a CALFED At-Risk Species (Priority Group I), and its recruitment and spawning are poorly described.

Israel, J.A., A.P. Klimley
UC Davis, Dept. of Wildlife, Fisheries, & Conservation Biology, Davis, CA 95616
jaisrael@ucdavis.edu

Population Biology, Life History, Distribution, and Environmental Optima of Green Sturgeon, *Acipenser medirostris*

Regulatory biologists of NMFS designated the Southern distinct population segment of green sturgeon, *Acipenser medirostris*, which inhabits the San Francisco Bay estuary and Sacramento River, as “threatened” on 7 April 2006 under the Endangered Species Act (ESA). Section 4(b) of the ESA mandates that NMFS designate critical habitat including “cover or shelter... [and] sites for breeding, reproduction, [and] rearing of offspring” (NOAA 2006). Due to this change in regulatory status, there is an immediate need for in-depth information about the population biology, such as the number of spawning females, life history, age of maturity of males and females, frequency of spawning, and habitat requirements of the species. We are undertaking telemetric, physiological, reproductive, research monitoring, and genetic studies to determine the critical habitat within the Sacramento-San Joaquin watershed and utilization of these areas by green sturgeon. Research funded by the California Department of Fish and Game’s Ecosystem Restoration Program and U.S. Bureau of Reclamation.

CALFED Statement of Relevance

Green sturgeon in the Sacramento River are the only reproducing population in the threatened Southern DPS of green sturgeon, are a CALFED At-Risk Species (Priority Group I), and its critical habitat is poorly described.

Jigour¹, V.M.* , V.M. Ponce²

¹Verna Jigour Assoc, Conservation Ecology & Design Services, 3567 Benton Street #302, Santa Clara, CA 95051

²Dept. of Civil, Construction & Environmental Engineering, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-1324

vjigour@sbcglobal.net

Watershed Restoration for Baseflow Augmentation – The Restored Soil Profile as a Natural Reservoir

Watershed restoration to date has focused on water quality goals, despite California's historical water quantity problems. Contrast the Kumeyaay and early 20th century Americans who sought to "stop the water where it falls" for, respectively, spring sustainability and flood concerns. Documentation of baseflow augmentation/flood peak attenuation through stream-bank storage has been around for two decades, but has seen limited application – apparently including the CALFED arena of research and projects. The urgency of the state's water quantity/timing issues is only exacerbated by the threat of impending climate change. Thus, the time for watershed restoration approaches to the quantity/timing issues may finally be upon us. Along with stream-bank/floodplain storage enhancement, opportunities exist to enhance the water storage functions of vast areas of upland watersheds throughout the state currently clothed in nonnative annual grasslands. Shallow-rooted compared with almost any suitable native vegetation type, the dominant species die as the soil dries, with much less diverse and active soil ecosystems. Depth of roots and soil ecosystem activity strongly influence the structural ability of the soil to infiltrate and detain water, including routing it to deep subsurface storage potential, depending on bedrock type. Furthermore, especially after these nonnative annual grasses die each year, the albedo of vast areas of the inner coast ranges and Sierran foothills is raised significantly, with altered feedbacks on regional climate, relative to native cover – perhaps enough that watershed restoration could help stave off predicted decreases in regional precipitation. A preliminary Central Coast regional GIS analysis indicated significant potential for watershed restoration for baseflow augmentation benefiting historical steelhead watersheds impacted by access problems in their mainstems, especially the Salinas River, as well as for flood reduction on the Pajaro River. Such an analysis of the watersheds feeding the Bay-Delta system is called for.

CALFED Statement of Relevance

A strategy is proposed to enhance Bay-Delta water supply by restoring water-storage functions of stream-banks and foothill watersheds, while simultaneously restoring and protecting habitat and ecosystem functions supporting native species and improving water quality through soil ecosystem filtration.

Journet¹, S.*, B.A. Pellerin², P.A. Bachand³, B.A. Bergamaschi², P.J. Hernes⁴

¹UC Davis, 134 Veihmeyer Hall, One Shields Avenue, Davis, CA 95616

²US Geological Survey, 6000 J Street, Placer Hall, Sacramento, CA 95819

³Bachand & Associates, 2023 Regis Drive, Davis, CA 95616

⁴UC Davis, 129 Veihmeyer Hall, One Shields Avenue, Davis, CA 95616

sjournet@ucdavis.edu

Partitioning of Sediment-associated Organic Matter in Agricultural Watersheds: Controlling Parameters and Water Quality Implications

Sediment-associated organic matter may constitute a significant source of dissolved organic matter (DOM) in agricultural watersheds. However, our understanding of the partitioning of sediment-associated organic matter is limited in such systems. The Willow Slough watershed, a 415-km² agriculturally-dominated catchment in the northern Central Valley of California, USA, is the focus of a study of DOM dynamics in agricultural watersheds. Weekly surface water samples collected at the watershed mouth since January 2006 show that dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) concentrations increase during summer irrigation, peak in August around 7 mg/L and 0.7 mg/L (respectively), and steadily return to winter baseline concentrations (2 mg/L and 0.2 mg/L, respectively). A similar trend is observed for total suspended sediment concentrations (TSS), which peak about five weeks earlier than DOC (late June) around 200 mg/L, suggesting that sediments may contribute significantly to the delivery of DOM in the Willow Slough surface waters. Field observations suggest that the high TSS and turbidity in the slough may be related to the transport and deposition of carbon-rich field sediments to the surface water network during irrigation events. This hypothesis is further supported by an observed loss of organic matter content in TSS between the Willow Slough mouth (up to 10% OC) and the Sacramento River, as well as the strong correlation ($r^2=0.79$) between lignin biomarkers (a vascular plant-derived biochemical) and TSS. Here we will describe a conceptual model and preliminary laboratory data related to the equilibrium, photolytic and microbial release of DOM from suspended, bed, and bank sediments collected in the Willow Slough watershed over a range of land uses and hydrologic conditions. In particular, the role of environmental parameters (such as temperature, electrical conductivity, and pH) and a detailed biogeochemical characterization (including amino acids biomarkers) and microbial incubations will be discussed.

CALFED Statement of Relevance

By assessing the contribution of dissolved organic matter (DOM) from sediments in agricultural watersheds, this research is essential for managing drinking water quality and maintaining the Delta ecosystem health, as sediment export could be managed by targeted agricultural practices.

Kao, K.K., J. Anderson, M. Mierzwa, B. Coleman, F. Chung
Department of Water Resources, 1416 Ninth Street, Room 215-12, Sacramento,
CA 95814
kkao@water.ca.gov

Sea Level Change – Historical Analysis and Future Projections

Problem Statement: Sea level rise is a key issue for management of California's water resources. Higher water levels and salinity intrusion into the Sacramento-San Joaquin Delta could affect water supplies, water quality, levee stability, and aquatic habitat. Historical analysis and future projections of sea level can help formulate appropriate guidelines and standards for water resources management. Approach: Global sea level rise has been reported with an average rate of 1.7 ± 0.3 (mm/year) from 1870–2004 reconstructed tide gauge data; A higher rate of 3.36 ± 0.41 (mm/year) has been observed with satellite altimeter data since 1993. These data are used to derive an empirical relationship between sea level changes and surface air temperatures, and then the future sea levels are projected based on this empirical relationship and the future temperature projections from global circulation models. A similar regression analysis is also tested with California Golden Gate tide data. Results: The analysis performed on California Golden Gate tide data over 1900–1989 shows significant correlation with global temperature; however, the correlation over 1900–2007 shows weak correlation with global temperature, suggesting local sea level change could deviate from the global trend. Possible contributing factors such as local atmospheric effects and vertical land movements will be discussed.

CALFED Statement of Relevance

An improved understanding of historical sea levels and future sea level projections is relevant to the CALFED objectives of understanding water supply reliability, water quality, and levee stability.

Kawakami¹, B.T., R.A. Denton², G. Gartrell¹

¹Contra Costa Water District, P.O. Box H2O, Concord, CA 94524

²Richard Denton & Associates, 6667 Banning Drive, Oakland, CA 94611

bkawakami@ccwater.com

Investigation of the Basis for Increases in Delta Fall Salinity

Future decision making on water management and habitat and species preservation in the Bay-Delta system will be dependent upon an understanding of the factors affecting salinity in the Delta. Recent observations have shown statistically significant increases in fall Delta salinity. These increases have been identified as a potential contributing factor in the decline of delta smelt. To inform ongoing research efforts and water management decision making, an understanding of the underlying causes of the increases in fall salinity is required, as well as an evaluation of the relative significance of human versus natural influences. Contributing factors behind the increases in fall salinity have been determined through an investigation of the significance of historical water management operations. Factors examined include temperature control releases for salmon, State Water Resources Control Board D-1641 requirements, Delta cross channel (DCC) and Suisun Marsh salinity control gates operations, rice field operations, natural vegetation changes, Trinity River operations, and operational changes in flood management. Our initial evaluation shows that the increases in fall salinity appear to be closely linked to an increase in fall exports (with a corresponding decrease in QWEST during the fall) attributed to meeting D-1641 requirements. More frequent closure of the DCC for salmon protection also appears to be a contributor. Analysis of water costs incurred to restore fall water quality has also been conducted. To separate the effects of water management (represented by reservoir operations and exports) and natural variability, the empirical orthogonal function analysis of Knowles has been extended from 1987 to the present. By examining this period, which includes the Pelagic Organism Decline and the recent increases in fall salinity, we can quantify the relative impact of water management operations on observed salinity increases in the context of natural variation.

CALFED Statement of Relevance

This research improves understanding of the basis for recent increases in fall salinity that may be linked to the decline in delta smelt population. Additionally, this research provides insight on the effects of further modifications to operations to protect endangered species under recent Federal court decisions and biological opinions.

Kendall¹, C., M.B. Young¹, S.R. Silva¹, B.A. Pellerin¹, B.A. Bergamaschi¹, W.T. Stringfellow²

¹USGS, 345 Middlefield Road, Menlo Park, CA 94025

²LBNL and UoP

ckendall@usgs.gov

Evaluating Temporal and Spatial Changes in DOC Sources using Stable Isotope Techniques

Selected DOC samples collected March-December 2005 from the San Joaquin River (SJR) showed a wide range of $\delta^{13}\text{C}$ values (-34 to -22 permil), with mean values ($n = 325$) of -26.4 permil. The corresponding POM samples have a similar mean (-26.2 permil) and ranges (-33 to -21 permil). The major tributaries, drains, creeks, and wetlands sites show more variability in DOC- $\delta^{13}\text{C}$ than the mainstem sites; the Stanislaus showed the widest range of DOC- $\delta^{13}\text{C}$ values, ranging from -23 to -30 permil. The smaller west-side tributaries (Turlock and Modesto irrigation district drains) have higher $\delta^{13}\text{C}$ than the mainstem SJR, whereas the other minor tributaries generally have lower $\delta^{13}\text{C}$ values. The general correspondence of $\delta^{13}\text{C}$ values of DOC and POM suggest that they share similar origins; that and the large range of $\delta^{13}\text{C}$ values indicate that a large portion of the DOC at most sites is derived from algae. Whether the algal-derived DOC is a byproduct of algal productivity (e.g., "leaked" from algae) or respiration of algae or algal sediments is currently unknown. The occasional high $\delta^{13}\text{C}$ values of the POM and DOC (-24 to -21 permil) at many sites could reflect contributions from C4 plants. Alternatively, they could result from such intensive photosynthesis in a semi-confined location that the pool of DIC was highly fractionated, resulting in high DIC- $\delta^{13}\text{C}$ values. We have seen DOC- $\delta^{13}\text{C}$ values as high as -20 permil during an intense algal bloom in Willow Slough. At that site, $\delta^{13}\text{C}$ was inversely correlated with DOC concentration and positively correlated with nitrate concentration. Therefore, it is likely that large number of samples with high DOC- $\delta^{13}\text{C}$ values reflect DOC derived from photosynthetic activity. This hypothesis could be evaluated by measuring the BOD of the DOC, and/or by making additional isotopic measurements such as analyzing the DOM for $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$.

CALFED Statement of Relevance

This study evaluates the source of the DOC in the SJR, which contributes to low dissolved oxygen levels in the SJR and impacts the quality of drinking water, a major concern of the Ecosystem Restoration Program of the CALFED Drinking Water Quality Program.

Kiriakopoulos¹, S.L.* , W. Norden², K. Boyer¹

¹Romberg Tiburon Center, San Francisco State University, 3152 Paradise Drive, Tiburon, CA 94920

²Tiburon Audubon Center

skpolos@sfsu.edu

Variation in Eelgrass (*Zostera marina*) Growth Patterns along a Depth Gradient in San Francisco Bay

Recent modeling efforts for San Francisco Bay indicate substantially more habitat suitable for eelgrass (*Zostera marina*) than is currently utilized, and restoration efforts are being initiated. Existing populations of eelgrass that could serve as donors of seed or transplants for restoration efforts inhabit different depth ranges and vary in morphological characteristics and flowering phenology. Thus prediction of donor plant responses at potential restoration sites is difficult. Depth location differences between eelgrass beds indicate that there may be environmental parameters that need to be considered when pairing donor plants with restoration sites. To assess what these environmental variables are and how they impact plant survival and morphology we conducted a series of common garden experiments using two donor populations at three depths (-1m, -0.5m, 0.0m MLLW) at two existing eelgrass bed locations, Richardson Bay and Crown Beach (Alameda). The extant population at Richardson Bay grows primarily at deeper depths, while Crown Beach harbors the most shallow population in the Bay. Our transplant experiment showed that seedlings and adult plants from both of the donor populations established and persisted only at the deepest sites (-1m depth, always submerged) in Richardson Bay. Adult plants at the deepest sites in Richardson Bay also showed the greatest growth and productivity. Conversely seedlings and adult plants established, persisted and had greatest growth and productivity at shallower sites (0.0m depth, exposed 14 days/month) at Crown Beach. To help to discern environmental parameters that led to these results, we measured light attenuation and total suspended solids at the three depths at both Richardson Bay and Crown Beach. Preliminary results suggest that low light availability due to fine sediment resuspension is impacting eelgrass establishment and persistence at shallow depths in Richardson Bay, an effect not seen with the sandy sediments of Crown Beach.

CALFED Statement of Relevance

This work meets the goals and objectives of the CALFED program by providing new insights into the processes governing the establishment and persistence a key species and habitat in the estuary. This information will aid in the development of guidelines and tools to promote successful ecosystem restoration of this species in San Francisco Bay.

Kizito, F.K., C.M. Joab, M. Amanda
Central Valley Regional Water Quality Control Board, 11020 Sun Center Drive,
#200, Rancho Cordova, CA 95670-6114
fkizito@waterboards.ca.gov

Temporal and Spatial Trends of Organo-chlorine Pesticides in Central Valley and Delta Estuary Waterbodies

Organo-chlorine (OC) pesticides such as DDT possess unique physical and chemical properties that contribute to their ability to concentrate in biota, magnify in the food chain and persist in the environment especially in soils and sediment. In addition to their toxicity to aquatic organisms, OC pesticides bioaccumulate in fish and other aquatic life, posing cancer risks to humans consuming these organisms as food and potentially impair wildlife reproduction. Although OC pesticides have been banned from use in the United States since in 1972, concentrations of these chemicals have been detected in fish tissue and sediment samples in various reaches within watersheds in the Central Valley (San Joaquin, Sacramento and the Delta) at concentrations high enough to warrant the listing of the affected reaches on the 2006 Clean Water Act (CWA) section 303(d) list of impaired water bodies. In 2006 California Regional Water Quality Control Boards listed 22 waterbodies as impaired by OCs. The 303(d) listings require States to develop Total Daily Maximum Loads (TMDLs), which establish the maximum amount of pollution a water body can receive without violating existent regulatory water quality standards. The authors are involved in an extensive on-going review of data sources (fish tissue, water column and sediment) for OCs in Central Valley waterbodies and the Delta estuary. This work highlights the occurrence, spatial distribution and temporal trends of OCs in the Central Valley and Delta estuary as part of an effort towards developing the OCs TMDL.

CALFED Statement of Relevance

Organochlorine pesticides cover a wide range of chemical structures such as DDT and create problems related to translocation and biomagnification in the food chain. This poses a cancer health risk to humans consuming contaminated aquatic life and deserves serious attention.

Knowles, N.

USGS, Menlo Park, 345 Middlefield Rd., MS 496, Menlo Park, CA 94025

nknowles@usgs.gov

Projected Hydrologic Changes and Management Challenges Under CASCaDE Climate Change Scenarios: Data Availability

As part of the CASCaDE Project, four scenarios of climate change, corresponding to different climate models and emissions scenarios, were selected to represent a range of possible futures. The goal of the hydrologic modeling component of CASCaDE is to assess the response of hydrology and management in the Sacramento and San Joaquin basins to each of these scenarios, and to provide plausible translations of the climate model outputs into managed Delta inflows and water temperatures for use by other components of the CASCaDE study. To this end, downscaled versions of the corresponding daily meteorology from each of these scenarios were used to drive a hydrology model, resulting in daily 100-year projections of snowpack and unimpaired streamflow. These outputs were then aggregated to the monthly scale and used to drive modified versions of the CALSIM operations model and the U.S. Bureau of Reclamation stream temperature model. The results demonstrate potential management challenges associated with each of the climate projections over the next century. Data from each stage of this approach are available online. This poster shows examples of the available outputs.

CALFED Statement of Relevance

The results demonstrate potential management challenges associated with each of the climate projections over the next century. In particular, impacts of extreme or multi-year events such as very wet years or prolonged droughts become more difficult to mitigate as snowpacks diminish under a warmer climate.

Kraus¹, T.E., B. Phillip², W.R. Horwath³, R. Fujii¹, Bergamaschi¹, Y. Henneberry³, D. Mourad³

¹US Geological Survey, California Water Science Center, 6000 J Street, Sacramento, CA 95819

²Bachand and Associates, Davis, CA

³University of California, Davis, CA

tkraus@usgs.gov

The Use of In Situ Coagulation in Conjunction with Constructed Wetlands to Decrease Island Drainage Water DOC Export and Mitigate Land Surface Subsidence

The farmed islands of the Sacramento-San Joaquin Delta have subsided below sea level and require extensive levee and drainage systems to maintain dry land for agriculture and other uses. The strength and reliability of these levees, as well as the costs required to maintain them, are of growing concern. In addition, island drainage water pumped back into Delta waterways contains high concentrations of dissolved organic carbon (DOC), which has a negative impact on drinking water quality because during disinfection DOC reacts to form carcinogenic disinfection by-products (DBPs). In light of these issues, CALFED and the Department of Water Resources have funded a study investigating the feasibility of using coagulation to remove DOC from island drainage water prior to release into Delta channels in conjunction with constructed wetlands aimed at subsidence reversal. Iron and aluminum based coagulants (e.g. FeCl₃, FeSO₄, AlSO₄) are routinely used by drinking water treatment plants to remove DOC prior to disinfection. We hypothesize that 1) on-island coagulation can effectively reduce DOC and DBP precursor loads to the Delta and 2) accumulation of the resulting DOC-metal flocculate in addition to plant biomass will augment wetland accretion rates. The project will combine laboratory and field studies to assess (1) how effective coagulants are at removing DOC and DBP precursors from island drainage waters, (2) the long-term stability of the DOC-metal precipitate under varying environmental conditions, (3) rates of land surface accretion in wetlands receiving flocculate compared to wetlands alone; (4) potential aquatic environmental and toxicity effects, and (5) if the technology is promising, the logistics, feasibility and costs of implementing this approach at a larger scale.

CALFED Statement of Relevance

The goal of this study is to determine if coagulation in conjunction with constructed wetlands can improve Delta water quality by decreasing disinfection by-product precursor loads to the Delta while also mitigating land surface subsidence and thereby improving levee stability.

Kurth, R.L., T. Kastner, H. Kyle
Department of Water Resources, 460 Glen Dr., Oroville, CA 95966
rkurth@water.ca.gov

Movement of Wild and Hatchery Origin Feather River *O. mykiss*

Previous observations of naturally and hatchery produced *O. mykiss* within the Feather River suggest there may be two runs, winter and spring, or at least a display of multiple life histories. However, we have limited data on their specific timing and movement. Additionally, we do not know the proportion of anadromy exhibited within the Feather River. In order to increase our understanding, we examined the movement patterns of Feather River *O. mykiss*, of natural (“wild”) and hatchery origin, through the lower Feather River and the Sacramento San Joaquin Delta using ultrasonic telemetry. Our objectives were to: (1) compare and contrast the temporal variation in movement of hatchery and wild steelhead; (2) determine the dominant life history patterns for hatchery and wild *O. mykiss*. In this poster we summarize our preliminary results.

CALFED Statement of Relevance

It is important to understand the temporal variations and dominant life history stage of wild and hatchery *O. mykiss*, a species of interest throughout the watershed.

Lang, S.Q., L.I. Aluwihare

Geosciences Research Division, Scripps Institution of Oceanography, MS 2044,
University of California San Diego, La Jolla, CA 92093

sqlang@ucsd.edu

Investigating the Carbon and Nitrogen Sources Supplying the Base of the Suisun Bay Food Web: A Compound-specific Isotope Approach

Simultaneous declines of multiple pelagic organisms in the upper San Francisco Bay suggests a possible trophic linkage and that a decline in food resources is an important factor in the decline of juvenile fish (Bennett and Moyle, 1996). Our research goal is to determine the carbon and nitrogen sources being utilized by the lower trophic levels of this food web, the dominant zooplankton inhabiting Suisun Bay, and to monitor how the consumption of these sources changes over time and with different water management practices. Our approach is to track the isotopic signatures of primary carbon and nitrogen sources entering Suisun Bay and compare these signatures to those in dominant zooplankton. Filtered water, suspended particulate matter, and zooplankton have been collected from Suisun Bay and its primary inputs and outputs including the Sacramento River, the San Joaquin River, Suisun marsh, and the Carquinez Strait. These samples are being analyzed for bulk isotopic composition and biomarker concentrations (lipids, amino acids). Additionally, the isotopic signature of individual amino acids of Suisun Bay zooplankton will be determined. The ^{15}N composition of individual amino acids in zooplankton has the potential to be used for both food-source information and to infer the trophic status of the consumer. Certain amino acids become strongly fractionated as trophic-level increases (e.g. alanine, glutamic and aspartic acid) while others are transferred more or less conservatively from the food source (e.g. glycine, phenylalanine, serine and tyrosine). We hope this data will allow us to elucidate changes to the carbon and nitrogen sources consumed by the base of the Suisun Bay food web.

CALFED Statement of Relevance

We hope this work will contribute to an understanding of the pelagic organism decline.

Lehman, P.W., L. Liu, A. Tang, S. Mayr, C. Enright
CA Department of Water Resources, Division of Environmental Services,
Sacramento, CA 95814
plehman@water.ca.gov

Daily and Seasonal Inorganic and Organic Material Flux in the Freshwater Tidal Wetland, Liberty Island, CA

It is hypothesized that restoration of perennial freshwater tidal wetland habitat may help to restore fishery production in San Francisco Estuary by exporting inorganic and organic material needed to support the estuarine food web and create favorable habitat for aquatic organisms. To evaluate the potential export of material by freshwater tidal wetland habitat to the San Francisco Estuary a series of studies that included monthly, hourly and high frequency (15 min) flux measurements was conducted for a suite of inorganic and organic materials at the perennial freshwater tidal wetland Liberty Island between 2004 and 2006. Material flux was measured for the inorganic nutrients (nitrogen, phosphorus and silica), physical factors (water temperature, salinity, turbidity, pH and dissolved oxygen), organic nutrients (total and dissolved organic carbon and dissolved organic nitrogen) and biota (phytoplankton and zooplankton group biomass and chlorophyll a and phaeophytin pigment). Material flux varied seasonally with most materials exported in the spring. Hourly sampling within sub-habitats over a tidal day revealed the importance of material transport between vegetated ponds and open water ponds. Internal ponds with emergent vegetation contributed between 4% and 90% of the inorganic and 20% to >100% of the organic material exported over the year by the wetland and was the primary source of phytoplankton carbon. Year-long high frequency (15 min) sampling revealed up to twice as much of the material flux was caused by dispersion, probably due to tidal action than caused by advection due to river discharge. We conclude perennial freshwater tidal wetland habitat was a source of inorganic and organic nutrients and plankton to the San Francisco Estuary and accurately quantifying this contribution requires high frequency spatial and temporal sampling.

CALFED Statement of Relevance

This abstract of CALFED funded research is important because one of the potential management strategies proposed as part of the management for POD species is to use freshwater tidal habitats to export organic and inorganic material into the estuary to produce habitat and support food web production. Because Liberty Island is a freshwater tidal habitat and is located in the lower Sacramento River where the threatened Delta smelt occur, knowing its potential export of organic and inorganic material to the estuary is of particular concern.

Letain¹, T.E., W.T. Stringfellow^{1,2}

¹University of the Pacific, Environmental Engineering Research Program,
Stockton, CA 95211

²Lawrence Berkeley National Laboratory, Berkeley, CA

teletain@hotmail.com

Declining Trends in the Volume of Agricultural Return Flows Entering the San Joaquin River between 2000 and 2006: What is of the Impact of Changing Agricultural Management Practices on the SJR Ecosystem?

A restricted water supply throughout California has resulted in changes in agricultural management practices to maximize conservation and reuse of available water. We investigated the impact of summertime agricultural water manipulations on San Joaquin River (SJR) water body flow rates by examining how well the San Joaquin Region 60-20-20 Water Supply Index (WSI) correlates with the seasonal flow rates of drainages in the San Joaquin Basin. We find an overall decline in water flow as a function of year in SJR drainages compared to the WSI. This decline in water flow may also have implications on the loading of pollutants such as phytoplankton and various nutrients. Water flows in the San Joaquin Basin are dependent on natural factors such as rainfall and snowmelt, and on artificial water manipulations such as water storage, diversions, and irrigation return flows. Average daily flow for six San Joaquin Basin drainages and for two SJR sites from January/February and from July/August were compared with the WSI for the water years 2000 through 2006. The WSI has an upward trend from 2000 through 2006, indicating an overall increase in available water over the time period. However, several SJR drainages show a downward trend in summertime average flow over the same time period, suggesting a dependence on agricultural water management activities, not water availability. This declining trend in drainage flow rates could reflect a change in Central Valley agricultural water use resulting from various water conservation best management practices (BMP) such as drip irrigation, water recycling, and a shift from row crops to orchards. We will also discuss how declining water flow trends may indicate changes in flow effect pollutant loadings to the SJR.

CALFED Statement of Relevance

This study analyzes the impact of changes in agricultural practices in response to restricted water supply on the flow rates and on pollutant loading of San Joaquin Basin drainages. We find changes implemented between 2000 and 2006 may be manifest in declining return flows in SJR agricultural drains.

Lewis, J.A., W.M. Lori, P.J. Hrodey
US Fish and Wildlife Service, 4001 N. Wilson Way, Stockton, CA 95205
Jerrica_Lewis@fws.gov

A Survey of Nearshore Fish Communities in Liberty Island using Minnow Traps

Since flooding in 1997, Liberty Island has been undergoing passive restoration returning it to a tidally influenced freshwater marsh. As levees erode and natural vegetation emerges, new dynamic habitats are formed where they previously did not occur. This nearshore habitat is thought to be beneficial to native species by providing key habitat requirements for nearly all life stages; however, little is known about the fish communities using them. Between 2003 and 2005, the Delta Juvenile Fish Monitoring Program of the U.S. Fish and Wildlife Service's Stockton office used minnow traps to identify species presence in nearshore habitats of Liberty Island. Sampling was conducted inside and outside the perimeter of the island once a week from March to June 2003 and twice a month for the remainder of the study. Preliminary results indicate that the majority of the catch, representing 37 species, was dominated by non-native species. Our data indicate that a diverse fish community uses nearshore habitats of Liberty Island. Freshwater tidal marsh is thought to be an important nursery area for native fishes in the delta. Understanding how these habitats are used by native and non-native fish species can help direct future restoration activities.

CALFED Statement of Relevance

Ecosystem Restoration: Since flooding in 1997, Liberty Island has undergone passive restoration returning it to a tidally influenced marsh. This dynamic, nearshore, habitat is thought to be beneficial to native species by providing key habitat requirements for nearly all life stages; however, little is known about the fish communities utilizing them.

Li¹, S.K., J.R. Gildersleeve²

¹Aquatic Systems Research, 1210 Spencer Avenue, Santa Rosa, CA 95404

²Portsmouth Naval Shipyard, Kittery, Maine

stacy_li@sbcglobal.net

Critical Considerations for a New Water Distribution System in California

The voters of California overwhelmingly rejected funding for the Peripheral Canal in 1982. The economy of California is at risk if the water distribution system is not fixed soon and it will not be fixed without public support. We identify seven considerations that the public must know so that they can fairly evaluate and support any water distribution system exporting from the Delta: 1) The waters of the Sacramento and San Joaquin rivers do not mix in the Delta, making through Delta water conveyance infeasible. 2) The Central Valley Project was never designed to export Sacramento River water. The present system is dependent on waters from the San Joaquin River and the water demand on the San Joaquin is approaching the full water capacity of that river. 3) The present system is dependent upon the integrity of a fragile levee system that can fail at any time. 4) Current export pumping location creates flow reversals pulling salt waters into the Delta and eliminates backwater habitat that has caused ecological ruin to anadromous salmonid runs in the San Joaquin watershed and the decline of pelagic organisms living in the Delta. 5) The Delta is a highly altered system that is not in equilibrium, so location of infrastructure will be critical. 6) The Delta is a major transportation network that may affect water quality in the Delta. 7) Climate change will increase stress on the levee system and will increase the need to increase water storage capacity. We conclude that there is need for a new water distribution that exports Sacramento River water rather than retrofitting the existing export system, but the question remains will the public agree?

CALFED Statement of Relevance

In 1982, both sides appealed to emotional issues rather than the technical issues showing that it is in the best interest to everyone in California that the water system be fixed. The electorate rejected the Peripheral Canal then and probably will again unless these considerations are presented to them.

Lidstrom, U.E.*, E.J. Carpenter
Romberg Tiburon Center for Environmental Studies, SFSU, 3152 Paradise Drive,
Tiburon, CA 94920
lidstrom@sfsu.edu

CALFED Foodweb Project: Phytoplankton Ecology within the Low Salinity Zone of the Northern San Francisco Bay Estuary

In San Francisco Bay Estuary (SFBE) the low salinity zone (LSZ; between 0.5 to 5 psu), is an important habitat for many estuarine organisms, including the threatened delta smelt. Reports of severe pelagic organism declines have increased the need to identify the factors controlling this system. Earlier evidence showed food limitation could be a factor in the failing LSZ ecosystem, suggesting a link between organism decline and changes at lower trophic levels. Long term phytoplankton monitoring in the SFBE includes chlorophyll measurements (biomass) but rarely, direct primary production measurements and species identification. This is the first study of phytoplankton primary production and community structure in the LSZ that includes continuous monitoring over two seasons, for two years. Primary production, biomass and species composition were measured in samples from three salinities within the LSZ (0.5, 2 and 5 psu) from March to August, weekly in 2006 and biweekly in 2007. Phytoplankton were size fractionated to assess the relative contribution of larger (>5 μm) and smaller (<5 μm) cells. Production was measured using the ^{14}C method and incubating at ten light levels (100 - 0.1% ambient light). Phytoplankton were identified and enumerated using light and epifluorescence microscopy of preserved samples. The three salinities within the LSZ showed similar trends in all parameters measured. Results showed differences in biomass, production, and species composition between the two years, possibly associated with the extremely different water years and subsequent geographic location of the LSZ. Biomass and production were higher, and more variable, in 2006 than 2007. Cells < 5 μm in size appear to be particularly important in summer, making up >50% of the biomass and production. Data presented here was collected as part of a CALFED funded collaborative study aimed to characterize the LSZ foodweb.

CALFED Statement of Relevance

These results help to characterize the foodweb of the low salinity zone, an important habitat for many estuarine organisms, including the threatened delta smelt.

Lievanos¹, R.S. *, F.M. Shilling², J.K. London³

¹UC Davis, Dept. of Sociology, One Shields Ave, Davis, CA 95616

²UC Davis, Dept. of Env. Science and Policy, One Shields Ave, Davis, CA 95616

³UC Davis, Center for the Study of Regional Change & Dept. of Human and Community Development, One Shields Ave, 2334 Hart Hall, Davis, CA 95616

rslievanos@ucdavis.edu

Third Parties and a Process of Elimination: Environmental Justice within and beyond CALFED

This paper explores the rise and fall of environmental justice (EJ) as a function of the governance and planning of ecosystem management within the California Bay-Delta Authority's (CBDA) policy-development process and the current Delta Vision process. We suggest that EJ can be understood as a 'canary in the coal-mine' to assess the initiative's broader commitments and capacities relative to communicative planning and to equity as a planning principal and outcome. We interpret the fate of EJ within CALFED as indicative of the inherent tensions between a system based on increasing market dominance and state legitimation and the value-system of EJ based on equitable access to policy processes and resource benefits. We draw upon the personal experiences of one of our co-authors and others who are former members of the EJ sub-committee of CBDA's Bay Delta Public Advisory Committee, as well as interviews with other key EJ interests, and a comprehensive review of internal and public CBDA documents relating to the EJ program including budgets and program plans, and ethnographic field work. We conclude that by learning from the mistakes of CALFED, a positive model of collaborative, environmental-justice-based planning for water and ecosystem management is possible.

CALFED Statement of Relevance

The historical development of California's Water management has institutionalized a power structure of agencies, urban users, irrigated agriculture, and large reform environmental groups, which positions all others as 'third parties' to the contracts these powerful interests sign and the decisions they make about water. Many, including those just listed, refer to this system of relationships as 'business as usual' and are even suggesting that the paradigm of strict (utilitarian) focus on water supply is faulty without taking into account disproportionate exposures to poor, and sometimes toxic, water quality born on people of color and low income communities. There are also calls for more meaningful public participation from those communities in the environmental decision making processes that impact them where they live, work, play, pray and go to school. All too often, these third parties represent community groups advocating broadly for environmental justice, particularly for equitable access to clean, safe, and affordable water for all of Californians. This paper is an intervention in this area of concern and will set the tone for the proposed special session on CALFED Environmental Justice in Theory and in Practice by providing a historically and contemporarily informed critique of CALFED, its approach to environmental justice, and review of the lessons learned from its attempt for 'everyone to get better together' while marginalizing environmental justice concerns.

Linares-Casenave, J., J.P. Van Eenennaam, S.I. Doroshov, D. Kueltz
Animal Science, UC Davis, One Shields Ave., Davis, CA 95616
jlinares@ucdavis.edu

The Yolk Sac Larvae of White and Green Sturgeon are Highly Sensitive to Selenium and Temperature Stresses

Viability of sturgeon larvae in the Sacramento River can be affected by changes in river temperature and selenium bioaccumulation in the egg yolk. Using three progenies of white sturgeon and single mating green sturgeon, we examined effects of selenium enrichment (3-4 times higher than normal) and elevated temperature (26°C, compared to 18°C normal) on the larval development and survival during the yolk absorption phase (stages 36-45). Temperature and selenium stresses were applied separately and in combination. The selenium was introduced by the Se-L-Met microinjections into the yolk sac of newly hatched larvae, increased the body burden to 7-10 µg g⁻¹, compared to 2 µg g⁻¹ in the L-Met injected control. Mortality and proportion of abnormal larvae were monitored and the samples were collected for further proteome analysis (in progress). The combined selenium and temperature stress significantly increased mortality of green (61%) and white sturgeon (11%). Temperature stress alone affected green sturgeon (16% mortality) but not the white sturgeon (1%). The selenium stress caused mortality in both green (60%) and white (7%) sturgeon. Both species exhibited clear stressor-specific abnormalities. Selenium induced edema and lethargy, and temperature induced notochord flexure and impaired swimming. These results indicate high sensitivity of sturgeon larvae to environmental stressors relevant to the Sacramento - San Joaquin Estuary and potential negative effects of these stressors on the reproduction and health of two indigenous stocks.

CALFED Statement of Relevance

The study indicates potential negative effects of temperature changes and selenium bioaccumulation on reproduction and stock recruitment of two native species of sturgeon in the Sacramento-San Joaquin Estuary.

Loboschefsky¹, E.J.*, A. Massoudieh¹, T.R. Ginn¹, K.A. Rose², F.J. Loge¹

¹UC Davis, Department of Civil & Environmental Engineering, One Shields Ave., Davis, CA 95616

²Louisiana State University, Department of Oceanography & Coastal Sciences, Coastal Fisheries Institute, 218 Wetland Resources, Baton Rouge, LA 70803
elobo@ucdavis.edu

Development and Application of an Individual-Based Population Life-Cycle Model of Striped Bass in the San Francisco Bay Delta to Understand the Role of Selected Stressors on the Decline of Population Numbers

Recent declines in the abundance of striped bass (*Morone saxatilis*) in the Sacramento Delta and San Francisco Bay (Bay-Delta) have increased the need for causal identification. Evidence suggests that health effects associated with multiple stressors in the Bay-Delta have substantially contributed to the decline of the striped bass population. Stressors can affect fish health through changes in growth, movement, reproduction, and survival, which in turn, can lead to decline in population numbers. The challenge of understanding this decline calls for data-supported quantification of relationships between the dynamics of striped bass population numbers and ecosystem components that affect survival. To address this challenge, a population life-cycle model that integrates field and laboratory data into a quantitative measure of the impact of multiple stressors on striped bass population dynamics has been developed. The model addresses important constitutive relationships at each life-stage that govern striped bass movement, growth, contaminant uptake, mortality and fecundity in the Bay-Delta. This overall model is subdivided into an egg/larvae component, represented by a distributed model, and a juvenile/adult component, represented by an individual based model. The use of two different model types reflects largely on the differences governing constitutive relationships at each respective life stage. This modeling approach allows for the evaluation of population level effects under multiple different simulations by varying flows, contaminant concentrations, prey availabilities and habitat suitability.

CALFED Statement of Relevance

The development of a striped bass life cycle model aims to assess the significance of contaminants relative to other factors (e.g., food web modifications and water exports, to mention a few) in the Pelagic Organism Decline (POD) conceptual model on the observed decline in population numbers.

Loboschefskey, E.J.*, A. Massoudieh, T.R. Ginn, F.J. Loge
UC Davis, Department of Civil & Environmental Engineering, One Shields Ave.,
Davis, CA 95616
elobo@ucdavis.edu

Development of a Fate and Transport Model for Striped Bass Eggs and Larvae in the Sacramento River and Delta

The egg and larval stages of striped bass are typically spent within the Delta or the nearby reaches of the Sacramento or San Joaquin Rivers. Constitutive relations that govern movement, age and mortality in these early life stages were developed and then applied to: (1) transport eggs from the spawning grounds within the Delta or the nearby reaches of the Sacramento or San Joaquin Rivers and larvae further downstream into the Delta region; (2) transition viable eggs into larvae; (3) transition viable larvae into juveniles; and (4) account for losses of viable eggs and larvae associated with mortality. Collectively, the constitutive relations embody a model of striped bass eggs and larvae. The egg/larvae model utilizes the Delta Simulation Model II (DSM2), developed by the California Department of Water Resources, as the hydrodynamic model to guide the transport of eggs and larvae throughout the Delta; eggs and larvae are considered passively moving particles and their motions are assumed to be controlled purely by hydrodynamic forces as they have little to no control over movement compared to flow and tidal forces in the Sacramento River/Delta. An explicit finite volume approach was used to solve the fate and transport governing equations. Coupled but separate transport models were used to model the transport of egg and larval populations. Spatial and temporal age distribution of eggs was estimated using the method of moments and used to estimate the rate of transfer of eggs to larvae. Field data from the California Department of Fish and Game's Egg and Larval Survey, which sampled various locations throughout the Sacramento River, Delta, and Suisun Bay between 1967 and 1994, was used as a basis of comparison with model output. The egg/larvae model was used to (i) estimate the fate and transport of striped bass eggs and larvae in the Sacramento River and Delta under different flow conditions (i.e. wet, dry, average flow years) and (ii) generate input for the juvenile/adult model.

CALFED Statement of Relevance

This egg/larvae model was developed as a component of a larger population life-cycle model to integrate field and laboratory data into a quantitative measure of the impact of multiple stressors on the striped bass population in the Sacramento River and Bay-Delta region.

Loboschefsky¹, E.J.*¹, A. Massoudieh¹, H. Haeri¹, T. Ginn¹, K. Rose², D.J. Ostrach³, F.J. Loge¹

¹UC Davis, Department of Civil & Environmental Engineering, One Shields Ave., Davis, CA 95616

²Louisiana State University, Department of Oceanography & Coastal Sciences, Coastal Fisheries Institute, 218 Wetland Resources, Baton Rouge, LA 70803

³UC Davis, John Muir Institute for the Environment, One Shields Ave., Davis, CA 95616

elobo@ucdavis.edu

Development of a Juvenile and Adult Striped Bass Individual Based Model in the San Francisco Bay Delta Inclusive of Growth, Movement, Contaminant Uptake, Mortality and Fecundity

The juvenile and adult life stages of striped bass are typically spent throughout the Delta and San Pablo and San Francisco Bays or the nearby reaches of the Sacramento or San Joaquin Rivers during spawning season. Constitutive relations were developed for: (1) movement of individual juveniles and adults within a spatially heterogeneous environment of food and contaminants; (2) growth based on food availability; (3) aging; (4) contaminant uptake; (5) mortality; and (6) fecundity. Movement was modeled utilizing a two-dimensional biased Levy flight approach, where the bias reflects habitat suitability (i.e. food availability, salinity, temperature). Growth and contaminant uptake were modeled using bioenergetics and contaminant accumulation models, which account for food availability and both aqueous and dietary contaminant concentrations. Mortality was modeled as a decay rate expression per life-stage. The fecundity model included both the quantity and location of egg production. The juvenile/adult model was used to (i) generate number and location of egg production for input into the egg/larvae model and (ii) determine the weight/length, contaminant body burden, and mortality of individual fish over the course of one spawning cycle.

CALFED Statement of Relevance

This juvenile/adult model was developed as a component of a larger population life-cycle model to integrate field and laboratory data into a quantitative measure of the impact of multiple stressors on the striped bass population in the Sacramento River and Bay-Delta region.

London, J.K.

UC Davis, One Shields Avenue, Davis, CA 95616

ijklondon@ucdavis.edu

Regional Governance, Environmental Justice and Water Management in CalFed and Beyond

Regional governance is increasingly the scale at which water and other natural resources are being managed by the state. Environmental justice organizations are also increasingly mobilizing on a regional scale. Understanding how these two regionalizing processes intersect is a critical task for both public agencies and social movement actors. This paper will provide a conceptual framework for this analytical project. In particular, this paper uses the attempted incorporation of environmental justice within CalFed and its follow-on processes (e.g., Delta Vision) – and the challenges faced by these efforts – to analyze the problems of state and social movement versions of regionalism. It further offers a set of alternative regional frameworks for water management in California that can incorporate environmental justice and regional equity in more effective and sustainable ways.

CALFED Statement of Relevance

Environmental justice was to be a core element of CalFed, informing all program areas and outcomes. The failure to realize this goal was produced by multiple factors and must be understood to avoid reproducing such problems in future regional water management endeavors.

Lowe¹, S., K. Gehrts², P. Salop³, S. Bay⁴

¹San Francisco Estuary Institute, 7770 Pardee Lane, Oakland, CA 94621

²Department of Water Resources, Division of Environmental Services, 901 P St., Sacramento, CA 95814

³Applied Marine Sciences, Inc., 4749 Bennett Dr., Ste. L, Livermore, CA 94551

⁴Southern California Coastal Water Research Project, 3535 Harbor Blvd., Suite 110, Costa Mesa, CA 92626

sarahl@SFEI.org

Sampling the Freshwater Reaches of the Lower Delta for Sediment Quality Objective Measures

A 2001 court decision ordered the State Water Resources Control Board (State Water Board) to adopt SQOs pursuant to the California Water Code §13393. Under Phase I of the SQO Program, the State Water Board made significant progress within the major enclosed bays and harbors. This next phase of development focuses on the Delta, for which little information exists about sediment contamination and toxicity. In the Fall of 2007, the SQO Program collaborated with the Department of Water Resources- Environmental Monitoring Program to collect benthos, sediment chemistry, and toxicity data to investigate sediment condition and develop objectives for this tidal-freshwater region. Preliminary sediment toxicity results, using both acute and sublethal toxicity endpoints, indicated that most of the region was not toxic to the amphipod *Hyalella azteca* or the midge *Chironomus dilutus* (10-day survival and growth tests). Preliminary chemistry results indicate that several persistent legacy contaminants of concern and current use pesticides were detected in sediments from many of the stations sampled in the lower Delta. Comparison of median concentrations of select contaminants of concern between the Delta samples and the RMP-Status and Trends program samples from the northern estuary (Suisun Bay and downstream of the confluence of the Sacramento and San Joaquin Rivers; 2005 & 2006) indicate that: · Sums of PCB and PAH concentrations are similar in the lower Delta region as in the northern Estuary. · Sum of DDT and Chlordane concentrations are about ten times higher in the lower Delta than the northern Estuary Except for PAHs, the highest concentrations of these contaminants were 30 to 70 times higher in the lower Delta sample area than the northern Estuary.

CALFED Statement of Relevance

Sediment quality data are crucial for understanding ecological condition of sediments in the lower Delta and will provide the foundation for developing SQOs that will inform future management and restoration efforts in the region.

Luoma, S.N., L.D. Muscatine
John Muir Institute of the Environment, UC Davis, One Shields Avenue, Davis,
CA 95616
snluoma@ucdavis.edu

San Francisco Estuary and Watershed Science: A Journal of Regional Focus and Global Impact

San Francisco Estuary and Watershed Science is an open access scholarly journal established to provide the opportunity for on-line publication of peer-reviewed papers dealing with all aspects of the San Francisco Bay-Delta estuary, its watershed, and adjacent coastal ocean. SFEWS fosters the communication of collaborative, peer-reviewed research by presenting original findings, reviews, techniques, and comments to broaden the current state of knowledge about the ecology of the San Francisco Bay-Delta region. Through publication in the journal researchers can readily share their observations and conclusions with policymakers who are using their information for management applications. Now in its fifth year of publication, SFEWS has continued to provide local researchers with critical information about this complex, highly managed and ecologically important region. Because this high quality scientific information is in electronic format and is freely accessible to computer users, its global impact is evident.

CALFED Statement of Relevance

San Francisco Estuary and Watershed Science has continued to provide local researchers with critical information about this complex, highly managed and ecologically important region. Because this high quality scientific information is in electronic format and is freely accessible to computer users, its global impact is evident.

Luster, R.A., M.D. Roberts
The Nature Conservancy, 500 Main St., Chico, CA 95928
rluster@tnc.org

Final Results of the Sacramento River Ecological Flows Study With An Emphasis On Management Applicability of Key Findings

The Nature Conservancy's Sacramento River Project and its partners have worked for nearly two decades to restore natural ecosystem function within extensive tracts of the riparian corridor of the Sacramento River, one of California's most important rivers. Restoration strategies have focused on active floodplain revegetation to provide an immediate local increase in ecological value. Although these strategies are successful, TNC and others recognize that a long-term conservation strategy for the Sacramento River involves restoring or replicating the natural river processes that create and maintain these dynamic ecosystems. Consistent with this approach and in an effort to address CALFED ERP goals, TNC initiated the Sacramento River Ecological Flows Study in 2002. The study contributed to restoration planning for the Sacramento River through a thorough investigation of linkages between stream flow and habitat characteristics and responses of a carefully selected set of species and ecological targets for the Sacramento River. Two years ago at the 2006 CALFED Science Conference, a series of eight presentations provided status reports on various aspects of the study ranging from gravel augmentation strategies, to flow management strategies aimed at providing quantified management actions and habitat responses to those actions. The project is now complete and this presentation will summarize the findings of the study with an emphasis on those findings most easily and rapidly applied to water management and planning exercises conducted for the Sacramento River.

CALFED Statement of Relevance

The Nature Conservancy formed a team of ecologists and river management specialists and submitted a proposal to the CALFED Ecosystem Restoration Program in 2001 in order to advance our understanding of ecological linkages between patterns of river flow and the native species, natural communities, and natural processes found in and around the Sacramento River. Our objective is not to return to a completely natural flow regime but rather to determine which elements of the Sacramento River's natural flow pattern must be in place to promote a healthy ecosystem and still respond to human needs. The Sacramento River Ecological Flows Study has the following goals: 1) synthesize existing interdisciplinary information, 2) develop a decision analysis tool to evaluate trade-offs among different ecological objectives, 3) propose strategies to achieve multiple species conservation benefits, and 4) provide information on ecological flow needs to other efforts seeking to balance ecosystem and human needs related to river flow. This presentation summarizes findings of this multi-year effort seeking to link management actions to biological responses of a suite of ecological targets on one of the State's most important river systems.

Madison, R.K.*, D. Kueltz
UC Davis, Animal Science Department, One Shields Ave., Davis, CA 95616
rkmadison@ucdavis.edu

Development of Biomarkers for Toxicity Exposure of Sturgeon

Problem statement: Two species of sturgeon that are endemic to the San Francisco Bay Delta (SFBD) water system are exposed to stressors such as selenomethionine (SeMet) and methylmercury (MeHg) and it is not know how these fish respond to such stress. Approach: We are investigating whether specific protein biomarkers are correlated with exposure of white sturgeon (*Acipenser transmontanus*) and green sturgeon (*Acipenser medirostris*) to SeMet and MeHg. Juvenile sub-yearling green and white sturgeon were fed a diet of either control pellets or pellets supplemented with 3 measured doses of either SeMet or MeHg. Samples were taken from the sturgeon gill and white muscle tissue at week 0, 2, 4, 6, and 8. They were processed by two-dimensional gel electrophoresis and the proteomes of these samples compared in different treatment groups. Results: Green sturgeon were found to be significantly more sensitive to SeMet than white sturgeon. Since the SeMet concentrations used in our study are within ecophysiologicaly relevant levels this finding may contribute to explaining why green sturgeon populations are declining at a faster rate than white sturgeon in the San Francisco Bay Delta. Several proteins showing significant up or down-regulation in gill tissue in response to exposure to toxicity stress were purified and analyzed using mass spectrometry. These proteins are good candidates for biomarkers that are indicative of exposure history to SeMet and MeHg stress. Conclusions: Identification of several novel proteins significantly affected by SeMet and MeHg stress provide an opportunity to develop more specific biomarker assays for assessing exposure of sturgeon to stressors in the field. Knowledge of these proteins will also provide insight into which biochemical pathways are most affected by SeMet and MeHg stress.

CALFED Statement of Relevance

Lack of knowledge about SeMet or MeHg effects on sturgeon physiology hinders prediction of population-level effects. This deficiency can be overcome through identification of sensitive biomarkers supporting modeling at the organismal level, allowing better prediction of population-level effects and improve the ability to foresee consequences of stress on sturgeon.

Manly, B.

Western EcoSystems Technology Inc., 200 South 2nd St., Cheyenne, WY 82070
bmanly@west-inc.com

Estimating Delta Smelt and Longfin Smelt Salvage Numbers and the Proportion of the Population in the Southeast Delta

The question is what parameters are strongly associated with the losses of listed fish at Delta export pumps? A log-linear modeling approach has been used for the prediction of daily salvage numbers at the Banks and Jones pumping plants, and for the proportion of the population in the southeast Delta, for delta smelt and longfin smelt, based on river flow rates and other variables. The analyses have included searches for the best model out of all possible models, subject to various constraints on the combinations of variables considered. Details on the methods used and the results obtained will be discussed in this talk. In some cases very good predictions appear to be possible based on the available past data while in other cases the variable of interest appears to be inherently more difficult to deal with in this respect. In conclusion, statistically significant regression equations can be and have been developed that quantitatively relate fish losses to Old and Middle rivers flow and other parameters.

CALFED Statement of Relevance

Relevance is in relating water supply reliability to ecosystem restoration, especially for listed species. In particular, Old and Middle river flows are related to potential smelt losses at export pumps, and operation that minimize such losses are identified.

Marshall, M.J., P. Brandes, L. Wichman
U.S. Fish and Wildlife Service, 4001 N. Wilson Way, Stockton, CA 95205
mike_j_marshall@fws.gov

Abundance Trends of Juvenile Fall-run Chinook Salmon Smolts Monitored in the Sacramento/San Joaquin River Delta

Abundance of returning fall-run adult salmon to the Central Valley sharply declined in 2007. The objective of this analysis was to determine whether fall run smolt abundance in 2005 was lower than in previous years. To determine if the decline in adult Chinook salmon escapement could be related to inland factors, we estimated the annual abundance of unmarked juvenile Chinook salmon smolts leaving the Delta between April and June. We hypothesize that if the abundance of smolts in 2005 was similar to the abundance in previous years, then the decline in the abundance of adult salmon in the fall of 2007 was not related to inland factors. Smolts were sampled using a mid water trawl at Chipps Island. A total of ten 20 minute tows was conducted three to seven days per week from April 1 through June 30 between 1978 and 2005. Smolt abundance was calculated using three methods. The three methods resulted in an estimate of relative abundance and two estimates of absolute abundance. We assumed for this assessment that smolts migrating past Chipps Island between April and June were smolts of fall run origin. Our smolt abundance estimates at Chipps Island are likely biased low as we did not account for hatchery reared smolts that were released downstream of Chipps Island. These and other limitations reduce the precision of our estimates, but they should be robust enough to index the population between years. Mean abundances of juvenile salmon were not significantly different between years, indicating that the low adult returns in 2007 were not related to low abundance of juveniles emigrating from the Delta in 2005. Further assessments should be conducted to verify this conclusion and to determine the cause of the decline in adult Chinook salmon escapement in 2007.

CALFED Statement of Relevance

This analysis supports CALFED objectives by providing information to managers relative to understanding the population dynamics of key species in the Bay-Delta and its watershed.

Matanga¹, G.B., L. Peltz-Lewis¹, L. Rainger¹, D. DeMarco², M. Kang², K. Nelson¹

¹Bureau of Reclamation, 2800 Cottage Way, MP-740, Sacramento, CA 95825

²HydroGeoLogic, Inc., Waterloo, Ontario Canada

gmatanga@mp.usbr.gov

HydroGeoSphere: Model Enhancements and Application on Reclamation's MP Region

Optimal management of water resources at a watershed scale requires consideration of comprehensive restoration and long-term protection of complex surface-based ecosystems and subsurface flow-systems. The surface-based ecosystems include aquatic habitats (stream channels, wetlands, vernal pools, lakes, periodic floods and other surface-water bodies); riparian zones; lowlands (valley floor); and uplands (mountains) and are closely interconnected with the subsurface flow systems. The riparian zones of the surface-based ecosystems are generally small in area in comparison to the landscapes of lowlands and uplands. Therefore, in order to accurately evaluate the hydrologic processes at a watershed scale, in terms of process simulation, it may be necessary to apply a small-scale approach (refined model grid) for the stream channels and riparian zones and a large-scale approach (coarse model grid) for the lowlands and uplands. In accordance, appropriate numerical models for hydrologic analyses require capability to account for the multi-scales in management of water resources in a watershed. Geospatial technologies such as geographic information systems (GIS) can easily support both large and small scale data integration within the model. Success of conjunctive analyses of hydrologic processes in combined surface and subsurface water regimes depend on availability of robust numerical models, with capability to account for hydrologic processes within and at the interfaces of the surface and subsurface water regimes. Capability to accurately account for integrated processes will facilitate accurate evaluation of fluid, energy and chemical exchange between surface and subsurface water regimes. Understanding of hydrologic processes is valuable in management of water resources and ecosystems. Issues of concern in management of water resources need to include optimal allocation of scarce water resources, water quality, and ecosystem health. In HydroGeoSphere, surface-based ecosystems are treated as two-dimensional systems, while the subsurface is accounted for as a three-dimensional system. The two- and three-dimensional systems are combined into a single hydrologic regime with transfer and interconnectivity of flow between systems. The following enhancements to HydroGeoSphere are being considered or have been incorporated to further improve its capabilities for ecosystem analyses: snowmelt; extension of temperature (heat) transport to both surface and subsurface water regimes; dissolved oxygen and nutrient transport and reactions; sediment transport and linkage to an operational model, such as CalSim. Ongoing model applications include: appraisal study of an off-stream reservoir in a valley located in Oregon; evaluation of interaction between surface and subsurface water regimes in Sacramento River Basin; testing of sub-timing and sub-gridding schemes incorporated into the model; and surface/subsurface modeling support for San Joaquin River Restoration Program.

CALFED Statement of Relevance

HydroGeoSphere is a fully-coupled flow and transport model for evaluation of water supply, water quality and ecosystem health in an integrated manner. It is being linked to an operational model to facilitate evaluation of impact of climate change on California's water resources.

McCord¹, S.A., V. Fry², D. Hardin³, D. Slotton⁴, G. Thomas¹

¹Larry Walker Associates, 707 Fourth Street, Suite 200, Davis, CA 95616

²Sacramento Regional County Sanitation Dist., 10545 Armstrong Ave., Ste. 101, Mather, CA 95655

³Applied Marine Sciences, 2125 Delaware Ave., Suite D, Santa Cruz, CA 95060

⁴University of California Davis, 512 Jerome St., Davis, CA 95616

sam@lwa.com

Localized Mercury Bioaccumulation Study in the Sacramento River

Problem Statement: Elevated methylmercury concentrations in tissue of some fish species collected in the lower Sacramento River and Delta have led to the listing of the Delta as impaired. The Sacramento Regional County Sanitation District (SRCSD) operates and manages the largest inland surface water discharger in California, which contributes two percent of the annual average total mercury load and six percent of the methylmercury load to the lower Sacramento River, the Delta's largest tributary. Concerns that allowing mercury offset projects would create a localized effect from effluent compelled SRCSD to undertake a localized mercury bioaccumulation study. Approach: In addition to effluent, five sample stations for water column and sediments were monitored in the five-mile study reach of the Sacramento River: two upstream of the outfall, one within the effluent mixing zone, and two farther downstream. Monthly monitoring tracked multiple media and constituents from July to November 2006. Approximately 6000 transplanted clams were distributed among the stations and subsampled monthly. Resident clams also were collected from each station monthly. In addition, three small, naturally-occurring fish species of widespread abundance and high site-fidelity were collected at the furthest upstream and downstream stations once during the study period, in conjunction with CALFED's Fish Mercury Project. Results: Transplanted clams and two of three fish species (silversides and juvenile bass) showed ~10% increase in methylmercury in the study reach downstream of the SRWTP outfall, following the season with lowest effluent dilution. Prickly sculpin, integrating across the full year, showed no increase downstream of the outfall. Resident clams showed no change outside of the effluent mixing zone. These results lead to the conclusion that SRCSD's effluent does not create a "hot spot" and mercury offsets should be a viable regulatory compliance option.

CALFED Statement of Relevance

This study pioneers measurement of mercury bioaccumulation upstream and downstream of a municipal wastewater discharge and demonstrates using the relative importance of sources of bioaccumulative pollutants to guide implementation of TMDLs. Quantifying localized effects allows assessment of opportunities to utilize equivalent compliance alternatives, like offsets, to achieve water quality objectives.

McMartin, L., R.W. Smith
U.S. Fish & Wildlife Service, 4001 N. Wilson Way, Stockton, CA 95205
Louanne_McMartin@FWS.GOV

Projects and Perspectives of the CALFED Non-native Invasive Species Program

The CALFED Bay-Delta Program mission is to improve California's water supply and ecological health of the San Francisco Bay/Sacramento-San Joaquin River Delta. The Ecosystem Restoration (ERP) and Watershed Program Element objective is to improve the ecological health of the Bay-Delta watershed. As a CALFED implementing agency, the Stockton Fish and Wildlife Office (STFWO) works to improve and protect the Bay-Delta habitats, ecosystem functions and native species. The STFWO provides coordination and leadership to the Calfed ERP Non-native Invasive Species Program (NISP). This program actively works to accomplish three primary goals. The first of these is preventing new introductions and establishment of NIS into the ecosystems of the Bay-Delta, the Sacramento/ San Joaquin Rivers and their watersheds. The second goal is limiting the spread or, when possible and appropriate, eliminating populations of NIS through management. The third goal is reducing the harmful ecological, economic, social and public health impacts resulting from infestations of NIS through appropriate management. The NISP provides technical guidance and implements strategies to develop prevention, control, and management practices to watershed groups, state and federal agencies, universities, not-for-profit organizations and the public. This program helps to build the capacity of partners to address NIS issues through activities and assistance such as providing funding opportunities and offers technical support to local watershed groups. In 2008, the NISP held one NIS symposium and is coordinating two more for the end of the year. The NISP held training seminars on Hazard Analysis Critical Control Point (HACCP) and assisted in the development of HACCP plans. NISP has provided training on non-native species and prevention techniques including collaborative efforts with the Department of California Fish and Game to educate agencies and the public concerned with the recent quagga and zebra mussel infestation.

CALFED Statement of Relevance

The Ecosystem Restoration (ERP) objective is to improve the ecological health of the Bay-Delta watershed. As a CALFED implementing agency, the Stockton Fish and Wildlife Office (STFWO) works to improve and protect the Bay-Delta habitats, ecosystem functions and native species by providing leadership and coordination to ERP non-native invasive species program (NISP). The poster will provide information on current activities that the CALFED NISP is involved in and how the public benefits from the NISP.

McMillin¹, S.C., B.J. Finlayson¹, B. Cypher², R. Hosea¹

¹California Department of Fish and Game, 1701 Nimbus Road, Suite F, Rancho Cordova, CA 95670

²California State University, Stanislaus, P.O. Box 9622, Bakersfield, CA 93389
smcmillin@ospr.dfg.ca.gov

Anticoagulant Residues in San Joaquin Kit Foxes in Bakersfield

Analysis of San Joaquin kit fox livers was performed to determine the extent of exposure to anticoagulants in the Bakersfield urban area. In 1999, the California Department of Fish and Game, Pesticide Investigations Unit, in conjunction with the Endangered Species Recovery Program's Urban Kit Fox Project began monitoring exposure of San Joaquin kit foxes from the Bakersfield population to various anticoagulant rodenticides. Necropsies have been performed and liver tissue samples collected from all recovered kit fox carcasses that are not severely decomposed. Between 1999 and 2007, tissue samples from 87 animals from either the Bakersfield population or a reference population from Lokern have been analyzed for residues of anticoagulant rodenticides. Anticoagulant compounds that have been identified include brodifacoum, bromadiolone, pival, chlorophacinone, and diphacinone. Brodifacoum was detected the most frequently. Habitat use by the kit foxes, home ranges and possible routes of exposure for the rodenticides are discussed. This research was funded by a grant from the US Fish and Wildlife Service.

CALFED Statement of Relevance

San Joaquin kit foxes are a State and federally listed species. Exposure to anticoagulants in the urban environment may pose a threat to the recovery of the population.

Melcer, R.E., I. Woo, R.J. Gardiner, J.Y. Takekawa
USGS, San Francisco Bay Estuary Field Stn., 505 Azuar Dr, Vallejo, CA 94592
corvid88@gmail.com

Pre-restoration Monitoring of the Giacomini Restoration Project (Part II): Avian Focal Species

In 2000, the Point Reyes National Seashore (PNRS) acquired the 228 ha Giacomini Ranch with the goal of restoring historic natural and hydrologic tidal and freshwater processes to the largest freshwater input to Tomales Bay. The response of the avian community was selected as one of the main indicators of restoration success. In November 2004, USGS-WERC initiated seasonal avian census surveys at the Giacomini Ranch Restoration Project and two local reference marshes (which were chosen for their location within the Tomales Bay watershed and the presence of wetland habitat types that will likely be represented at project site as the restoration progresses). Due to their effectiveness in representing avian biodiversity and guiding management and conservation efforts, focal species have been selected for analysis with representatives from the CalFed Multi-species Conservation Strategy Natural Community Conservation Plan, Cal Partners In Flight, and Riparian Habitat Joint Venture, and saline wetland indicator species and include: Snowy Egret, California Clapper and Black Rail, Black-necked Stilt, Willet, Long-billed Curlew, Short-eared Owl, Northern Harrier, White-tailed Kite, Osprey, Peregrine Falcon, Belted Kingfisher, Marsh Wren, Salt Marsh Common Yellowthroat, Savannah Sparrow, and Song Sparrow. Though these species rely on similar habitat, habitat requirements are species specific. Preliminary baseline abundance estimates of Song Sparrow were fairly consistent during the spring breeding season across years: 1.33 birds/station in 2005, 1.33 birds/station in 2006 and 2.33 birds/station in 2007 at the Giacomini Restoration Site. Common Yellowthroat abundances were not as consistent at 0.17 birds/station in 2005, 0.33 birds/station in 2006, and 0 in 2007, similar to Marsh Wren at 0.25 birds/station in 2005, 0.50 birds/station in 2006, and 0 in 2007. Preliminary abundance estimates for reference marshes in the 2007 breeding season are 1.98 birds/station for Song Sparrow, 0.09 birds/station for Common Yellowthroat, and 0.10 birds/station for Marsh Wren. The California Black Rail is present in the reference marsh Inverness, but detection rates are low and inconsistent. Abundance estimates of these key species can be used for post-restoration comparisons and will allow managers to evaluate the differential response by select avian species to restoration actions.

CALFED Statement of Relevance

This project supports CALFED Ecosystem Restoration Program, by providing a biological evaluation of a restoration project improving the function of aquatic and terrestrial habitats in an adjacent coastal region of the California Bay-Delta. Information gained from this study will support an adaptive management approach to restoration.

Mierzwa, M.D., B.K. Coleman, J. Dudas, H. Hereth
CA Department of Water Resources, PO Box 219000, Sacramento, CA 95821
mmierzwa@water.ca.gov

Analyzing Changes in 100-Year Stages in the Delta

Problem Statement: High event water levels in tidal estuaries are a product of several physical processes including local sea levels, local atmospheric events, local elevation changes (subsidence or uplifting), long-term astronomical variations, and upstream river outflows. By using an extreme event analysis similar to the standard methodology used to calculate the return period of flow rates in rivers for different 19-year periods, changes in the 100-year return period of the stage for various locations in the Sacramento-San Joaquin Delta can be used to assess the combined long-term rate of change of local water levels.

Approach: The original approach used here updates an analysis used by the USACE in 1982 to evaluate the frequencies of annual high water levels in the Delta. Historical stage data from multiple locations in the Delta was converted to the current standard datum for the Delta (NAVD88). The data for each station was corrected to account for observed local uplifting or subsidence trends. The annual extreme higher-high stages for multiple independent 19-year periods were used to develop period specific 100-year stages for each location using an extreme value distribution. The different 100-year stages for each location were then compared with the other 100-year stages calculated for the same location in order to identify periods in which changes to either the tidal prism or downstream mean sea level have resulted in a significant change in the level of the 100-year water level.

CALFED Statement of Relevance

Updated calculations of the 100-year stages in the Delta and an estimation of the rate of change of water levels at various locations within the Delta meets CALFED's levee integrity objective by establishing better risk based measures to use in levee maintenance programs.

Mierzwa, M.D., J. Anderson
CA Department of Water Resources, PO Box 219000, Sacramento, CA 95821
mmierzwa@water.ca.gov

Climate Change Research Roadmap

Problem Statement: Though climate change research has increased, new research and work addressing climate change is complex enough that it is difficult to spend time making clear connections to previous efforts and between parallel research efforts. By visually linking individual climate change research topics to general water management objectives and other research activities, the progress made in understanding climate change can be better understood.

Approach: This poster is a roadmap that is used to link the various posters included in the October 2008 DWR/Reclamation Climate Change Poster Cluster to each other and previous CALFED Science presentations and posters. Visual summaries of the key problems and conclusions of past and present topics will be mapped out on a California watershed.

CALFED Statement of Relevance

By establishing clear connections between past and present climate change research activities, it will be easier to illustrate the advances made in addressing the potential impacts of climate change on the Bay-Delta itself.

Mierzwa, M.D., G. Bardini
CA Department of Water Resources, PO Box 219000, Sacramento, CA 95821
mmierzwa@water.ca.gov

Linking Water Management Objectives and Tools to Describe System Re-Operation

Problem Statement: The use of our water management system is based on historical and present physical conditions and institutional arrangements. Many water management programs make use of very specific tools to accomplish specific objectives. Over time the present system will be subject to different water needs (demands) and a changing physical environment (climate). In order to continue to effectively management water resources in California it is necessary to link individual programs in a process that has been described by the California Water Plan as “System Re-operation”. Approach: An example based on several California Department of Water Resources water management programs is used to illustrate the general approach that can be used to integrate any existing water management program into a larger system for the benefit of statewide water management. First, the general water management objectives of existing programs are identified. Next, several key planning and operational decision making tools used to manage these individual programs are inventoried. The spatial and temporal domains / uses of these tools are then used to identify potential links between different programs with similar general water management objectives. By linking programs that make use of models capable of accounting for changes in either future demands or the physical climate to other programs, the benefits and costs of re-operating individual components can be better translated across the system of linked water management programs. Known demand and physical climate impacts that are not represented can also be used to guide new tool development and integration into an integrated water resources management program.

CALFED Statement of Relevance

This poster will demonstrate a systematic way in which assess the impacts of the operations of specific programs on other programs and also to promote increased efficiency in statewide water management. This is relevant to the CALFED objective of water supply reliability.

Miranda, J.B., R.J. Padilla, M.N. Johnson, J.M. Bergman
California Department of Water Resources, 1416 9th Street, Rm 252-35,
Sacramento, CA 95814
jmiranda@water.ca.gov

Evaluation of Predation at Salvaged Fish Release Sites using DIDSON

Predation on fish throughout the salvage process may reduce the benefit of the state and federal facilities that are operated to protect fish from entrainment into the export projects. Predation by piscivorous fish, including striped bass and Sacramento pikeminnow, has long been suspected as having a major impact on the survival of fish in the salvage process. This concern led the CALFED Management Team in 2002 to request the Interagency Ecological Program (IEP) to investigate the viability of fish exposed to the Collection, Handling, Transport, and Release (CHTR) phase of salvage. This study attempted to determine the magnitude of predation that occurs during the final “release” phase of CHTR process. Using a Dual Frequency Identification Sonar (DIDSON) system, the presence and abundance of predatory fish at 3 fish salvage release sites and 2 control sites in the central Delta was examined. Observations were conducted during 5 monitoring periods during August 2007 through March 2008. Predatory fish were observed throughout the study but were present in greater numbers during the summer (August) and Fall (October-November) monitoring periods. Piscivorous birds were also documented feeding on salvaged fish. The results of this study will be used to make recommendations and develop guidelines to improve release operation and physical changes to the existing release sites, and aid in establishing guidelines for locating and designing future fish release sites.

CALFED Statement of Relevance

The CALFED Record of Decision (ROD) (CALFED 2000a and 2000b) identifies reducing the direct loss of fish at state and federal diversions through construction and operation of new, improved fish screening facilities as a high priority restoration action.

Miranda, J.B., R.J. Padilla, M.N. Johnson, J.M. Bergman
California Department of Water Resources, 1416 9th Street, Rm 252-35,
Sacramento, CA 95814
jmiranda@water.ca.gov

Evaluation of Avian Predation at Salvaged Fish Release Sites

Predation on fish throughout the salvage process may reduce the efficacy of the state and federal fish facilities that are operated to protect fish from entrainment into the pumping facilities. Predation by birds, primarily Cormorants and Gulls, has long been suspected as having a major impact on the survival of fish as they complete the salvage process. This concern led the CALFED Management Team in 2002 to request the Interagency Ecological Program (IEP) to investigate the viability of fish exposed to the Collection, Handling, Transport, and Release (CHTR) phase of salvage. This study attempted to determine the magnitude of avian predation that occurs during the final “release” phase of the CHTR process. Using point counts and observations of behavior conducted from August 2007 through March 2008, the presence, abundance, and behavior of predatory birds at 3 fish salvage release sites and 2 control sites in the central Delta was examined. Several species of piscivorous birds were observed throughout the study, but only Cormorants and Gulls were consistently present at the release sites. The results of this study will be used to develop recommendations and guidelines for improved operation and physical changes to the existing release sites. These recommendations and guidelines will increase the effectiveness of the fish salvage process.

CALFED Statement of Relevance

The CALFED Record of Decision (ROD) (CALFED 2000a and 2000b) identifies reducing the direct loss of fish at state and federal diversions through construction and operation of new, improved fish screening facilities, as a high priority restoration action.

Morinaka, J.A., J. DuBois
California Department of Fish and Game, 4001 N. Wilson Way, Stockton, CA
95205
jmorinaka@dfg.ca.gov

Predation as a Factor Contributing to Mortality at Release at the State Water Project Fish Release Sites

Fish released into the Delta estuary, following salvage from the SWP's John E. Skinner Delta Fish Protective Facility, may experience increased mortality as a result of fish predation. The potential magnitude and severity of predation mortality, however, is unknown. From August 2007 through March 2008, the Department of Water Resources, the Department of Fish and Game (DFG), and the United State Bureau of Reclamation used a combination of Dual Frequency Identification SONar (DIDSON) technology, hydroacoustics, electrofishing, and acoustic telemetry to evaluate predator dynamics and the potential significance of predation mortality on the overall survival of salvaged fish within the near-field receiving waters at the existing SWP's Horseshoe Bend release site. DFG's function in this multi-agency effort was to use electrofishing to determine the composition and abundance of predatory fish species and acoustic telemetry to monitor the movement and behavior of tagged predators in the vicinity of the release site. We conducted bi-monthly sampling efforts using an electrofishing boat to sample and tag (acoustic and floy) predatory fish species at the release site and surrounding areas within Horseshoe Bend. An array of acoustic receivers was deployed in Horseshoe Bend and at all four SWP and CVP fish release sites to monitor the movement and behavior of acoustically tagged predators. Sacramento pikeminnow and striped bass were the predominant predatory fish species collected in the near-field receiving waters of the release site, while largemouth bass was the predominant predator found along the shoreline surrounding the release site. Acoustic tagged striped bass tended to leave the area and return from time to time while the tagged Sacramento pikeminnow tended to remain in the Horseshoe Bend area throughout the course of the study. Our preliminary results suggest a relationship between numbers of salvaged fish released and abundance of predatory fish species residing in the near-field waters of the release site.

CALFED Statement of Relevance

This study will provide a detailed assessment of predation as a factor affecting survival of salvaged fish and was funded as a CALFED directed action. Results will provide a foundation of information useful in identifying and evaluating potential alternative new technologies designed to reduce or avoid predation mortality of released fish.

Mourad¹, D.E., H. Yumiko¹, T.E. Kraus^{1,2}, T.A. Doane¹, W.R. Horwath¹, P.A. Bachand³, R.F. Fujii²

¹UC Davis, 1111 PES Building, One Shields Ave., Davis, CA 95616

²USGS Water Science Center, 6000 J Street, Placer Hall, Sacramento, CA

³Bachand and Associates, Davis, CA

demourad@ucdavis.edu

Seasonal Removal of Island Drainage Water DOC and Disinfection By-Product Precursors using Coagulation

The Sacramento-San Joaquin Delta provides drinking water to roughly 25 million people in California. Delta islands are used for agricultural purposes and water is pumped off drains on these islands to maintain agricultural production. This drain water typically contains elevated levels of dissolved organic carbon (DOC), which is a concern for drinking water because DOC reacts upon chlorination to form carcinogenic disinfection by-products (DBPs). Coagulation of organic matter with polyvalent metal cations (Al³⁺ and Fe³⁺) is an economical and effective treatment process for the removal of DOC, forming organic flocs through two major processes: charge neutralization and adsorption. A CALFED/Department of Water Resources funded project was initiated to investigate the feasibility of using coagulation to remove DOC from island drainage water prior to release into Delta channels, in conjunction with the use of constructed wetlands to reverse subsidence. We have begun to investigate the seasonal reactivity of DOC, in terms of DBP formation after coagulation at various doses for further research in constructed wetlands to reduce DOC and DBP precursor exports from Delta islands. Coagulation at optimal doses removed up to 85 percent of the total DOC. In addition, the composition of remaining DOC following varied coagulant doses was examined using non-ionic macroporous resins (XAD-4/DAX-8). Our data suggest that coagulation removes the hydrophobic portion of DOC and the main components responsible for the formation of several DBPs, including THMs and HAAs. Trihalomethane formation potential incrementally decreased with decreasing DOC concentrations as coagulant dose increased. In contrast, haloacetic acid precursor concentrations did not begin decreasing until after the intermediate dose of coagulant had been reached, which corresponds to roughly 67 percent of the total DOC removal.

CALFED Statement of Relevance

These results suggest that coagulation has potential to remove seasonal changes in DOC and DBP precursors from island drainage water. Further work will investigate the feasibility of coupling coagulation in wetlands to accelerating land-surface accretion.

Nelson, C.W.

Geographical Information Center, California State University, Chico, CA 95929
cwnelson@csuchico.edu

The 2007 Sacramento River Riparian Map - Colusa to Red Bluff

Public ownership of land adjacent to the Sacramento River has increased since 1986, when the State of California passed Senate Bill 1086 (SB 1086). One simple way to measure of the effectiveness of the programs called for by SB 1086 is to track changes in vegetation, land use and ownership. This data, along with historical GIS spatial data and available ground monitoring information, can be used to analyze changes in the extent and condition of habitat over time. In 2007, the CALFED Ecosystem Restoration Program awarded a grant to the CSU, Chico Research Foundation (RF) to quantitatively assess the extent to which various restoration projects in the Sacramento River Ecological Management Zone – Colusa to Red Bluff (EMZ) have achieved their stated goals. Partners in the project, called the Sacramento River Monitoring and Assessment Project or SRMAP, included researchers from CSU, Chico, the Geographical Information Center (GIC) and Sacramento River Conservation Area Forum (auxiliaries of the RF), the University of California, Davis and Santa Cruz campuses and The Nature Conservancy. The first major step in the SRMAP process was to update the 1999 Sacramento River riparian map. This map provides the basis for future discussions and follow-up monitoring activities. Information including updated vegetation change and change in channel dynamics will be cross walked with the 1999 and other available spatial data. Increase or loss in important indicator species help researchers evaluate restoration success and discuss strategies for future efforts. The Geographical Information Center's (GIC) mapping approach employed an iterative process of aerial photo interpretation and field verification. The mapping methodology included the acquisition of scanned aerial imagery, the development of a vegetation classification list, field rapid assessment reconnaissance surveys, photo interpretation and vegetation alliance delineations as polygons in ArcGIS, final field verification and edits. The final 2007 Sacramento River riparian map includes invasive species, channel location and attributes for the Sacramento River Ecological Management Zone – Colusa to Red Bluff (EMZ). Spatial data and orthophotos will be made available on the GIC's server at <http://www.sacramentoriver.org/sacmon>.

CALFED Statement of Relevance

One simple way to measure of the effectiveness of the restoration programs along the Sacramento River called for by SB 1086 is to track changes in vegetation, land use and ownership. Increase or loss in important indicator species help researchers evaluate restoration success and discuss strategies for future efforts.

Orr, B.K., C.S. Riebe, R.A. Peek
Stillwater Sciences, 2855 Telegraph Avenue, Berkeley, CA 94705
bruce@stillwatersci.com

Linking Biological Responses to River Processes: Implications for Conservation and Management of the Sacramento River—A Focal Species Approach

The loss and degradation of essential habitats in the Sacramento River corridor has generally reduced the river's capacity to support native species. The processes, habitats, and species of the Sacramento River have been the focus of much study, and the volume of available reports and datasets poses a challenge for synthesizing information and organizing a discussion of ecosystem components. Divergent conceptual models about process–habitat–biotic linkages complicate the process of summarizing what is known about the Sacramento River, and add to the challenge of evaluating alternative approaches for conserving and restoring the river ecosystem. To help overcome these challenges, our study discusses and analyzes the Sacramento River through the lens of six focal species. A focal species approach facilitates the exploration of linkages among ecosystem processes, resultant habitats, and biotic needs. For each focal species, we identify the different life history stages that occur in the Sacramento River, the habitats used by each of those life history stages, the ecological processes that create and maintain those habitats, and the management actions (e.g., changes in the flow regime or bank revetment) that influence those ecological processes and habitat conditions. The six focal species selected for this study are Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), green sturgeon (*Acipenser medirostros*), bank swallow (*Riparia riparia*), western pond turtle (*Clemmys marmorata*), and Fremont cottonwood (*Populus fremontii*). Because fish species have generally received more attention, our poster will focus on the three non-fish focal species. We will summarize key findings and hypotheses regarding (i) the effects of land use and water supply development on the broader ecosystem, and (ii) the key resource management challenges in the Sacramento River system using the focal species as a framework.

CALFED Statement of Relevance

This study was undertaken as part of the CALFED-funded Sacramento River Ecological Flows Study, which was initiated by The Nature Conservancy (TNC) in collaboration with ESSA Technologies, Stillwater Sciences, UC Davis, and UC Berkeley to define how flow characteristics (e.g., the magnitude, timing, duration, and frequency) and associated management actions (such as gravel augmentation and changes in bank armoring) influence the creation and maintenance of habitats for a number of native species that occur in the Sacramento River corridor

Ort¹, B.S., E. Crumb¹, K. Boyer¹, L. Reynolds¹, S. Wyllie-Echeverria², S. Cohen¹
¹Romberg Tiburon Center, San Francisco State University, 3150 Paradise Dr.,
Tiburon, CA 94920

²Friday Harbor Laboratories, University of Washington, 620 University Rd, Friday
Harbor, WA 98250

brianort11@msn.com

Genetics of Eelgrass in Natural and Restored Populations in the San Francisco Bay

Two important issues in plant restoration is the choice of source populations for donor material, and if the restoration technique effectively conserves levels of genetic diversity found in the chosen donors. We surveyed several extant eelgrass (*Zostera marina*) beds in the San Francisco Bay, including an annually reproducing bed, at seven microsatellite loci to characterize levels of diversity within and among beds. We then used the annual bed and two perennial beds as donors for field restoration experiments. Genetic differentiation was tested using summary statistics and Bayesian modeling. In the extant beds, we found moderately lower levels of eelgrass genetic diversity within the San Francisco Bay compared to elsewhere in the northern hemisphere, with the highest diversity in the annual bed. All beds surveyed were highly differentiated according to all models employed. In addition, higher-level structure suggests further differentiation between the east Bay and the west Bay. In the restoration, recruits were obtained from all three donors with the lowest recruitment in the annual bed. There was no significant loss of genetic diversity in the restored beds, but the genetic differentiation of the donors was lost in the restored populations, probably due to greater recruitment of genotypes similar to those of one of the donor locations. These results provide decision makers and restoration agencies with new information regarding the importance of including the conservation of genetic diversity during restoration planning and implementation. We recommend maximizing the genetic diversity of donor material to achieve restoration success, but caution that if maintaining the separation of localized genotypes is a restoration goal, mixing material from even closely spaced donors may erase localized genetic differences in the recipient population.

CALFED Statement of Relevance

This project meets CALFED goals by providing decision makers with important information regarding the consideration of genetic diversity during restoration planning and implementation. We recommend maximizing genetic diversity of donor material input to restorations, however mixing material from even closely spaced donors may erase localized genetic differences in recipient populations.

Ostrach¹, D.J., C.C. Phillis², J.H. Walsh³, G.E. Whitman¹, B.L. Ingram², P.K. Weber⁴

¹John Muir Institute of the Environment, Center for Watershed Sciences, Dept. of Civil & Environmental Engineering, UC Davis, One Shields Ave, Davis, CA 95616

²Depts of Earth and Planetary Sciences, UC Berkeley, 155 McCone Hall, Berkeley, CA 94720

³Moss Landing Marine Lab., 8272 Moss Landing Rd., Moss Landing, CA 95039

⁴Chemical Biology and Nuclear Science, Lawrence Livermore National Laboratory, 7000 East Ave., Livermore, CA 94550

djostrach@ucdavis.edu

Striped Bass Habitat use in the San Francisco Estuary Determined by Otolith Microchemistry Techniques & the Bioaccumulation of Contaminants in the San Francisco Estuary

Habitat use has been shown to be an important factor in the bioaccumulation of contaminants in striped bass. This study examines habitat use in striped bass as part of a larger study investigating maternal transfer of xenobiotics in the San Francisco Estuary. Significant levels of PCB, PBDE & pesticides are being transferred to progeny with severe adverse effects. In addition, mercury, PCB and other contaminants are found in these striped bass at levels that can adversely affect human health. As such limits have been placed on their consumption. Habitat use, residence time and spawning migration over the life of adult striped bass was studied (n = 162). Striped bass were collected on the Sacramento River during the spawning runs of 1999, 2001, 2006 & 2007. Additional samples were obtained in 2006 & 2007 from other areas in the estuary and near shore Pacific Ocean. Otoliths were removed, processed and aged via otolith microstructure. Subsequently, otoliths were analyzed for ⁸⁷Sr/⁸⁶Sr to determine habitat residence and migration patterns. Strontium isotopic results indicated 79% of the analyses were in the freshwater range, 18% were in the estuarine range and 3% were found to be in the marine range. The last 2 years before capture was examined more closely for comparison of habitat use by the maternal parent to contaminant burden transferred to progeny. Results have been combined with contaminant and histological analyses to better understand the bioaccumulation of contaminants and the effects they and habitat use have on fish populations in the San Francisco Estuary.

CALFED Statement of Relevance

Striped bass is an important sentinel species in the San Francisco Estuary. It is one of the four POD species of great interest to those managing the San Francisco Estuary and its watershed. The results of this study can help to better understand how habitat use affects the bioaccumulation of contaminants in this population and other local fish species which is essential for managing water quality and ecosystem restoration.

Paine¹, S.A., G. Golet¹, E. Girvetz², S. Greco³, C. Nelson⁴, M. Carlson⁴, S. Fraser³, H. Schott³

¹The Nature Conservancy, 500 Main Street, Chico, CA 95928

²University of Washington

³UC Davis

⁴CSU Chico

spaine@tnc.org

Effects of Ecosystem Restoration on Riparian Habitat Patch Configuration and Yellow-Billed Cuckoo Habitat on the Sacramento River, California

Conservation organizations and public agencies have worked for over 20 years to conserve and restore the native riparian ecosystem along California's Sacramento River between the cities of Colusa and Red Bluff. There is a need to demonstrate the efficacy of these efforts through empirical analysis of the effects of ecosystem restoration on the quantity and quality of habitat for indicator species within the study area. This poster presents the changes in critical habitat patch size, shape, and contiguity for one indicator species, the yellow-billed cuckoo (*Coccyzus americanus occidentalis*), using the "PatchMorph" algorithm developed by Evan Girvetz and Steven Greco. This algorithm eliminates spurs of habitat too narrow to be valuable to the indicator and allows inclusion of habitat gaps of insignificant size. Bio-physical characteristics of selected patches were determined using the program FRAGSTATS. Results show a significant increase in the average size of suitable habitat patches and greater connectivity of patches along the river.

CALFED Statement of Relevance

CALFED has funded acquisition and restoration of property on the Sacramento River. This research seeks to give a metric of the efficacy of that effort.

Palumbo, A.J., R.S. Tjeerdema
UC Davis, Department of Environmental Toxicology, Davis, CA 95616
ajpalumbo@ucdavis.edu

Methodology for Derivation of Pesticide Water Quality Criteria for the Protection of Aquatic Life

Water quality criteria for the protection of aquatic life are typically derived by using existing toxicity data to extrapolate to a concentration that should be protective of sensitive aquatic organisms. Our project focuses on developing and applying a methodology for deriving aquatic life water quality criteria for pesticides with various amounts of toxicity data, including data sets that do not meet the minimum requirements for the current EPA (1985) aquatic life water quality criteria method. The derivation of criteria by our method consists of four main steps. 1) Data gathering, 2) Evaluating the quality of the data with a numerical screening system, 3) Criteria calculation, 4) Considering other factors that may affect the final criteria, such as, water quality effects, mixtures, bioavailability, and bioaccumulation. Our method primarily uses a Burr Type III probability distribution to extrapolate criteria that should be protective of all species. Also included are empirically derived assessment factors for cases of very limited data. Criteria from draft reports where we applied our method to chlorpyrifos, diazinon, and bifenthrin will be presented.

CALFED Statement of Relevance

Criteria derived by this methodology can assist researchers, regulators and risk managers in making management decisions by providing information on concentrations of pesticides that represent potential threats to aquatic life in the Delta.

Parchaso, E., J.K. Thompson
USGS, 345 Middlefield Rd, Menlo Park, CA 94025
parchaso@usgs.gov

***Corbicula fluminea* Distribution and Biomass Response to Hydrology and Food: A Map for CASCaDE Scenarios of Change**

The freshwater bivalve *Corbicula fluminea* can limit the biomass of phytoplankton in the Delta. Because the Delta is considered to be food limited for zooplankton and potentially for fish, the distribution and grazing rate of this bivalve can affect restoration success in the system. As part of CASCaDE (Computational Assessments of Scenarios of Change for the Delta Ecosystem), we are projecting the distribution, biomass, and grazing rate of *Corbicula* for the different climate scenarios. Our distribution and biomass projections are based on laboratory findings and relationships from field data. Juvenile *Corbicula* settle throughout the system in areas such as the central Delta, showing a persistent, low abundance of juveniles, superimposed with periods of peak recruitment. Recruitment in the peripheral Delta, such as the Sacramento River, is seasonal (spring and fall). This recruitment pattern may reflect the spatially varying release of juveniles as the optimal temperature for juveniles (13-26°C) is achieved. Therefore, we use temperature as a limiting factor to alter the temporal and spatial distribution of juveniles in the system for the future climate scenarios. Once settled, juvenile *Corbicula* grow into large populations of adults only in the Central and Western Delta. Laboratory studies have reported *Corbicula* growth to be food limited, thus the current distribution of adult populations is limited to areas where waterborne food is imported and mixed from many sources. Population biomass and grazing rate are derived as functions of these growth relationships. *Corbicula* populations are food limited throughout most of the Delta and any increase in phytoplankton biomass is likely to be consumed by the “ever-present” juveniles. Restoration plans that include moving the Delta away from its present low productivity status may be difficult as long as *Corbicula* still reproduces in the Delta and connected systems.

CALFED Statement of Relevance

The freshwater bivalve *Corbicula fluminea* can limit the biomass of phytoplankton in the Delta. Restoration plans that include moving the Delta away from its present low productivity status may be difficult as long as *Corbicula* is present in the Delta and connected systems.

Parker, A.E., P. Cohen
Romberg Tiburon Center, SFSU, 3152 Paradise Drive, Tiburon, CA 94920
aeparker@sfsu.edu

Organic Matter and Nutrient Processing in Open Water Slough Habitats of Suisun Marsh, CA

Tidal salt marshes are recognized as playing an important role in biogeochemical cycling in estuaries. In undisturbed systems, salt marshes are hypothesized to modulate nutrient exchange between the terrestrial and aquatic environments, acting as sinks for inorganic nutrients and sources of organic matter for estuarine foodwebs. Salt marsh restoration activities may reestablish this capacity to once degraded systems. Phytoplankton biomass has been shown to be the predominant source of bioavailable organic matter in the San Francisco Estuary and salt marsh sloughs may be favorable areas for phytoplankton biomass accumulation as a result of relatively high nutrient concentrations, shallow water depths and long residence times. The fate of this primary production, either being a) metabolized by bacteria within the marsh, b) consumed within the marsh by foraging estuarine fish and invertebrates, or c) exported to the estuary is presently unknown. A study funded through the UC Sea Grant / CALFED Science Fellows Program was established to evaluate spatial and temporal patterns in nutrients, primary production and organic matter processing in Suisun Marsh. Nutrient and organic matter exchange between restored marsh habitats and sloughs were also investigated. Not surprisingly, phytoplankton and bacterial production were higher within Suisun Marsh sloughs compared to Suisun Bay. Distinct spatial differences in these parameters were also observed between eastern and western sites within Suisun Marsh. The results from this study may be used to evaluate how different salt marsh habitats likely influence the biogeochemistry of the estuary.

CALFED Statement of Relevance

This presentation is part of the UC Sea Grant Calfed Science Fellows program and is related to salt marsh conservation and restoration. The project will provide estimates of organic matter supply for foodwebs of the San Francisco Estuary.

Parker¹, V.T., J.C. Callaway², L.M. Schile³, E.R. Herbert¹, M.C. Vasey¹

¹San Francisco State University, Dept. of Biology, San Francisco, CA 94132

²University of San Francisco, San Francisco, CA

³UC Berkeley, Berkeley, CA

parker@sfsu.edu

Potential Impacts of Climate Change on Bay-Delta Marsh Vegetation

Climate change is likely to cause substantial shifts in estuarine salinity and water levels over the next century, with higher summer salinities due to reduced snowmelt and higher water levels due to increased global sea-level rise. Predicted shifts in salinity and inundation will affect vegetation distributions throughout the San Francisco Bay-Delta. Our research is focused on evaluating effects of climate change on vegetation dynamics across the estuary, including potential impacts on plant community composition and diversity, primary productivity, and decomposition rates. We are evaluating these dynamics at six marshes along a salinity gradient within the Bay-Delta, from China Camp to Sand Mound Slough. Across the Bay-Delta, salt marshes have lower levels of both plant diversity and productivity. Increases in salinity and inundation combine to reduce productivity rates of the salt marsh dominant, *Sarcocornia pacifica*. Plant diversity within the salt marsh averaged approximately 2 species within a 3-m diameter sampling area. The highest rates of diversity and productivity are found in freshwater tidal marshes, with end-of-year standing biomass close to 2000 g m⁻² and an average of over 6 species in the same 3-m diameter sampling area. Brackish marshes are intermediate in productivity and salt marshes range from 270-1900 g m⁻². Litter dynamics from China Camp indicate that short-term decomposition rates for *Sarcocornia pacifica* are slightly higher than those for *Schoenoplectus americanus* and *Typha* sp. Further sampling will evaluate longer-term decomposition rates for dominant species across a range of salinity conditions in the field. Results from this research point to the potential for large-scale changes in marsh composition and productivity from climate-change related shifts in salinity and inundation. Results will give insight into the magnitude of potential climate change effects on Bay-Delta wetland vegetation, including potential impacts on food webs through changes in composition, productivity and decomposition rates.

CALFED Statement of Relevance

Results from this research are of direct interest for evaluating potential effects of and management responses to climate change. The research on vegetation responses is also linked directly to food web impacts on fish within the Bay-Delta, through isotopic analysis of primary producers and consumers.

Parker¹, V.T., J.C. Callaway², L.M. Schile³, E.R. Herbert¹, D.M. Talley⁴, V.T. Vredenburg¹, N.M. Kelly³

¹San Francisco State University, Dept. of Biology, San Francisco, CA 94132

²University of San Francisco, San Francisco, CA

³UC Berkeley, Berkeley, CA

⁴San Francisco National Estuarine Research Reserve, San Francisco, CA

parker@sfsu.edu

Climate Change Impacts to San Francisco Bay-Delta Wetlands and their Links to Pelagic Food Webs

Of the many impacts of climate change, increases in sea-level rise and estuarine salinity will affect San Francisco Bay-Delta wetlands the most rapidly and significantly. We have initiated a multi-year investigation of the effects of salinity and inundation on wetland processes: carbon cycling, plant distributions, primary production and decomposition. In order to evaluate the impacts of future shifts in salinity, we are monitoring vegetation dynamics in wetlands across the existing salinity gradient at six sites, from the freshwater tidal parts of the western Delta, to brackish areas in the Suisun and Napa River and salt marsh areas in the San Pablo Bay region. We are also sampling across inundation gradients to allow for projections of results across a range of future sea-level conditions. Using stable isotopes, we will investigate the food web links between pelagic and wetland systems. Collections of invertebrates, fish, benthic algae and wetland plants will establish the broad percentages of detrital and herbivorous pelagic food web connections with wetland productivity. Plant species distributions and productivity across salinity and inundation gradients are being developed to generate landscape-level models to use as a predictive tool to determine priorities in restoration, wetlands policy and resource management.

CALFED Statement of Relevance

Wetlands policy and resource management efforts require an understanding of how climate change will impact wetland dynamics and will influence restoration efforts. Because these ecosystems are linked through herbivory and detrital food webs to the pelagic system, understanding how these systems might change is critical to future management.

Pawley¹, A.L., M. Knecht²

¹Stillwater Sciences, 279 Cousteau Place, Suite 400 Davis, CA 95616

²Sacramento River Watershed Program, PO Box 188585 Sacramento, CA 95818

anitra@stillwatersci.com

Sacramento River Roadmap and Watershed Health Indicators Project: Data Availability and Proposed Measures to Compare Health Across Sub-Regions

The SRWP began work on watershed health indicators (WHIs) in 2004 in response to stakeholder recommendations to expand SRWP monitoring efforts beyond mainstem river water quality monitoring. The SRWP also held several meetings with state and federal agencies leading the SRWP to adopt the Watershed Assessment Framework (WAF); an element of the 2006 California Watershed Action Plan. Through the Sacramento River Watershed Roadmap Prop 40 Grant Project (Roadmap Project), the SRWP is compiling and summarizing key watershed information on six major sub-regions of the Sacramento River Watershed. Through the Roadmap Project, the SRWP is evaluating its straw list of WHIs relative to data sources, management actions, and issues that are critical to the sub-regions of the Sacramento River Watershed. Through a new program, the Sacramento Watershed Health Indicators Program (WHIP), we propose to evaluate social, economic, and environmental conditions at the watershed scale, in order to compare relationships between watershed condition and watershed management actions. Using the WAF, the relative benefits gained by investments and alternative actions can be evaluated in terms of their resultant changes in particular ecologic and community based indicators. Working together, these projects provide a holistic integrated picture of health. Roadmap synthesis products including summaries of existing studies, management assessment questions, proposed indicators, and preliminary results will be presented for the Feather River watershed. An example of the WAF process for a selected indicator will also be presented. By demonstrating how the development of these products can be integrated for a representative Sacramento watershed, we illustrate the difficulties in assessing watersheds typical of the Central Valley: watersheds that are bisected by major dams, include multiple and or variable sampling programs, and multiple habitat types. We also explore the complexities of developing indicators across multiple geographic scales.

CALFED Statement of Relevance

Watershed indicators are essential to assess the effects of management on resources at multiple temporal and geographic scales. In part, the design of these reporting tools will include linkages to assess the effects of previously funded CALFED Restoration Programs in the Sacramento River watershed.

Peterson, H.A.

U.S. Geological Survey, 345 Middlefield Rd. MS 496, Menlo Park, CA 94025

hapeters@usgs.gov

Benthic Invertebrate Assemblage Variations along Gradients of Time, Salinity, and Invasion in the Upper San Francisco Estuary: Are there Unique Attributes during the POD?

Interannual and seasonal changes in benthic invertebrate assemblage composition were explored using data from nearly 30 years of monitoring at four benthic monitoring stations located along a salinity gradient in the upper San Francisco Estuary. Variations in benthic assemblage composition were assessed relative to hydrologic variability, the presence of the high-impact invader *Corbula amurensis* in the estuary, and as a means of investigating benthic assemblage variations during the recent collapse of several pelagic populations in the upper estuary. Benthic assemblages at all stations were sensitive to hydrologic variability. The distribution of taxa along the salinity gradient indicated a continuum of benthic assemblages whose composition was more sensitive to salinity than physical habitat attributes such as substrate or location in embayment vs. channel habitat. Benthic assemblages at all four stations were affected by invasive species, with both direct and indirect effects associated with significant changes in assemblage structure. Benthic assemblages did not show unprecedented patterns of species or composition during a period of pelagic organism decline in the upper estuary, but did show unexpected composition relative to hydrologic conditions.

CALFED Statement of Relevance

In the San Francisco Bay-Delta benthic invertebrates have been important indicators of ecosystem change as well as instigators of ecosystem change - through benthic grazing of pelagic phytoplankton. For these reasons analysis of historic patterns in benthic assemblage composition is considered to be important to understanding the ecosystem of the upper estuary as well as the mechanisms contributing to ecosystem-level changes, such as the POD. Long-term monitoring data provide a natural laboratory that can be used to explore ecosystem responses to the broad range of natural conditions recorded in the monitoring record. Nearly three decades of monitoring of the aquatic environment and benthic macro-invertebrates of the upper San Francisco estuary has chronicled benthic assemblages from multiple salinity regimes, and multiple habitat types in their responses to physical and biological perturbations of natural and anthropogenic origin. If management and restoration activities seek to re-create or mimic conditions observed during historic monitoring, then ecosystem responses to those management and restoration activities can be better anticipated with the products from analysis of the monitoring record.

Peterson, R.M.

California Department of Water Resources, Division of Environmental Services,
Sacramento, CA 95816

rpeterso@water.ca.gov

Climate Change Influences on Biological Components of Evapotranspiration

Problem Statement: Within the soil-plant-atmosphere continuum, the biological features of plants response to the combined increase of temperature and CO₂ is difficult to determine. Experimental inclusion of the canopy boundary layer while manipulating temperature and CO₂ together is best approached in the free air CO₂ enrichments (FACE) studies but biological uncertainties persist. The future climate impacts on evapotranspiration (ET) needs a quantitative summary to better plan for future landscape water demands. Approach: A quantitative model of plants within landscapes that uses a relative growth rate in relation to water use efficiency, assimilation per water uptake, is developed and applied to future expected temperature and CO₂. The conceptual model sums biological features involved in ET. The morphological, physiological and biochemical features that concern the fixing of carbon and transference of water provide the state variables for the model. The summary of biological modulation of the variables for ET covers a large scale. It ranges from canopy and soil root changes down to stomatal, Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO) and upstream biochemical pathways. This inclusive goal can help provide a unified view of possible ET changes in future climates. Results: The best available experimental results are summarized within the developed quantitative conceptual model together with expected variance. The results from this study can be scaled to help with regional water demands.

CALFED Statement of Relevance

The results are relevant to the CALFED objectives of ecosystem and of water supply reliability.

Pimental, J.M., S. San Julian
Department of Water Resources, 901 P Street, Sacramento, CA 94236
pimental@water.ca.gov

Real-Time, Continuous Monitoring of Bromide and Nutrients at H.O. Banks Pumping Plant and San Joaquin River near Vernalis

Fluctuating source water quality in the Sacramento-San Joaquin Delta (Delta) and more stringent regulatory requirements have made providing safe, reliable and economical drinking water increasingly challenging for water utilities. Water utilities are strictly regulated with respect to the formation of disinfection by-products. Disinfection by-products of greatest concern for Delta water users are total trihalomethanes (TTHM) and bromate. Bromide concentrations in source water are a key factor in the formation of these compounds. CALFED has established a target of 50 ug/L bromide at Delta intakes to address the issue of disinfection by-product formation. In order to meet this target data needs to be collected at a high frequency. Process analyzers are now available that make continuous measurements of bromide and other anions possible. Having such instruments installed in the field can give water utilities the tools they need to meet the CALFED target. In this poster we describe a program conducted by DWR's Municipal Water Quality Investigations Unit (MWQI), to install and operate laboratory-grade ion chromatography process analyzers at key points in the Delta. The ion chromatography analyzers measure bromide, chloride and nutrients in the imported water supply. To our knowledge, this is the first time this type of analyzer has been used to make continuous measurements of bromide and other anions in natural waters of the United States. We describe the installation process of the analyzers, discuss whether these instruments, used in a field setting, are feasible and present results from QA/QC procedures. Overall, we found the analyzers have the capability to produce high quality measurements and through the use of continuous and real time data, high bromide levels can be anticipated downstream and operational changes can be made at water utilities to lower THM formation.

CALFED Statement of Relevance

Data generated by this program allow utilities, resource managers and researchers real-time access to high frequency water quality data to make operational decisions, track changes over time and populate water quality models. Continuous monitoring also provides critical baseline water quality information and the ability to determine changes in water quality.

Pittman, S.A., G.V. Matthews
Graham Matthews and Associates, 4902 Cedar Ravine, Placerville, CA 95667
smokey@gmahydrology.com

Sediment Transport Dynamics in Lower Clear Creek: Gravel Injections, Saeltzer Dam Removal, Paige Boulder Debris Flow and Annual Ambient Transport

For over forty years, Whiskeytown Dam has cut off upstream sediment supplies and reduced the frequency and magnitude of peak flows in lower Clear Creek. Ambient sediment sources below the dam are limited to colluvial delivery, remnant alluvial features and tributary input. While tributaries contribute little coarse sediment, stochastic events can deliver up to ½ million cubic yards of material, much of which is sand. The preponderance of fine material (< 8mm) in Clear Creek reduces the quality of spawning gravel in downstream reaches. Since 1998, gravel injections have contributed over 70,000 cubic yards of high quality spawning gravel. Injection types include recruitment piles (talus cones requiring high flows for entrainment), and placed riffles (offering short term benefit in the absence of high flows). Gravel injection sources include abandoned floodplain material and relic tailing piles which are cleaned and sorted. A primary management goal on lower Clear Creek is to restore the process of complete sediment routing. Channel conditions and sediment transport capacity vary greatly by reach and management actions are limited by various regulatory, logistical and ecological constraints. In order to assess the relative effectiveness of restoration actions, we established sediment sampling stations, conducted repeat topographic and longitudinal surveys and collected particle size and bed mobility-threshold data at various locations along Clear Creek. Longitudinal bulk sample particle-size analyses reveal increases in the fine sediment component related to tributary delivery of sand. Tracer gravel studies below gravel injections indicate a reduction in the critical shear stress required to mobilize the D84 at some locations. Annual bedload sediment discharges (computed from pressure-difference sampler data) ranged from 392 to over 6,800 tons/yr while annual suspended sediment discharges ranged from 1,250 to over 35,000 tons/year. These large differences reflect the variability in water year types and the signature of the Saeltzer Dam removal.

CALFED Statement of Relevance

Understanding the relative role of various sediment sources and rates of transport is paramount to making informed choices regarding gravel additions and planning restoration designs in Clear Creek. Project-scale sediment budgets facilitate restoration design evaluation and help determine appropriate gravel injection volumes.

Pittman, S.A., G.W. Matthews

Graham Matthews and Associates, 4902 Cedar Ravine, Placerville, CA 95667
smokey@gmahydrology.com

Longitudinal Profile as an Analytical Tool: Channel Response to Peak Flows, Saeltzer Dam Removal, Stream Restoration, and Gravel Injection in Clear Creek

The legacy of gold and gravel mining, flow regulation and sediment-starvation on lower Clear Creek has caused a profound disruption of physical process and resulted in a suite of undesirable habitat conditions. Despite restoration efforts (including channel manipulation, gravel injection and floodplain lowering), headcutting, channel incision, bedrock exposure and discontinuity in sediment transport still occur. Of the many assessment and monitoring tools available for studying stream channels, repeat longitudinal profile surveys prove most valuable for describing channel geometry, tracking channel evolution, predicting response and guiding restoration efforts. Portions of Clear Creek have been surveyed for a longitudinal profile nearly every year since 1998 and some surveys date back as far as 1936. Long term comparisons indicate up to six feet of channel incision in the lower alluvial reach where historic gold mining radically altered channel form and gravel mining removed over ½ million cubic yards of material. Shorter-term comparisons reveal: headcut migration of over 1,000 feet of channel length into restoration projects; downstream translation of gravel injection lobes; massive re-organization of placed riffles; and the depositional reach profile for over 20% of the sediment liberated by Saeltzer Dam removal. When combined with other types of land-based, water-based or aerial/LiDAR surveys (yielding cross sections, bathymetry, and topography), longitudinal profiles facilitate assessments of channel/floodplain connectivity, changes in volume of fluvial sediments, floodplain deposition, channel pattern and sinuosity, and the relative geomorphic implications of various hydrologic events. These assessments guide management strategies for subsequent phases of stream restoration along Clear Creek.

CALFED Statement of Relevance

Functional headwater streams are fundamental to the health and function of the Bay-Delta system. The longitudinal profile is a vital parameter to monitor in the attempt to understand how systems respond to various manipulations, historic influences and natural phenomena.

Portz¹, D.E., G. Benigno²

¹US Bureau of Reclamation, Denver Federal Center, Denver, CO 80225

²California Department of Water Resources, P.O. Box 942836 Sacramento, CA 95814

dportz@do.usbr.gov

Laboratory Evaluation of Underwater Video Technology for Identifying and Measuring Abundance of Pelagic Fishes

Trawls presently form the foundation of Interagency Ecological Program (IEP) fish monitoring in detecting pelagic organism decline (POD) and population trends for pelagic Bay-Delta fishes. While these long term sampling data have been exceptionally useful in monitoring population trends, additional sampling is necessary to gain further understanding of the distribution and life histories of rare and patchy species and their ecosystem requirements. Moreover, the recent pelagic organism decline has led to concern over lethal "take" by trawling methods. Implementation of new sampling efforts is increasingly difficult due to protection of threatened and endangered species. Towed video imaging systems may provide a supplemental method that could be used to examine pelagic fish distribution and abundance without potentially harming or increasing the lethal "take" of threatened and endangered species. The purpose of this study was to determine the feasibility of using video imaging systems for sampling fish in turbid delta water. Using a high speed camera mounted in an underwater housing, we examined video imaging limitations under simulated mid-water trawl conditions. We performed our analysis under a range of turbidities found in the Delta (10-60 NTU), which is the primary limiting factor for performing video recognition in these waters. Preliminary results indicate that it is possible to use video for identifying delta fishes in turbid water by keeping the fish within close range of the camera and provide lighting that will not illuminate particles in the water. Further laboratory testing and development of using underwater video technology is underway and field trials are being considered for 2009.

CALFED Statement of Relevance

Traditional sampling techniques may inadvertently cause harm to sensitive or rare fishes that we are attempting to save and potential future ESA listings will likely further restrict additional sampling efforts. Implementing alternative methods of collecting population data that won't harm or increase lethal take is necessary to sustaining fish species.

Poytress, W.R., J.J. Gruber, D.A. Trachtenberg
USFWS, 10950 Tyler Rd, Red Bluff, CA 96080
bill_poytress@fws.gov

Upper Sacramento River Green Sturgeon Egg and Larval Surveys

Study of the adult spawning habitat of green sturgeon, *Acipenser medirostris*, in the Upper Sacramento River system is an essential component of a comprehensive life-history study being conducted by UC Davis, the US Bureau of Reclamation, and the US Fish and Wildlife Service. We used substrate mats placed in known adult green sturgeon holding locations, based on acoustic telemetry data, above and below the Red Bluff Diversion Dam to obtain information regarding the spawning habitat used by Southern Distinct Population Segment green sturgeon. Paired substrate samplers were set in microhabitats of these locations at the 'head', 'within', and 'tail' of two deep holding pools (>5m) in varied substrates examined using deep water video technology. We found sturgeon eggs consistently 'within' pools of these locations indicating that spawning is likely occurring in or near the deepest portions of the pools whereby some eggs drifted onto samplers directly flanking these areas. Larval sturgeon sampling was conducted at four sites using a benthic D net to begin to determine spatial and nocturnal distribution patterns of age-0 sturgeon as well as to guide future sampling of adult spawning sites. Information regarding the deposition of eggs and the spatial distribution of green sturgeon may ultimately guide managers of water resources in the upper Sacramento River as to the effects of management operations on this native species. Ultimately, information derived from this study may allow more informed decision making and better conservation of California's limited water resources and this imperiled native species, respectively.

CALFED Statement of Relevance

Information derived from this study may allow for more informed decision making and better conservation of California's limited water resources and this imperiled native species, respectively.

Psaros, M.S.

San Francisco Bay National Estuarine Research Reserve, 3152 Paradise Dr.,
Tiburon, CA 94920

mpsaros@sfsu.edu

The Coastal Training Program: Updates and Opportunities

Every day, individuals in government agencies, private businesses, and non-profit organizations make decisions that affect the health of coastal resources. To manage and protect these resources effectively, decision makers need timely access to the most current scientific information and tools, as well as opportunities to interact with the research community. In order to meet these needs and bridge gaps between science, policy and management communities, NOAA's National Estuarine Research Reserve system has developed a highly effective nationwide education program called the Coastal Training Program. In 2007, the San Francisco Bay National Estuarine Research Reserve launched a regional Coastal Training Program to serve the Bay Area and Delta. The San Francisco Bay Coastal Training Program focuses on a variety of local and regional issues related to habitat management, invasive species, water quality, climate change impacts, and land use planning. Since its inception, the program has brought together hundreds of researchers and decision-makers to facilitate collaboration and information exchange. This CALFED Science Conference poster presentation will describe the Coastal Training Program approach, highlight upcoming events, and invite feedback for additional training and partnership opportunities.

CALFED Statement of Relevance

The Coastal Training Program addresses many topics within CALFED's water quality and ecosystem restoration themes. A number of CALFED-funded researchers have been attendees and presenters at Coastal Training Program events.

Ransom, B.H., T.W. Steig, S.V. Johnston, P.A. Nealson, M.A. Timko
HTI - Hydroacoustic Technology, Inc., 715 NE Northlake Way, Seattle, WA
98105

bransom@HTIsonar.com

Basin-Wide Monitoring of Acoustic Tagged Salmon Smolts (*Oncorhynchus* sp.) at Hydropower Dams

In the Columbia River Basin, USA, acoustic tags have been used since 1998 to monitor the survival and fine-scale behavior of downstream migrating salmonid smolts (*Oncorhynchus* sp.) at 11 major hydropower dams. During 2006, approximately 8,000 smolts were tagged with micro-acoustic tags and tracked at Rocky Reach, Rock Island, Wanapum, and Priest Rapids dams, plus nine additional open-river detection sites in the mid-Columbia River Basin. Smolts as small as 100 mm in length were surgically implanted with micro-acoustic tags weighing as little as 0.75 g. Tags operated at 307 kHz, with a signal pulse width of 1 msec. Detection histories and travel speeds for tagged smolts were monitored while they migrated up to 360 river km. Detection ranges for acoustic tags were estimated to be 400-600 m near the hydropower dams, and up to 1 km in the open river. A number of advances in 3D acoustic tag tracking techniques have been made over the past decade, permitting fine-scale 3D tracking of fish movement with sub-meter position resolution. Improvements include the development of various fish density algorithms, stream trace modeling analyses, and advances in 3D animation techniques. Three-dimensional tracks of fish approaching a surface bypass entrance are presented, as are estimates of passage effectiveness for bypass routes. Stream trace modeling animations based on empirical data show predicted fish passage routes. Estimated survivals for smolts passing through the reservoirs and dams of Rocky Reach and Rock Island dams were 94% to 96%, with standard errors of approximately 1%.

CALFED Statement of Relevance

To aid in protecting fish populations and help water agencies, public utility professionals, and researchers meet state and Federal guidelines (i.e. FERC licensing), HTI provides tools and services for the evaluation and improvement of fisheries management, including: Presence/Absence Detection, Population Assessments, Distribution Details, Passage Assessments, and Behavior Monitoring. HTI's acoustic tag systems track fish and other aquatic life in 3D with sub-meter resolution - helping agencies make the most informed decisions. HTI also designs and manufactures high-resolution hydroacoustic systems (telemetry) for establishing fish distribution and density in any aquatic environment.

Rettinghouse, T.L., B. Baskerville-Bridges, L. Ellison, J. Lindberg
UC Davis, Bio and Ag Engineering Dept, Davis, CA 95616
trettinghouse@earthlink.net

Investigation of Temporary Storage of Delta Smelt Sperm

The delta smelt (*Hypomesus transpacificus*) was listed as threatened in 1993 and a change to their status is currently under consideration. At the Fish Conservation and Culture Lab (FCCL), an off-site lab of UC Davis, in-vitro fertilization (strip-spawning) has been successfully implemented for the last several spawning seasons to provide hatchery origin (HOR) smelt to researchers. This year due to the smelt's continuing decline, the FCCL has been developing a refugial population in collaboration with state and federal agencies. The purpose of this study was to evaluate whether delta smelt semen could be collected and stored to help maintain the genetic diversity of captive wild fish. Milt was collected from 2 yr old natural origin, birth year 2006 (NOR, BY) fish and 1 yr old HOR, BY 2007 smelt. Semen from NOR was collected individually and refrigerated for 9 days while the HOR semen was pooled and refrigerated for 7 days. Eggs from ripe females were manually expressed and divided into two groups to compare fertilization using fresh semen and refrigerated sperm. Fertilization rate of the NOR, BY 2006 was lower (12.1%) with stored semen (9 day), compared to fresh semen (39.6%). Fertilization was greater overall with the HOR, BY 2007 and stored semen (7 day) resulted in comparable fertilization (89%), compared to fresh semen (94%). Delta smelt semen can be collected and stored for short periods of time. This may be a useful tool for collecting samples from wild fish as there are currently collection restrictions. Semen can also be transported on ice to fertilize NOR fish eggs in the field. Gametes from NOR fish can supplement the genetic diversity of the refuge currently on-site at the FCCL. Future studies would determine if the semen can be cryogenetically stored for longer periods of time.

CALFED Statement of Relevance

The delta smelt are a high priority species with the Cal-Fed Bay-Delta Program. Development of preservation techniques for delta smelt sperm could potentially transfer genetic material across years for this annual fish. Development of this technique provides a broader genetic base for the delta smelt refugial population

Ridolfi¹, K.C., R. Hoenicke¹, K. Van Velsor²

¹San Francisco Estuary Institute, 7770 Pardee Lane, Oakland, CA 94621

²Association of Bay Area Governments, Oakland, CA

kat@sfei.org

Communication and Outreach Strategies in Three Coastal California Watersheds

Unlike most water quality programs, the Critical Coastal Areas (CCA) Program is a non-regulatory planning and communication tool intended to foster collaboration among local stakeholders and government agencies, to better coordinate and direct resources to coastal watersheds in critical need of protection from polluted runoff. Local public works, flood protection, planning, stormwater management and other agencies often work on specific aspects to protect water quality, but not necessarily communicating across programs in order to share resources and implement actions in a timely manner. We convened diverse groups of stakeholders working in three pilot CCAs, and worked with them to identify goals and specific targets for protection and restoration of beneficial uses, identify opportunity areas for restoration or other appropriate actions, and identify local champions to carry out high priority projects. We also identified the main barriers to implementation in order to assist local governments with suggestions for how to overcome them to achieve results. We found that barriers to implementation were numerous and diverse, including financial, political, social, and technical barriers that prevented many seemingly simple actions from being completed. However stakeholder involvement from the beginning resulted in greater local commitment to identified projects and long-term action plan development. In addition, our outreach efforts and policy analysis were successful in opening lines of communications among agencies to eventually coordinate resources and implement early actions. The framework developed for these three pilot areas, will provide necessary guidance for the rest of California's 101 CCAs to surmount implementation barriers, increase coordination among agencies and NGOs, and ultimately achieve their goals of beneficial use protection in a more efficient manner.

CALFED Statement of Relevance

The CCA program, like CALFED, is a unique collaboration among agencies with the goal to improve watershed health by reducing the impacts of non-point source pollution. The lessons learned in the pilot areas will inform science and future action in the entire bay-delta region to improve ecological health.

Roos, M.

CA Dep't of Water Resources, P. O. Box 219000, Sacramento, CA 95821

mroos@water.ca.gov

Changing Sierra Nevada Runoff Patterns

There is a long record, over 100 years, of monthly unimpaired or natural runoff in the files of the California Cooperative Snow Surveys program. This paper would use that record for an examination of runoff trends for the four rivers comprising the Sacramento River region water supply index and the four rivers of the San Joaquin River region water supply index, looking at changes occurring over the 20th century and the earlier and latter half of the record. The presentation would be built around a set of 4 or 5 charts for each regional runoff index. It will show a declining trend in the percent of water year runoff during the April through July snowmelt period since the middle of the century. Water year runoff has not changed much but the portion coming off the watersheds during the historical spring and early summer snowmelt period is less. The southern group, that of the Stanislaus through upper San Joaquin Rivers, shows a smaller decline, presumably because of the higher elevation of the mountain range in this region. The first 3 charts will show the percentage trend, the April through July volume trend and the water year trend. The latter charts for each region will be a comparison of monthly distribution data for roughly the first half and last half of the record.

CALFED Statement of Relevance

Climate change is likely to profoundly affect water resources in California. Monitoring is very important to see if some of these changes are happening and to what extent. Long records of unimpaired runoff make it possible to look for the kind of trend changes expected and to confirm some of the modeling predictions.

Ruhl, C.A., P. Stumpner
U.S. Geological Survey, 6000 J Street, Sacramento, CA 95819
caruhl@usgs.gov

Hydrodynamic Field Measurements in Clifton Court Forebay

Delta smelt are at the center of a water supply crisis in the State of California. Found only in the San Francisco Bay-Delta Estuary, this small (55-70 mm, adult size), open-water species has experienced a sharp population decline since 1999. To properly manage water exports from the Delta, studies are being done to better understand the role of entrainment losses for delta smelt in the population decline. During June 2008, the U.S. Fish and Wildlife Service and the California Department of Fish and Game conducted a mark-recapture study using cultured delta smelt released in Clifton Court Forebay (CCFB) to provide an estimate of the predation losses across the forebay. In support of the fish study, the U.S. Geological Survey conducted a field hydrodynamic study that is the subject of our poster. Drifters that travel with the currents were released in conjunction with the delta smelt and were tracked for several days. The travel times of the drifters and fish across the forebay were compared. Velocity transects were collected for several days during one of the juvenile delta smelt mark-recapture experiments. The transects were collected in the entrance channel to CCFB immediately outside the radial gates and on the western side of the Forebay in front of the approach channel leading to the Skinner Fish Facility. Finally, upward-looking acoustic Doppler profilers were deployed at several locations in CCFB to measure time series of velocity-profiles over a period of several months. All the hydrodynamic field data are being used in validating a three-dimensional hydrodynamic model of the Forebay.

CALFED Statement of Relevance

This poster presents fundamental hydrodynamic data collected in Clifton Court Forebay in conjunction with the 2008 juvenile delta smelt mark-recapture study. The results are relevant to the CALFED goal of evaluating management strategies to protect fish populations.

Sandstrom¹, P.T.*, A.J. Ammann², E.D. Chapman¹, A.P. Klimley¹, R.B. MacFarlane², S.L. Lindley², C. Michel²

¹University of California Davis, One Shields Ave., Davis, CA 95616

²NOAA Fisheries, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060

ptsandstrom@ucdavis.edu

Fine-Scale Movement and Depth Distribution of Juvenile Steelhead Trout in the Sacramento River and San Francisco Bay Estuary

Little is known about the movement patterns of juvenile steelhead trout. Four juvenile steelhead trout were tagged and tracked with miniature ultrasonic transmitters that recorded depth. Tagged steelhead made small initial movements for the first 24 hours after release. The two individuals tracked for multiple days exhibited a significant response to tidal flows. Fish moving the greatest distances upstream or downstream were observed in the top 3 m of the water column and closely followed changes in water flow direction. Steelhead trout were observed near the bottom of the water column, where influence of flow is reduced, when making fine-scale movements or ignoring the prevailing water flow. The fish we tracked continuously for five days during the summer showed a diel pattern, moving during the daytime and typically holding in an area of less than 1 km at night. This fish was found at depths ≤ 3 m 86% of the total daytime detections. The second steelhead tracked during the spring, when juveniles are outmigrating, moved further at night than during the day for the first four days. This fish also exhibited behaviors of holding and localized movements during the daytime rather than at night. 81% of daytime detections were ≤ 3 m in depth, while 79% of nighttime detections occurred in the top 3 m of the water column. By characterizing movement patterns of smolts we will increase our understanding of the behaviors other juvenile steelhead may exhibit between automated receiver sites along the outmigration corridor at various times of the year.

CALFED Statement of Relevance

The movements of juvenile steelhead trout are of importance in the Delta because of predation and water flows. Understanding the fine-scale movements and responses of steelhead trout is important because of tidal flows and water diversions throughout the Delta.

Sandstrom¹, P.T.*, A.P. Klimley¹, R.B. MacFarlane², S.L. Lindley², A.J. Ammann², E.D. Chapman¹, C. Michel²

¹University of California Davis, One Shields Ave., Davis, CA 95616

²NOAA, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060

ptsandstrom@ucdavis.edu

Survival and Migratory Patterns of Central Valley Juvenile Salmonids

High resolution data is being collected on juvenile salmonids through the use of acoustic telemetry. The development of miniature acoustic tags has made it possible to tag fish under 140 mm fork length, and automated monitors allow for continuous sampling at multiple sites. In 2007 the California Fish Tracking Consortium (CFTC) was formed. The consortium is comprised of research, academic, resource, and consulting agencies. This group downloads and maintains a large array of acoustic monitors throughout the San Francisco Bay Estuary, Delta, Sacramento River, Cosumnes River, Mokelumne River, American River, and Feather River. This group tagged more than 700 juvenile salmonids and released fish in various locations as defined by researcher's specific questions. In the second year of study the CFTC has tagged more than 1000 juvenile salmonids and deployed additional monitors to improve detection probabilities and resolution of river reaches. Several other groups have joined the consortium in the past year increasing the number of automated monitors deployed throughout the watershed and the number of rivers containing monitors. This poster cluster presents the work of members of the CFTC concerned with the migratory movements, success rates, and behaviors of central valley juvenile salmonids. The cluster presents CALFED funded studies by the University of California Davis and NOAA's Southwest Fisheries Science Center, as well as studies by other CFTC members such as East Bay Municipal Utilities District, Department of Water Resources, U. S. Fish and Wildlife Service, U. S. Army Corps of Engineers, and the Bay Planning Coalition/E-CORP.

CALFED Statement of Relevance

This poster cluster examines two species of fish that are of interest throughout the Sacramento River Watershed. Several of the posters examine success and movement rates of fish, while others are concerned with anthropogenic impacts, or the effect of hydraulic configurations in the Delta.

Scavone¹, M.D., M. Koller²

¹California Department of Fish and Game, 1807 13th Street, Sacramento, CA 95811

²Pacific States Marine Fisheries Commission
msscavonetansey@dfg.ca.gov

CalFish - A California Cooperative Anadromous Fish and Habitat Data Program

CalFish is a multi-agency cooperative program designed to gather, maintain, and disseminate fish and aquatic habitat data and data standards. There are many programs in California that are actively gathering, compiling and analyzing fish and aquatic habitat data. Bringing all of this information together and making it available to a variety of users is crucial to the success of fisheries and habitat monitoring, evaluation, and management within the state. Centralizing access to California fisheries data makes it much easier to develop and maintain state-wide data standards and promote further development of related data programs in California. CalFish addresses the needs of a variety of natural resource management agencies by serving as both data publisher and data clearinghouse, providing access to original data and links to sites with related fish and aquatic habitat information.

CALFED Statement of Relevance

CalFish launched the California Habitat Restoration Project Database (CHRPD), which contains data from the CALFED Ecosystem Restoration Program, among other programs.

Schreier, B.M., J. Janik, D. Messer
California Department of Water Resources, 1416 9th St., Room 620,
Sacramento, CA 95616
bschreie@water.ca.gov

Preventing and Controlling Invasive Zebra/Quagga Mussels at Automated Water Quality Stations

Invasive mussels of the genus *Dreissena* were first reported in California in Lake Havasu, in January 2007, and they have since been observed in several of southern California's reservoirs and aqueducts and in one central Californian reservoir. These mussels could soon find their way into the water bodies and conveyance systems important for California's State Water Project. Many of these water bodies are continuously monitored for water quality, and the instrumentation in these monitoring stations could be severely affected by mussel biofouling. In order to prepare for the possibility of mussel invasion, California's Department of Water Resources has evaluated several prevention and control measures suitable for remote, low-flow water quality monitoring stations with an emphasis on environmentally benign and low maintenance solutions. Several methods are currently in place at the Harvey O. Banks pumping plant headworks water quality station located at the beginning of the California Aqueduct in the south Delta, in preparation for dreissenid mussels entering from the Delta. Here we present a synopsis of the methods and techniques evaluated, and our plan for protecting the water quality monitoring stations of the California State Water Project.

CALFED Statement of Relevance

This presentation discusses possible tools in dealing with a potentially dangerous invasive species in the Delta. Given the importance placed on the monitoring of water quality in the Delta, this presentation will also be pertinent to a wide range of organizations interested in Delta water quality.

Seavy^{1,2}, N.E., C.A. Howell¹, J.F. Quinn²

¹PRBO Conservation Science, 3820 Cypress Drive #11, Petaluma, CA 94954

²Department of Environmental Science and Policy, UC Davis, Davis CA 95616

nseavy@prbo.org

Restoring Riparian Wildlife Habitat in California's Central Valley: New Tools and Greater Urgency

Riparian habitat in California's Central Valley has been transformed by agricultural development, urbanization, and water management. This transformation has motivated ecological restoration designed to boost riparian wildlife populations toward their historical abundance and restore important ecological processes. Today, the urgency of riparian restoration has increased, because these areas enhance the potential for ecosystem resistance, resilience, and response to climate change. New tools and information are increasing our ability to measure and predict the response of riparian birds to restoration. LiDAR imagery of riparian areas, typically collected for purposes other than understanding wildlife habitat, has great potential as a tool to measure the abundance of riparian birds over large spatial extents. At much smaller spatial scales, detailed demographic data are improving our understanding of how and when restoration increases the growth rates of riparian bird populations. However, the utility of these tools depends on the ability to inform on-the-ground decisions. Our collaborative research program is working to develop these tools and understand the best ways to make them useful and accessible to decision makers.

CALFED Statement of Relevance

Our work supports agency planning and decision making by 1) using birds as performance measures of riparian restoration success, 2) developing restoration objectives for a future where restoring historical conditions may not be possible, 3) developing guidelines that will help to improve the utility and accessibility of decision support tools.

Seneviratne¹, S., J. Anderson², F. Chung²

¹CA Dept of Water Resources, 1416 Ninth St, Rm 252-4, Sacramento, CA 95814

²CA Dept of Water Resources, 1416 Ninth St, Rm 215-17, Sacramento, CA 95814

sanjaya@water.ca.gov

Developing Artificial Neural Networks to Represent Delta Salinity Intrusion from Sea Level Rise

Problem Statement: Understanding potential salt water intrusion into the Sacramento-San Joaquin Delta system due to sea level rise is critical for management of California's future water supply. The Delta is the hub of California's state and federal water projects, the State Water Project (SWP) and Central Valley Project (CVP) respectively. Water released from upstream storage reservoirs flows into the Delta. Pumps in the southern Delta export the water to canals that convey the water to central and southern California. About two-thirds of California's water supply passes through the Delta system. Rising sea levels would enter the Delta through San Francisco Bay and would bring higher water levels and salinity concentrations. Water managers need methods for quantifying the increased salinity intrusion to develop strategies for protecting the Delta's future water quality and California's future water supply. Approach: The California Department of Water Resources has developed a methodology for creating Artificial Neural Networks (ANNs) to estimate salinity intrusion for sea level rise scenarios. Although simulation models can be used to estimate salinity intrusion, setting up and running the models can be time consuming. A tool to quickly assess salinity intrusion into the Delta was desired to support decision making. To meet that goal, ANNs were developed for five scenarios. Outputs from various simulation models were used to create the data sets for training the ANNs. These ANNs correlate Delta inflows and electrical conductivity (EC), a measure of salinity, at key water quality compliance locations. The ANNs can then be incorporated into decision making tools to assess potential impacts of sea level rise on water project operations. Results: As an initial application, the ANNs have been incorporated into CalSimII, a SWP and CVP operations model, to investigate possible mitigation measures, such as changes in reservoir releases and export pumping, to maintain Delta water quality standards. Resulting impacts to water supply can also be examined. The coupling of sea level rise ANNs with a water resources operations model provides a powerful decision support tool for managing California's future water resources.

CALFED Statement of Relevance

Incorporating climate change into the decision making process is relevant to the CALFED objectives of water supply reliability and water quality.

Sesser, B.J., P. Stiefer, D. Di Pietro
Sonoma Ecology Center, PO Box 1486, Eldridge, CA 95431
bryan@sonomaecologycenter.org

Prioritizing Arundo donax Eradication in Northern California

The invasive plant *Arundo donax* has become widespread in California. In Southern California some riparian habitat has been reduced to monotypic stands, devastating native species locally. Eradication has been extensive and costly. In Northern California, *Arundo* infestations are less widespread. However, eradication efforts began later and have been occurring piecemeal as individual organizations fight local infestations. Team *Arundo* Del Norte is mapping the distribution of *Arundo* in the San Francisco Bay and Delta Regions and recommending eradication priorities based on the value of the threatened habitat. We began by integrating available mapping data from disparate organizations, field mapping critical gaps, and combining all distribution data into a single GIS layer. To determine eradication priorities, habitat suitability data for a suite of representative riparian species are combined with Federal and State threat indices to derive a multi-species conservation value index. At a given location, this index suggests the eradication priority for any threatening *Arundo*.

CALFED Statement of Relevance

The multi-species conservation value methodology for riparian habitat is based on representative species and their threat levels. This suggests eradication priorities for *Arundo* infestations and improves management decisions on *Arundo* and is applicable to other invasive species which damage the ecological function of riparian habitats.

Shilling, F.M.

University of California, Department of Environmental Science & Policy, Davis,
CA 95616

fmshilling@ucdavis.edu

***Bay-Delta Decisions Processes in the Context of Regionalism,
Environmental Justice, Scales, and Conservation***

Decision-making and studies in the CALFED or Delta Vision study area are quasi-regional processes with statewide implications. Regionalism, at its core, is a geographic expression of a social or institutional desire to organize human activities, usually around an economic idea or set of principles at the extent of a region defined by human institutions or sense of identity. CALFED and now Delta Vision have struggled with the complex problem of addressing water management, ecosystem survival, public safety, and equity issues for the estuary and Bay region, in the context of watershed processes extending beyond this extent and water deliveries to various other regions. What has been missing from this regional planning process in general is an understanding of how variation in scale (extent and resolution), inadequate knowledge of natural and human processes, inadequate equity in decision-making and analysis, and the effects of the different artificial regional boundaries can affect planning outcomes. What has been missing from the definition of this region as a geographic unit (and from regional planning in general) has been a real attempt to match the needs of communities, especially poor communities of color, and natural systems, with the concept of the region. Understanding ecological flows, power dynamics, variability in relevant scales for different processes, and environmental justice and equity are all critical to developing both a sustainable planning process and a sustainable naturally-functioning estuary.

CALFED Statement of Relevance

CALFED and now Delta Vision decision-making and studies occur at various extents and resolutions. These scales impact the types of processes considered and the communities impacted. How ecological and human communities and processes are included or excluded is a critical question.

Shimizu, D.M., A.U. Eke
California Department of Water Resources, 1416 Ninth Street, Sacramento, CA
94236
dshimizu@water.ca.gov

The Water Quality Monitoring Program in the State Water Project

The State Water Project (SWP) provides many Californians a portion or all of their daily residential water needs. Water for agriculture, industry, power generation, recreation, and fish and wildlife is also provided by the SWP. The SWP water quality monitoring program, undertaken by the Division of Operations and Maintenance within the Department of Water Resources (DWR), began 40 years ago, primarily to monitor water quality at key locations along the aqueducts, lakes, and reservoirs. The SWP water quality monitoring program consists of an automated network of continually operating recorders and laboratory analyses of field samples collected weekly, monthly, quarterly, or annually. The automated stations continuously monitor a variety of water quality parameters such as electrical conductivity (EC), temperature, turbidity, pH, fluorometry, dissolved organic carbon (DOC), etc. This statewide monitoring network was installed to provide to the water contractors and stakeholders, water quality data in order to document spatial and temporal changes in SWP water quality, plan water treatment operational changes, identify and respond to pollution or other water quality episodes, and compare SWP water quality to drinking water standards. Water quality monitoring is an important operational component of the SWP, and the data generated is also used to assess short- and long-term trends, the influence of operations and hydrology, and the general suitability of SWP water for drinking water purposes. This presentation will discuss water quality data, analyses, and trends from key locations of the SWP, including the California Aqueduct, the Delta, and North Bay and South Bay Aqueducts. It will also acquaint the scientific community and stakeholders of the efforts DWR is undertaking to enhance the quality of water throughout the SWP. The SWP water quality monitoring program is currently being enhanced by a series of upgrades at several stations and the installation of new series of stations. This presentation will present these improvements and outline the increased capabilities of the SWP water quality monitoring program.

CALFED Statement of Relevance

This poster presentation will acquaint the scientific community and stakeholders of the efforts the California Department of Water Resources is undertaking to enhance the quality of water throughout the State Water Project.

Silva¹, S.R., C. Kendall¹, M.B. Young¹, W.T. Stringfellow²

¹U.S. Geological Survey, 345 Middlefield Rd., M/S 434, Menlo Park, CA 94025

²University of the Pacific, Ecological Engineering Program, 3601 Pacific Avenue, Stockton, CA 95211

srsilva@usgs.gov

A Refined Assessment of Spatial and Temporal Dynamics of Algal Occurrence in the San Joaquin River, California, from Data Collected between 2005 and 2007

The occurrence of algae in the San Joaquin River (SJR) is of concern principally for its role in biological oxygen demand (BOD) associated with periodic low dissolved oxygen (DO) conditions in Stockton deep water shipping channel (DWSC). Low DO conditions in the DWSC inhibit the migration of several fish species including Salmon. The dynamics of algal production and its primary nutrient sources must be understood in order to adequately assess possible mitigation strategies. The isotopic signatures of nitrate and algae in the San Joaquin River (SJR) and its tributaries are used here to add spatial and temporal detail to previous findings about nitrate sources and mixing, nitrification and denitrification, the sources of algae, and the relationship between algae and nitrate. A general relationship between algae and nitrate in the SJR has previously been shown (Kratzer et al., 2004) and indicates that nitrate acts as a primary nutrient source to algae. Particulate organic matter (POM) in the SJR has been shown by various lines of evidence to consist primarily of algae. It was found that the $\delta^{15}\text{N}$ of POM generally tracks that of nitrate indicating that the algae are using nitrate in the river. When nitrate concentrations are relatively high, the $\delta^{15}\text{N}$ of POM is around 4‰ below that of nitrate and when concentrations are lower, the separation between the $\delta^{15}\text{N}$ of POM and nitrate is reduced consistent with assimilation of nitrate by algae. A new data set collected between March 2005 and December 2007 confirms this finding and also reveals spatial and temporal anomalies within these patterns which require additional processes to explain. The exact mechanisms responsible for anomalous patterns are not always apparent but testable hypotheses can usually be obtained. These new data yield a more complete picture of the dynamics controlling algae and nitrate in the SJR.

CALFED Statement of Relevance

Isotopic analyses of algae and nitrate in addition to more conventional water chemistry analyses helps in formulating ideas about algal generation and behavior not available through concentrations analyses alone. The resulting interpretations will be useful in assessing mitigation options for the low DO problem in the DWSC.

Singer, M.S., R. Liebig, B.K. Orr
Stillwater Sciences, 2855 Telegraph Avenue, Berkeley, CA 94705
maia@stillwatersci.com

Fish Community Composition on the Merced River: Spatial and Seasonal Patterns at Multiple Scales and Between High-flow and Low-flow Years (2006-2008)

The Merced Alliance Project biological monitoring component was designed to address the deficiency of contemporary watershed-scale data for fish, benthic macroinvertebrates (BMI), and birds along the Merced River, a major tributary to the San Joaquin River. The data deficiency was problematic because, although a number of Merced River restoration projects have been undertaken during the past two decades, baseline information has not been available for evaluating the effects of reach-scale restoration efforts. The fish study component was conducted as a two-year, six-season (2006-2008) effort, with study plan development incorporating several ideas detailed in CALFED's Comprehensive Monitoring, Assessment, and Research Program (CMARP) regarding the distribution and relative abundance of resident fish and introduced species. Objectives included documenting baseline fish community species composition, identifying spatial patterns at multiple scales (e.g., segment, reach, habitat unit, microhabitat), and determining seasonal shifts in fish species composition and distribution. Samples were collected using a variety of sampling methods at 36 sites along the mainstem Merced River, from the confluence with the San Joaquin River to Yosemite Valley. Cluster analyses indicated that at the basin scale, there was a general conformity to the broader water temperature assemblages, but there was no discernable distinction between previously developed San Joaquin River Drainage community assemblages on a seasonal or annual basis. An inter-year comparison of longitudinal community distributions for relatively higher flow conditions (2006) to that of lower flow conditions (2007), suggested that flow may not have had a profound effect on the downstream extent of native Foothill Community species, nor did it appear to effect the upstream extent of the predominantly introduced Valley Floor Community. Broad overlap between fish communities in the Merced River, at both the basin and segment scale, has potential implications for restoration approaches, particularly if native and introduced species are competing for similar habitat.

CALFED Statement of Relevance

Study findings are relevant to the CALFED Program objective of ecosystem restoration because they support a better understanding of fish communities and habitat quality on major California Central Valley rivers, and provide information for prioritizing ecosystem restoration within the San Joaquin Basin.

Slater, S.B.

California Dept. of Fish and Game, 4001 N. Wilson Way, Stockton, CA 95205
sslater@dfg.ca.gov

Feeding Habits of Longfin Smelt in the Upper San Francisco Estuary

In recent years, abundance of longfin smelt (*Spirinchus thaleichthys*) in the estuary has declined to levels that have resulted in the petition for its listing under the endangered species act. This decrease in abundance has coincided with the long term decline of other pelagic organisms, including calanoid copepods and mysids, some of which are important food for young pelagic fishes. There is little information currently regarding longfin smelt use of available prey in the estuary. This study was conducted to investigate the composition and temporal trends in the diet of age-0 longfin smelt as part of the Interagency Ecological Program's (IEP) Pelagic Organism Decline (POD) special studies. Fish examined for gut contents were collected in 2005 and 2006 by several California Department of Fish and Game (CDFG) surveys in the upper San Francisco Estuary that sampled from San Pablo Bay upstream through the Delta. Fish were processed for length, weight, and diet, with the gut contents identified to the lowest taxon level possible and counted. Diet composition was reported by percent number, percent weight, and percent frequency of occurrence. The juvenile and adult stages of the calanoid copepod *Eurytemora affinis* and adult *Sinocalanus doerrii* were important food for age-0 longfin smelt in the spring. In the summer and early fall, larger longfin smelt shifted to primarily eating mysids and amphipods. Other regionally abundant calanoid copepods, such as *Pseudodiaptomus forbesi*, *Acartia* spp., and *Tortanus* spp. were utilized as food. The abundant cyclopoid copepod *Limnoithona* spp. was consumed only a small amount by young longfin smelt. Understanding longfin smelt's role in the estuarine food web provides information on the factors affecting its abundance and is important for the management of this fish and its habitat.

CALFED Statement of Relevance

Longfin smelt diet data is an important component in understanding the food web ecology of the estuary and provides necessary information in the management of this fish.

Slaughter, A.M., W. Kimmerer
Romberg Tiburon Center, SFSU, 3152 Paradise Drive, Tiburon, CA 94920
aslaught@sfsu.edu

CALFED Foodweb Project: Zooplankton Abundance, Composition, and Mortality during 2006-2007

Recent declines in abundance of delta smelt and several other species of estuarine fish, and evidence that they may be food limited, have prompted efforts to characterize the foodweb of the low salinity zone (LSZ) of the northern San Francisco Estuary (SFE). Toward this effort, we examined abundance of copepods during a two-year field sampling program in 2006 and 2007, years of contrasting hydrology. Weekly sampling cruises were conducted in March-August to provide a finer temporal resolution than is available from IEP data. Zooplankton (>53µm) were collected by vertical net tow at three salinities (0.5, 2 and 5 psu) both years. We examined the temporal and spatial differences in abundance and composition of some of the numerically abundant zooplankton species in the larger spatial and temporal context of the IEP data. Together with experimental data on growth and development rates, these data enabled us to estimate mortality and the influx of calanoid copepods (*Pseudodiaptomus forbesi*) from the Delta. *Pseudodiaptomus forbesi* and *Eurytemora affinis* were more abundant in 2006 than 2007 possibly because of a modest increase in phytoplankton biomass in 2006. The small cyclopoid *Limnoithona tetraspina* was also more abundant in 2006 than 2007 at all salinities, although reproductive rates were generally similar between the two years. Mortality rate estimates for copepodites and adults of *P. forbesi* were 30 and 16% /day (0.5 and 2 psu, respectively) while corresponding rates for *L. tetraspina* were ~15-20% /day. Naupliar mortality rates for both species were highly variable with means ~25% /day, possibly reflecting consumption by the clam *Corbula amurensis*.

CALFED Statement of Relevance

The POD has prompted an intense effort to understand the causes of long-term change in the estuarine ecosystem. Evidence for food limitation of planktivorous species suggests a need to examine the abundance and population dynamics of their food.

Sommer, T.R., B. Harrell, T. Swift
Department of Water Resources, 901 P Street, Sacramento, CA 95814
tsommer@water.ca.gov

Battle of the Bands: Extreme Hydrologic Banding in the Yolo Bypass

Where tributaries meet, certain conditions of flow and topography often result in incomplete mixing and the formation of spatially and temporally persistent plumes or bands. Yolo Bypass, the primary floodplain of the lower Sacramento River (California, USA), provides an extreme example of this effect. Inspection of recent and historical aerial photographs revealed that the four major tributaries of Yolo Bypass typically do not substantially mix laterally within the floodplain. The phenomenon is notable in the number of tributaries involved (4), the distance over which the bands remain distinct (>61 km), and the persistence of the bands despite channel constrictions and long cross-wind fetch. This effect demonstrates the importance of lateral variability during floodplain flow events, including transport and distribution of chemical constituents, and habitat for fish and other organisms that use floodplains as migration corridors and rearing areas.

CALFED Statement of Relevance

Floodplain represents one of the most important habitats in the SF estuary. This poster describes a remarkable physical phenomenon in the Yolo Bypass, with implications for contaminant transport, fish rearing and migration, and restoration.

Soong¹, O., K. Dulik², F. Davis¹

¹Donald Bren School of Environmental Science and Management, 2400 Bren Hall, University of California, Santa Barbara, CA 93106

²California Department of Water Resources, 3374 E. Shields Ave., Fresno, CA 93726

osoong@bren.ucsb.edu

Site, Management, and Community Effects on Riparian Vegetation Development on the Restored Floodplain of the Merced River, California

We investigate the relative importance of abiotic and biotic constraints on patterns of species establishment, as well as evidence for biophysical feedbacks and self-organization, on the restored floodplain of a reach of the Merced River. Efforts to restore habitat for endangered Chinook salmon occurred between 2000-2003 and involved filling former gravel quarry pits and engineering a meandering channel suited to a flow regime modified by upstream impoundments. Riparian vegetation treatments included planting tree species through cuttings and container stock, seeding sterile barley in 2002, and seeding native herbaceous species in factorial combination with mycorrhizae in 2003. We examine the role of the physical environment, restoration treatments, and annual flooding on vegetation development through soil samples and groundwater monitoring, vegetation censuses of herbaceous and tree species, and hydraulic modeling of floods in 2004 and 2005. Recruitment and performance of tree species is affected by moisture availability, but under modified flow regimes seen both onsite and on nearby unrestored reaches, we do not observe a flood-induced recruitment pulse. Non-metric multidimensional scaling analysis of herbaceous census plot data indicate moisture and seeding treatments most strongly influenced plot composition, but the effect of seeding treatments diminishes through time. Species composition on the restored reach is distinct from the upstream unrestored reach. The topographic homogeneity of the restored reach seems to result in diminished heterogeneity in species composition gradients relative to the unrestored reach.

CALFED Statement of Relevance

Results suggest that appropriate modifications to the physical environment may result in more persistent desired changes in vegetation under the prevailing flow regime.

Speegle, J.H.

U.S. Fish & Wildlife Service, 4001 N. Wilson Way, Stockton, CA 95205

Jonathan_Speegle@fws.gov

Inland Silverside Menidia beryllina, Red Shiner Cyprinella lutrensis and Threadfin Shad Dorosoma petenense: A Growing Concern?

The introduction and manipulation of forage-fish populations to enhance a sport fishery or control unwanted vegetation or insects are common management techniques used by fishery managers, but often lead to undesired results. Abundance of target species where non-native forage fish have been introduced are sometimes reduced as a result of interspecific competition with juvenile life stages. Threadfin shad *Dorosoma petenense*, red shiner *Cyprinella lutrensis* and inland silverside *Menidia beryllina* are several fish species that were introduced in attempts to increase abundances of sport fish. These introduced fishes have increased in abundance and their distributions expanded such that they have become some of the most abundant fishes in the Sacramento-San Joaquin Delta. Interspecific competition may have impacted sport-fish populations of Chinook salmon *Oncorhynchus tshawytscha*, white crappie *Pomoxis annularis* and striped bass *Morone saxatilis*. The objective of this study was to compare near shore abundance of the above mentioned species over time at beach-seine locations throughout the Sacramento-San Joaquin Delta. A one-way analysis of variance (ANOVA) was used to compare mean catch-per-unit effort (CPUE) of the above fish species over time. Mean CPUE was significantly different between years for inland silverside and red shiner, but not Chinook salmon or white crappie. Our results indicate that introduced forage-fishes may be outcompeting young-of-year sport fishes for available food and habitat. Information on interspecific competition may provide insight into ecosystem restoration efforts and the detrimental effects of exotic introductions and provide incentives to the public to help limit exotic introductions.

CALFED Statement of Relevance

Ecosystem Restoration: Information on intra-species competition may provide insight into ecosystem restoration efforts and the detrimental effects of exotic introductions and provide incentives to the public to help limit exotic introductions.

Swarowsky, A.A.*, A.T. O'Geen, R. Dahlgren
Soils and Biogeochemistry Graduate Group, Department of Land, Air and Water
Resources, UC Davis, Davis, CA 95616
aswarowsky@ucdavis.edu

Hydrologic Flowpaths in Oak Woodland Soils

Soils of the California foothill region possess multiple routes through which water can flow. Certain hydrologic flowpaths have the propensity to circumvent the filtering capacity of the soil matrix, and as a result, rapidly convey water quality contaminants to surface water bodies. We measured water flow and water quality in dominant hydrologic flowpaths of soils and compared changes in flowpaths to changes in soil moisture storage capacity. Temporal and spatial patterns in soil water storage were monitored during the 2006-2007 water year in an experimental oak woodland watershed. Water content was monitored in 100 soil profiles within four horizons (A, AB, Bt, and C/Cr) distributed throughout the catchment. A perched water monitoring trench, was retrofitted with tipping buckets to measure lateral flow from three soil profiles within the same four horizons. Water was collected from the trays for water quality analyses during flow events. Stream flow was measured at 15-minute intervals. A total of 50 cm of rain was recorded for the year resulting in two stream flow events. The second event (2/24/07-3/01/07) occurred after a total of 55 cm of rain, and corresponded in time with lateral flow from AB horizons. The total amount of lateral flow over the 16-hr storm event was 0.3 m³ in A, 1.5 m³ in AB, 0.4 m³ in Bt, and 0.2 m³ in C horizons. Before the event (2/24/07), soil water content in the top 10 cm ranged from 0.14 to 0.40 m³ m⁻³ in the watershed. During the storm, water content in the top 10 cm ranged from 0.21 to 0.47m³ m⁻³. Dissolved organic carbon concentration was highest in A and AB horizons during peak flow. Preliminary information indicates that stream discharge responds immediately to lateral flow once watershed storage capacity is reached and AB horizons are saturated.

CALFED Statement of Relevance

Oak woodlands play a major role in California's drinking water supply system, with almost all the State's surface water passing through these ecosystems as direct rainfall or snow melt from higher elevations. Transport of water quality contaminants are of concern, yet transport mechanisms in soils are poorly understood.

Swift, T.J., J.J. Christen
Department of Water Resources, 901 P Street, Sacramento, CA 95814
tswift@water.ca.gov

California DWR's Real-Time Data and Forecasting Project

There is a compelling and ongoing need to monitor, understand, and –as much as possible- predict and manage water quality in the Delta and the processes that affect it. The Delta is the source for much of the drinking water in California, and detailed knowledge of Delta water quality helps municipal water treatment operators manage treatment to comply with drinking water regulations while minimizing costs. There is also an ongoing need for detailed Delta water quality data to understand the Delta's dynamic ecological processes. The California Department of Water Resources together with the State Water Contractors have developed the Real Time Data and Forecasting (RTDF) program. The RTDF program consists of three interrelated efforts; Field monitoring, modeling and forecasting, and data dissemination. The goal of the project is to help municipal water supply providers with tools to make informed decisions in response to sudden changes in source water quality in the Sacramento-San Joaquin Delta and State Water Project. Field monitoring includes several permanent remote stations that measure organic carbon, anions, and other water quality parameters in real time and send results to a central server. Modeling and forecasting is a collaboration between modeling groups within DWR that produce volume, conductivity, and organic carbon source water contributions, as well as conductivity forecasts. Data dissemination includes real-time data posted to the web, and a weekly emailed water quality newsletter discussing trends, causes, and forecasts. RTDF data and information are organized by location and water quality constituents in a user-friendly format to meet the needs of a diverse audience of municipal water quality managers, scientists, and other interested parties.

CALFED Statement of Relevance

Changes in the quality of the Delta waters can affect the operations of the State Water Project and of the State Water Contractors in order to meet water quality objectives, and regulatory criteria. The RTDF program links real-time water quality data to modeling data and promptly communicates the information.

Teo¹, S.L., P.T. Sandstrom¹, E.D. Chapman¹, R. Null², K. Brown², A.P. Klimley¹, B. Block³

¹University of California Davis, One Shields Ave., Davis, CA 95616

²US Fish & Wildlife Service, 10950 Tyler Road, Red Bluff, CA 96080

³Hopkins Marine Station, Stanford University, 120 Oceanview Blvd., Pacific Grove, CA 93950

lteo@ucdavis.edu

There and Back Again: Tracking the Migration of Sacramento River Steelhead Kelts to the Pacific Ocean and Back Again

Salmonids are an important part of the Sacramento River and Delta ecosystem. Tracking their migrations and habitat use in both river and ocean are crucial for understanding the relative contributions of marine and freshwater conditions to their overall survival. However, it has been previously extremely difficult to track the same fish from the river to the ocean and back again. Here, we demonstrate a strategy to track steelhead and other salmonids throughout their range, using a combination of archival and acoustic tags. Archival tags are electronic tags that record the vertical and horizontal movements and ambient temperatures of individuals for long periods of time, up to several years. These archival tags have been used to track large pelagic fish, like tunas, for several years but recent reductions in their size and weight have finally allowed us to use them in salmonids. Acoustic tags have been used to track salmonids in river and estuarine systems, as well as coastal systems, wherever there is an infrastructure of acoustic receivers. By combining both technologies, we can leverage the strengths of both types of tags and reduce their weaknesses. As a pilot project, we tagged and released 14 steelhead kelts from Coleman National Fish Hatchery in May 2008. Some of these fish have been detected in the Sacramento River and Delta system on their migrations to the Pacific Ocean. With the expected return of the steelhead in Nov-Jan later this year, we will obtain our first glimpses of the complete migration and habitat use of steelhead in both river and ocean.

CALFED Statement of Relevance

Steelhead trout are an important species in the Central Valley and this work is the first step towards obtaining a complete track of their migratory movements and habitat use.

Thomas, M.J., E. Chapman, J.A. Israel, A.P. Klimley
UC Davis, Department of Wildlife, Fisheries, and Conservation Biology, Davis,
CA 95616
mjthomas@ucdavis.edu

Telemetric Studies of Adult Green Sturgeon in the Sacramento River

The green sturgeon, *Acipenser medirostris*, is one of two acipenserid fishes native to the Central Valley. There are two Distinct Population Segment (DPS). The northern DPS includes the spawning populations from the Rogue and Klamath Rivers. On April 7, 2006 the Southern DPS, which constitutes the spawning population of the Sacramento River, was listed as “threatened” under Endangered Species Act (ESA). Section 4(b) of the ESA mandates that NMFS designate critical habitat including “cover or shelter... [and] sites for breeding, reproduction, [and] rearing of offspring” (NOAA 2006). Due to the increasing interest to determine critical habitat, we have implemented a comprehensive telemetric study to evaluate the periodicity of spawning movements, spawning behavior and potential spawning habitat. Two acoustic tags, one individually coded and one depth sensing, were implanted within the peritoneum cavity of two green sturgeon. They were then tracked by boat for up to seven days while simultaneously recording GPS coordinates, depth, and water temperature at the sturgeon’s location, while environmental conditions (pH, dissolved oxygen, turbidity, and water temperature) were recorded using a shipboard hydrolab and flow was measured utilizing a Marsh McBirney meter. One male sturgeon was tagged and released at the confluence of Antelope Creek and the Sacramento River on 23 April 2008. Over the next two weeks this sturgeon was tracked for two three and a half day periods. We described two upstream migrations over a distance of ten kilometers from the confluence of Deer Creek to the confluence of Antelope Creek, where the fish was initially tagged. Based on shipboard tracking and monitor records there are alternating movements between widely separated reaches, which may be key spawning locations. The individual was tracked within the Antelope pool, where it stayed in the deep pool much of the day, but periodically made circular movements from the center to the head, then the tail of the pool and back to the center of the pool. Egg mats were placed at both the head and the tail of the pool below the confluence of Antelope Creek, and eggs were collected only in the lower location at the tail of the pool. This study indicates that shipboard tracking is a viable technique for identifying spawning site in the Sacramento River and its tributaries.

CALFED Statement of Relevance

Green sturgeon in the Sacramento River are the only reproducing population in the threatened Southern DPS of green sturgeon, are a CALFED At-Risk Species (Priority Group I), and its migration and spawning behavior is not well described.

Thompson, J.K., F. Parchaso
U.S. Geological Survey, 345 Middlefield Rd., Menlo Park, CA 94025
jthomps@usgs.gov

***Corbula amurensis* Distribution and Biomass Response to Hydrology and Food: A Map for CASCaDE Scenarios of Change**

The estuarine bivalve *Corbula amurensis* can be a determinant of ecosystem health and restoration success in the Estuary and Delta. *Corbula* is a consumer of phytoplankton, bacteria, and zooplankton and a vector for contaminants to upper trophic levels. Thus defining the temporal and spatial distribution of *Corbula* aids our understanding of food web dynamics and contaminant pathways in the northern estuary and western Delta. As part of the CASCaDE (Computational Assessments of Scenarios of Change for the Delta Ecosystem) project we are projecting the distribution and biomass of *Corbula* for different climate scenarios. Our distribution and biomass projections are based on a combination of laboratory findings and relationships gleaned from field data. Distribution of recruits is limited by salinity and abundance of recruits is related to adult bivalve abundance. Thus much of the observed temporal and spatial variability in recruitment is due to a combination of salinity at the time of recruitment and the salinity experienced over the previous 2-3 years (the lifetime of adults). *Corbula* growth in the estuary is food limited and relationships between growth and food concentration are based on field data from the northern and southern estuary. Because *Corbula*'s distribution is ultimately limited by salinity, any action or climate change scenario that results in decreases in freshwater flow, especially during *Corbula*'s reproductive periods, results in a spread of the species. Similarly any import of food, the goal of some restoration plans, is likely to result in a larger population of bivalves with more robust individuals.

CALFED Statement of Relevance

Corbula can limit phytoplankton biomass in the Estuary. Therefore we need to understand what factors control its spread and population dynamics (in particular biomass). The extent of *Corbula*'s distribution in the future Delta may limit our restoration options.

Thorne¹, K.M.* , N.D. Athearn², J.Y. Takekawa², S. Ustin³, D. Elliott-Fisk⁴

¹USGS/UC Davis, San Francisco Bay Estuary Field Station, Vallejo, CA 94592

²USGS, 505 Azuar Dr. Vallejo, CA 94592

³University of California, Davis, 233 Veihmeyer Hall, CA Davis 95616

⁴University of California, Davis, 1286 Academic Surge, CA Davis, 95616

kmthorne@ucdavis.edu

Modeling the Effects of Projected Sea-level Rise on Endangered Species of the San Pablo Bay National Wildlife Refuge: An Interdisciplinary Approach

San Francisco Bay salt marshes are critical habitat for endangered species, including the salt marsh harvest mouse (*Reithrodontomys raviventris*) and California clapper rail (*Rallus longirostris obsoletus*). Loss of habitat has been a major factor in the population declines of these species, as over 80% of historic SFB tidal salt marshes have been lost to urban and agricultural development. Salt marshes that remain, as well as planned restoration sites, are further threatened by predicted climate change and future sea level rise. Maintenance of critical habitat is crucial to the success of endangered species management, but it remains unknown how sea level rise may impact the quantity and quality of habitat for these species. This interdisciplinary study uses geographic remote sensing and analytical techniques to address an ecological problem, using elevation models and habitat suitability indices in geographic information system (GIS). Using available remote sensing imagery and LiDAR, this ongoing study will quantify and map the distribution of tidal salt marshes in and around San Pablo Bay National Wildlife Refuge under several different sea level rise prediction values. We will use existing vegetation data combined with species distribution information to assess habitat availability under current and simulated sea level conditions. This project will identify and prioritize non-marsh upland areas that have strong potential for future marsh creation and species habitat areas. This talk will discuss preliminary results and ongoing research objectives.

CALFED Statement of Relevance

The information that is provided by this study is critically needed by the U.S. Fish and Wildlife Service among other groups to address critical species management, conservation, and recovery plans to effectively consider the effects of climate change and projected sea-level rise.

Truan, M.A.

UC Davis, 1 Shields Avenue, Davis, CA 95616

mltruan@ucdavis.edu

Riparian Shreds: Implications for the Maintenance of Biodiversity in Linearly-fragmented Systems

Linear habitat fragments, because of their geometry and placement in the landscape, may display unique ecological patterns and processes not found in two-dimensional fragments. Long, linear habitat fragments are common in developed landscapes, especially in agricultural regions, often providing some of the only habitat available for many organisms. The conceptual model of habitat “shredding” (Feinsinger 1997) may be useful for generating hypotheses and making predictions where restoration and management of linear riparian fragments is desired. Habitat shredding may influence ecosystem flows and attributes at a variety of scales and for a variety of factors such as habitat productivity and nutrient cycling, demographics and dispersal, community composition, invasibility, isolation, edge effects, and ecosystem responses to landscape context. As part of a larger CALFED-funded biomonitoring effort, we collected, compiled, and analyzed data from a gradient of sites and a variety of taxonomic groups to investigate systematic variation along a representative riparian shred (Putah Creek, Yolo/Solano counties). Results from multivariate analyses of this data will be presented and discussed. The potential for ecological patterns and processes to be influenced by factors intrinsic to habitat shredding has particular relevance to restoration and management by establishing the template upon which actions may occur. Further, restoration and management endpoints and success criteria may depend in large part on constraints imposed by a fragment’s shape, convolution, and connectivity and by a site’s specific location along the shred continuum.

CALFED Statement of Relevance

The potential for ecological patterns and processes to be influenced by factors intrinsic to habitat shredding has particular relevance to ecosystem restoration by establishing the template upon which actions may occur. Thinking about restoration in a shredding context may offer new information and insights to improve agency planning and decision making in the Bay-Delta system.

Ujihara¹, A.M., L. Kent¹, I. Hendrickson¹, M. Tan¹, M. Gassel², S. Klasing², R. Brodberg²

¹California Department of Public Health, 850 Marina Bay Parkway, Building P, Richmond, CA 94804

²Office of Environmental Health Hazard Assessment, P.O. Box 4010, MS 12B, Sacramento, CA 95812-4010

alyce.ujihara@cdph.ca.gov

Evaluation of Fish Mercury Advisories: Improving Ways to Relay Complicated Information to the Public

Fishing is a culturally important activity to the ethnically diverse population living in the Sacramento-San Joaquin Delta. Due to historic mercury and gold mining, many fish in the watershed are contaminated with methylmercury, a neurodevelopmental toxin. Fish consumption advisories provide advice to fish consumers on the species and amounts that are safe to eat. Unfortunately, advisory messages are often very complex, resulting in limited awareness and comprehension. Under the CALFED supported Fish Mercury Project, the California Department of Public Health has conducted a variety of risk communication activities around fish contamination issues and the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment has expanded advisories for the Delta, Sacramento River, and other locations. An important component of these efforts has been an exploration of how target audiences perceive sport fish consumption advisories and how these advisories could be improved to increase awareness and comprehension. A qualitative approach using interviews and focus groups was chosen because of the need for in-depth information about beliefs, thoughts, and reactions that influence the decisions and behavior of the intended audiences. Participants included women of childbearing age and fishermen, from diverse ethnicities and income levels. Findings from this evaluation were used to develop a new advisory format for the Northern Delta and Sacramento River advisory. The new format emphasized pictures, rather than text, including a “mercury meter” to convey varying levels of mercury in different fish species.

CALFED Statement of Relevance

CALFED activities to restore ecosystems must consider the public health impacts from mercury in fish. We have improved ways to communicate advisory messages to fish consumers to better inform them of this important public health issue.

Ulrich, P.D.*, D.L. Sedlak
UC Berkeley, Dept. of Civil and Environmental Engineering, Berkeley, CA 94720
ulrich@berkeley.edu

Decrease in Net Mercury Methylation Following an Iron Amendment to Wetland Microcosms

Many wetland restoration projects are planned or underway within the Bay-Delta System, including a commitment by CALFED to restore around 40,000 acres in the Delta by 2030. However, wetlands have been shown to be important sources of methylmercury (MeHg) and there is concern that wetland restoration will increase MeHg loading to sensitive aquatic ecosystems. In recognition of this potential problem, the Delta Basin Plan and mercury TMDL establish a goal of no significant increases of MeHg due to restoration activities, however, restoration and management technologies have not yet been developed to control MeHg production in wetlands. This research tested the efficacy of one such potential control: the application of an iron sediment amendment. The conversion of inorganic mercury (i.e., Hg[II]) to MeHg is predominantly a microbially-mediated process under typical wetland sediment conditions. As a result, the net production of MeHg is controlled by both bacterial activity and the bioavailability of inorganic mercury species to the microbial community. Under reducing conditions typical of wetland sediments, dissolved mercury speciation and concentration is controlled by the presence of reduced sulfur, and it has been hypothesized that the bioavailability of Hg[II] can be decreased by amending wetland sediments with iron. To test this hypothesis, wetland microcosms collected from an estuarine tidal salt marsh in San Francisco Bay were amended with 180g-Fe/m², 360g-Fe/m² and 720g-Fe/m². Net methylmercury production and export from the microcosms decreased by over 90% at the highest iron doses and the effect of iron addition persisted over a period of at least 12 weeks. Further research is needed to assess the potential for using this approach in full-scale wetland restorations.

CALFED Statement of Relevance

By evaluating the efficacy of an iron amendment as a management approach to reducing methylmercury production in wetlands, this study addressed a core component of the CALFED Mercury Strategy. The development of management controls may be necessary to ensure that wetland restorations do not exacerbate methylmercury contamination in the Bay-Delta.

Unger¹, P.A., R. Sitts²

¹WaterWise Consulting, 1421 22nd Street, Sacramento, CA 95816

²Metropolitan Water District of Southern California, 1121 L Street, Suite 900, Sacramento, CA 95814

philip.unger@sbcglobal.net

Survival of Longfin and Delta Smelt Larvae and Potential Effect on the Recent Population Declines

Abundances of longfin and delta smelt have declined substantially in recent years (POD years), but reasons for the declines are poorly understood. Year-class strength of many fish populations is determined largely by survival during the larval stage. An insufficient density of small zooplankton prey, such as rotifers, has often been identified as critical to the survival of recently hatched larval fish. Survival has not been well studied for either longfin smelt or delta smelt, but a reduction in plankton food resources has recently been implicated as contributing to the recent decline in Delta fish populations. This poster presents results of analyses using modeling and statistical techniques, including the Hackney-Webb procedure, to estimate the survival rates of longfin and delta smelt larvae, determine environmental factors, including flow and food supply, potentially affecting their survival, and examine the influence of survival of the larvae on the recent decline of the two smelt populations. Preliminary results indicate very high mortality of delta smelt larvae in recent years.

CALFED Statement of Relevance

An understanding of the survival of longfin and delta smelt larvae, including effects of environmental factors and how survival affects the dynamics of the species' populations, is needed to improve management of the species.

Vasey¹, M.C., J.C. Callaway², E.R. Herbert³, V.T. Parker³, L.M. Schile⁴

¹University of California, Dept. of Environmental Studies, Santa Cruz, CA 95064

²University of San Francisco, San Francisco, CA

³San Francisco State University, San Francisco, CA

⁴University of California, Berkeley, CA

mvasey@sfsu.edu

Shifting Composition of Tidal Marsh Plant Species along a Salinity Gradient in the San Francisco Bay-Delta

Given the prospect of large-scale tidal wetland restoration, understanding complex patterns of marsh plant species composition ranging from Delta freshwater wetlands to the salt marshes of the lower estuary is of critical importance. We present preliminary results of vegetation sampling at ten sites over three years that include remnant historic marshes, old restored marshes, and newly restored marshes along a freshwater to saltwater gradient from the lower Delta to southern San Pablo Bay (Sand Mound Slough, Lower Sherman Island, Browns Island, Rush Ranch, Bull Island, Coon Island, Pond 2A, Petaluma Marsh, Carl's Marsh, and China Camp). A total of 3000 random 3-m diameter plots were sampled at these ten sites. Species in each plot were identified and cover classes estimated. Importance values for ~130 species were calculated for each site based on frequency of occurrence and proportion of total cover. Results reveal clear patterns of dominance for different suites of species in different subregions. For example, *Schoenoplectus americanus* dominates freshwater and brackish marshes in the upper estuary, declines significantly in the brackish marshes of San Pablo Bay, and is missing in the salt marshes of San Pablo Bay. Conversely, *Bolboschoenus maritimus* is absent in the upper estuary, is very important in the brackish and newly restored marshes of San Pablo Bay, and becomes less important in mature salt marshes of San Pablo Bay. This analysis also highlights the high level of species diversity in the upper estuary compared to the lower estuary, including several local endemic brackish marsh species. Insight into species composition in these representative tidal marsh sites will provide scientists and managers with a better understanding of what to plan for in the face of climate change and a greater capacity to set realistic goals for wetland restoration projects.

CALFED Statement of Relevance

These findings support the CALFED objective for ecosystem restoration which, for tidal wetlands, requires an accurate knowledge of plant species composition in representative settings and subregions throughout the estuary.

Veldhuizen, T.C., J. Janik, D.F. Messer
CA Department of Water Resources, 901 P St, Sacramento, CA 95814
tanyav@water.ca.gov

Zebra and Quagga Mussel Monitoring in the California State Water Project

Zebra and quagga mussels pose a serious threat to water delivery systems in California. In eastern North America, zebra and quagga mussels have been shown to have enormous negative economic and environmental impacts. These mussels are harmful fouling organisms and pose a significant threat to water-related infrastructure. California's economy in large part depends on the State Water Project (SWP) which transports large quantities of water across very long distances through a complex and vulnerable system of canals, pipes, reservoirs and pumping stations. In January 2007, quagga mussels were discovered in Lake Mead and have since spread through the lower Colorado River and the Colorado River Aqueduct and associated reservoirs. In January 2008, zebra mussels were discovered in San Justo Reservoir in San Benito County. In response, the Department of Water Resources (DWR) has played an active role in the multi-agency response efforts and has developed and implemented a mussel monitoring program for the SWP. Until mussels become established within the SWP or associated watershed, this program acts as an early warning system. Once mussels are established, the program will guide the selection and application of control measures and enable evaluation of control measure effectiveness. The monitoring program consists of three elements: 1) plankton tows to detect veligers (larval mussels) and spawning events, 2) settlement plates to detect mussel settlement and to quantify mussel densities and growth rates, and 3) flow-through bioboxes to monitor mussel settlement and growth rates within each facility. Depending upon the method, samples are analyzed using either polymerase chain reaction (PCR), polarized light microscopy, or visual enumeration. Monitoring stations are located throughout the SWP from the upper Feather River in Northern California to receiving reservoirs in Southern California. This poster will discuss each method, provide a map of monitoring stations, and show the results of this program.

CALFED Statement of Relevance

The purpose of the SWP Dreissenid Mussel Monitoring program is to provide data for making informed decisions on minimizing the impacts of Dreissenid mussels, the application of effective control measures, and minimizing facility shutdown, so that the SWP continues to provide reliable water deliveries.

Viers¹, J.H., R.A. Hutchinson¹, M.M. Jensen², C.E. Stouthammer¹, A.K. Fremier³
¹Department of Environmental Science and Policy, UC Davis, One Shields Ave,
Davis, CA 95616
²Purdue University
³University of Idaho
jhviers@ucdavis.edu

Sacramento River Riparian Map Validation: A Multi-Tiered Approach

Objective techniques for the validation of geospatial data are needed to better ascertain any inherent error in their use. We used a multi-tiered approach to identify and quantify errors in a map of Sacramento River riparian vegetation from Red Bluff to Colusa. The first tier established a sampling framework of 2500 m² blocks that were randomly selected. For each selected block, riparian vegetation was digitized in ArcGIS (v.9.2) with a heads up display and pen tablet using the same protocol as used to develop the map (i.e., classification and label schema) and same aerial orthophotographs as a backdrop for interpretation. This approach allowed for direct independent comparison of cover type composition, and for tests of bias by river length, distance from water, and floodplain age. The other complementary tiers to validation consisted of three forms of field validation: visual pass, rapid assessment, and intensive sampling. The visual pass consisted of visually inspecting delineated polygons of vegetation and determining accuracy of map labels. The rapid assessment approach implemented the CNPS RA methodology modified to allow deployment of GPS-based data forms. The intensive sampling focused on transects on point bars with varied land-age classes, with extensive geomorphic profiling using real-time kinematic survey. The combined field validation approach allowed for a hierarchical approximation of map validity, ranging from label accuracy to compositional and structural quantification across heterogeneous riverscapes. These data will help resource managers better utilize geospatial data for restoration planning.

CALFED Statement of Relevance

This work is currently funded by CALFED.

Vorster, P.T., C. Swanson

The Bay Institute, 3901 Balfour, Oakland, CA 94610

vorster@bay.org

The Delta Flow Index: A Multi-metric Index to Evaluate Flow Conditions in the Sacramento-San Joaquin Delta

The recent collapse of many Delta fish species has prompted renewed efforts to improve our understanding of the effects of Delta water management on this vital but highly altered ecosystem and its biological resources. As part of The Bay Institute's Ecological Scorecard project, which has already developed a series of multi-metric indices to evaluate and track ecosystem condition and management of the San Francisco Bay Estuary, we developed a multi-metric index to assess annual and seasonal flow conditions in the Delta. The Delta Flow Index uses eight indicators to measure and track changes over time in Delta inflows and outflows, in-Delta circulation, and flow-related ecological conditions. For each indicator, the measured value was compared to "reference conditions" and scored on a five-point scale. The indicators were then aggregated into a multi-metric index, calculated as the unweighted average of the indicator scores. Results are presented both as numeric scores and easily understood letter grades, A through F with an A grade representing relatively low hydrological alteration and good ecological condition. Although the results for the overall Index and individual indicators are significantly affected by the runoff magnitude – generally higher scores in wet years and lower in dry years-, there is a clear downward trend over the past 60 years as the Delta's hydrology has been increasingly altered and runoff removed from the system. The worst scores occurred during the 1987-1992 drought and several years during the 2000s including 2007. The Delta Flow Index appears to be a useful and responsive management and performance evaluation tool, for example, Index results were highly correlated with the abundance of multiple Delta-dependent fish species. The Flow Index is the first in a series of Delta indices that will be developed to assess Delta ecosystem health and management.

CALFED Statement of Relevance

The Delta Flow Index is a useful and responsive evaluation tool for the many proposals to alter Delta flows and conveyance currently being considered by the Delta planning processes that seek to restore ecosystem health and improve water supply reliability.

Walsh, R.G.* , M.A. Truan, A. Engilis, Jr., J.M. Eadie
UC Davis, Dept. of WFC, Academic Surge Bldg., Davis, CA 95616
rgwalsh@ucdavis.edu

Nestbox Trail Facilitates Expansion of Riparian Songbirds and Evaluation of Restoration

Riparian songbirds in California's Central Valley endure a set of challenges all too familiar to those working in the fields of conservation and restoration. The majority of their original habitat has been lost; that which remains is often degraded; and non-native, human-associated species are now ubiquitous members of the local species assemblage. Riparian songbirds are known to be sensitive to changes in habitat at a number of different scales, so it is of considerable interest to track how birds respond to restoration projects as well as natural processes and events. Since 2000, we have monitored a trail of approximately 200 nestboxes along Putah Creek, Yolo and Solano Counties. Eleven species of passerines have utilized these boxes since their deployment. With frequent nest monitoring and a color-banding program, we have been able to track nesting phenology, fledging success, and individual movements. Findings indicate that, as a group, cavity nesters are nest-site limited. Addition of nestboxes has altered community structure and has been tied closely to the recovery of local Western Bluebird populations and to significant increases in the density of House Wrens, Ash-throated Flycatchers, and Tree Swallows. As historically occupied areas are reclaimed, however, issues like predation by black rats, altered landscape processes, and parasitism by brown-headed cowbirds impact reproductive success. Inquiries into diet of nestlings, including relative dependence on aquatic and terrestrial insects, were initiated in 2008. Preliminary results from stable isotope analysis of nestling feathers, puppets, and behavioral observation are presented to highlight the potential research utility of the nestbox platform. Nestboxes simultaneously augment habitat for some species of birds and allow researchers direct access to nests and nestlings. Therefore, they play a unique and important role in understanding and facilitating the recovery of riparian cavity-nesting songbirds.

CALFED Statement of Relevance

This project focuses on the responses of a charismatic, conspicuous group of birds to restoration of riparian woodlands. Inland riparian habitats are an important part of the broader Bay/Delta system, and are themselves areas of particular conservation concern. We hope that by discussing the unique opportunities afforded by nestbox trails, other researchers will consider using them as a tool for looking at contaminants, population structure and genetics, diet analysis, and other lines of inquiry that require working closely with nests.

Wang, J., H. Yin, F. Chung
Department of Water Resources, California, 1416 9th Street, Room 252-36,
Sacramento, CA 95814
wangj@water.ca.gov

Regional Climate “Created” by the Downscaling of GCMs Is Realistic or Not?

With the increasing use of global climate model projection for the next 100 year on water resources planning in the Bay-Delta area of California, downscaling of global climate model projection onto the Bay-Delta area for the use by the water planning model CALSIM2 becomes critical and crucial in successfully evaluating water demand change in the future for the Bay-Delta area due to global warming. Currently, there are two popular statistical downscaling methods, bias-correction statistical downscaling (BCSD) and constructed analogy (CA). Before applying downscaled climate model projection to water resources planning in the Bay-Delta area, it is vital to double-check if these "created" regional climate by downscaling global climate model simulation of the past climate onto the Bay-Delta region is realistic or not. This poster focuses on comparing the downscaled long term mean (1961-1990) monthly streamflow and monthly precipitation from six global climate models and these two downscaling methods with the observed streamflow and precipitation including PRISM data on 18 river locations and 7 Depletion Study Areas (DSAs) in the Bay-Delta region, based on various statistical measures. The result of this comparison will affect how much confidence we can put on each global climate model and each downscaling method while doing water resources planning.

CALFED Statement of Relevance

These results are relevant to the CALFED objectives of understanding water supply reliability.

Weiskel, H.W., E.D. Grosholz
UC Davis, Dept. of Environmental Science & Policy, Davis, CA 95616
hweiskel@ucdavis.edu

Nutrient Loading and Benthic Native-invasive Species Dynamics

The effects of nutrient loading on the success of biological invasions is best understood in terrestrial systems, where studies have generally shown that increased nutrients facilitate the spread of invasive plants. To date, these relationships have remained largely unexamined in marine systems and in higher trophic levels. In addition to excess nutrients, small-scale disturbances caused by invasive species affect ecosystem processes in mudflat communities, potentially creating feedback loops that facilitate invasion. I conducted a suite of lab and field studies to examine the effects of interactions between nutrient loading and invasion-related disturbance by the invasive mud snail, *Ilyanassa obsoleta*, on the native mud snail *Cerithidea californica*, in San Francisco Bay, CA. Where both species coexist, *I. obsoleta* has been documented as competitively displacing the native snail through behavioral interactions. Using a complete factorial design, I experimentally manipulated densities of *C. californica* and *I. obsoleta* as well as nutrient levels to investigate the role of nutrients in invasion success in this system. Response variables included changes to microalgal community composition and snail growth and mortality. Results indicate that nutrient additions increased microalgal biomass on the open mudflat. Native snail growth was significantly positively affected by nutrients ($p < 0.0001$), while invasive snail growth was not ($p = 0.73$). Both species grew most in the low-density, single-species treatments and least in the 2-species (high density) treatments, confirming negative interspecific interactions. Both snail species lowered the diatom biomass at lower sediment depths, while maintaining high diatom biomass at the sediment surface, compared to the controls. The results suggest that the native species responds to the effects of the additional nutrients on diatoms in the open mudflat, while the invasive species is unaffected by shifting nutrient conditions. Nutrient loading impacts may be habitat-dependent and may play an important role in determining invasion success at higher trophic levels.

CALFED Statement of Relevance

My work will inform the CALFED community and resource managers tasked with managing SFB about the relationship between nutrients and invasion dynamics in benthic habitats. A greater understanding of nutrient-species interactions and habitat-specific effects on native species can facilitate better protection for native species and their habitats.

White, A.B., F. Shilling, L. Lippert
UC Davis, Dept. of Community and Regional Development, 7205 Hackman
Road, Dixon, CA 95620
abwhite@ucdavis.edu

Delta-wide Patterns in Subsistence Fishing, Fish Consumption, Mercury Exposure, and Communication Pathways

This presentation will discuss the past year's worth of angler surveying efforts on the Bay/Delta. Focus will be on the process of surveying along with findings from the surveys and ideas for the future focus of surveying and educational efforts. Initial findings include: fish consumption rates vary among the 2 dozen ethnicities, a majority of anglers consume more fish than what the EPA considers safe in terms of mercury intake, and 5% of anglers are estimated to be consuming mercury at 10 times the EPA safe rate. Awareness among anglers of mercury consumption warnings is low and the awareness of health warnings and rate of consumption are not correlated. Finally, subsistence anglers use a wide range of health communication pathways beyond the current educational efforts of placing warning signs at fishing locations. Outreach and education efforts should be reconsidered to include such important findings.

CALFED Statement of Relevance

Education efforts regarding mercury contamination among anglers does not accurately represent the demographic of people dependent on the Bay/Delta as a food source. Understanding the populations and accurate levels of fish consumption is necessary to establish more effective educational tools and more accurately understand who is present on the shores of the Delta. Additionally, sharing information on surveying done by a UC Davis graduate student discusses the important dynamics of researchers seeking information from anglers and seeks to improve existing channels of communication.

Wichman, L.M., H.D. Webb, J.L. Thompson
U.S. Fish & Wildlife Service, 4001 N. Wilson Way, Stockton, CA 95205
lori_wichman@fws.gov

Environmental Influences on Fish Assemblage Distribution of the Sacramento-San Joaquin River Delta

Identifying the spatial and temporal distribution of habitats used by juvenile fishes is an important element in the effective management of riverine populations. The juvenile fish life-history phase is often the most vulnerable to environmental disturbance. Monitoring nearshore aquatic habitats of the Sacramento-San Joaquin River Delta provides a qualitative ecological assessment of fish-community structure and abundance. The objectives of this study were to identify the spatial and temporal distribution of juvenile fishes in the Sacramento-San Joaquin River Delta and to identify significant relations between temperature and salinity and the abundance of species. Sampling was conducted weekly from 2003-2007 using a 15m x 1.2m beach seine within each region. Regions sampled were lower Sacramento River (n = 7 sites), north delta (n = 10 sites), central delta (n = 9 sites), and south delta (n = 9 sites). Relations between abiotic features and community structure and abundance were assessed using Pearson's Correlation Coefficients. Studies show abiotic factors, such as temperature and salinity, relate to nearshore fish-community structure and abundance. Within all regions catch was dominated by non-native inland silverside *Menidia beryllina* and threadfin shad *Dorosoma petenense*. Native species, including Sacramento sucker *Catostomus occidentalis*, splittail *Pogonichthys macrolepidotus*, and unmarked fall-run Chinook salmon *Oncorhynchus tshawytscha* were found to be more abundant in the lower Sacramento River and north delta regions. This study indicates that nearshore habitats in all four regions were primarily used by non-native fishes; however, native species were found in greater abundance in the lower Sacramento River and north delta regions. Having this type of information allows managers to make informed decisions about future restoration projects.

CALFED Statement of Relevance

Ecosystem Restoration: Diversity in juvenile fish communities is a key indicator of the ecological state of the Sacramento-San Joaquin River Delta. Identifying the spatial distribution of habitats used by juvenile fishes is an important element in the effective management of riverine populations.

Wilde¹, J.S., J. Burau², A. Blake²

¹CA DWR, 1416 Ninth Street, Sacramento, CA 94236

²USGS, Placer Hall, 6000 J St. Sacramento, CA 95819

wildej@water.ca.gov

An Overview of the 2008-09 North/Central Delta Regional Salmon Outmigration Study Plan

The field study of out-migrating juvenile Chinook salmon on the Sacramento River in the north and central Delta is planned to be conducted from November 2008 through February 2009. USGS will surgically implant acoustic tags in 5000 juvenile salmon. USGS and USFWS will oversee multiple releases of these salmon into the north Delta under four different Delta Cross Channel gate operations. The latest high technology will be utilized to monitor hydrodynamics and track the fish through the north/central Delta region for the study at two levels: 1) on a regional level to determine path selection and channel survival rate relationships to flows, and 2) on a junction level to determine behavior patterns related to local currents at the Sacramento River junctions at the Delta Cross Channel and Georgiana Slough. USGS will use the data from this study to develop management tools that can be used to better manage current facilities for minimal impact to salmon out-migration as well as estimate impacts of future planned projects to salmon movement in the region.

CALFED Statement of Relevance

The basis for this study is to gain scientific understanding of juvenile salmon out-migration to improve California's water supply through the Sacramento-San Joaquin River Delta while protecting out-migrant survival rates.

Wilkerson, F.P., A. Parker, V. Hogue, A. Marchi, R. Dugdale
Romberg Tiburon Center, San Francisco State University, Tiburon, CA 94920
fwilkers@sfsu.edu

CALFED Foodweb Project: The Interannual Variability of Nutrients and Phytoplankton Nutrient Uptake in the Low Salinity Zone

A collaborative research program was initiated to characterize the foodweb of the low salinity zone (LSZ) of the northern San Francisco Estuary (SFE). Recent declines in both pelagic animals (POD) and phytoplankton abundance in the northern SFE have been documented, although no direct link has been established. To understand the bottom up controls on POD, the availability of nutrients and their use by phytoplankton for growth was evaluated. Nitrate, ammonium, phosphate, silicate, and urea concentrations were measured along with 15-N labeled nitrate and ammonium uptake rates of the phytoplankton, almost weekly during spring 2006 and 2007. These two years were very different climatologically with a very wet spring in 2006 stretching the low salinity zone into Central SFE. Spring 2007 was atypically dry with no pronounced fresh water pulse. The differences in nutrient concentrations and dissolved inorganic nitrogen uptake between these two years and the consequence on the food web will be presented. This will include the interaction of the different forms of dissolved inorganic nitrogen (ammonium and nitrate) and how it affects potential bloom development of phytoplankton in the LSZ. How changing climate may impact future phytoplankton processes and the POD will be considered.

CALFED Statement of Relevance

This study addresses the bottom up controls on the pelagic food web of the low salinity zone and how climatic changes in nutrients and phytoplankton growth may be linked to the POD.

Williams¹, M.W., R. Breuer², D. Denton³, M. Zhang⁴, G. Hoogeweg¹, M. Cheplick¹
¹Waterborne Inc, 897-B Harrison Street S.E, Leesburg, VA 20175

²DWR, Sacramento, CA

³USEPA, Sacramento, CA

⁴UC Davis, Davis, CA

williamsm@waterborne-env.com

Spatial and Temporal Quantification of Pesticide Loadings to the Sacramento River, San Joaquin River, and Bay-Delta to Guide Risk Assessment for Sensitive Species

: A weight-of-evidence analysis is being conducted to identify major sources of pesticide loadings to the Sacramento River, San Joaquin River, and Bay-Delta estuary. The objective of this analysis is to improve decision making and optimize resource spending across a number of federal, state, and regional water quality programs. Objectives are being addressed through a combination of tools, including geographical information system (GIS) analysis, simulation modeling, and an evaluation of existing in-stream monitoring. Results are being used to: 1) provide further knowledge of the fate and transport of agricultural chemicals (e.g., copper, organophosphates) and emerging pesticides (e.g., pyrethroids); 2) match results to the location of sensitive species critical habitats; 3) identify and rank pesticide source areas; 4) evaluate implications of future pesticide use trends and changes in climatic conditions; 5) aid in developing plans to improve ecosystem quality and water quality by strategic placement of BMPs and hydrologic operations; 6) support future monitoring programs (strategic locations, sampling frequency); 7) link results to life cycle models currently under development for striped bass and delta smelt, as well as existing models for (salmonids); and 8) provide a data-link to support other water quality models and population models. This paper provides an overview of study methods and results to date.

CALFED Statement of Relevance

Need to identify hot spots for BMP placement and make informed management decisions to reduce pesticide runoff into waterways.

Williams, P.B., S. Crooks, M.K. Orr
Philip Williams & Associates, Ltd., 550 Kearny Street, San Francisco, CA 94108
p.williams@pwa-ltd.com

An Overview of the Potential for Achieving Large Scale Tidal Wetland Restoration in the Cache Slough System

Attention is focused on the NW delta as offering perhaps the best potential ecological opportunities for restoring freshwater tidal wetlands to counter the ongoing decline of endangered native fish species. In this presentation we shall review the physical functioning of the Cache Slough system with particular reference to geomorphic thresholds that define different future trajectories of system-wide ecosystem evolution. We shall review how the North West Delta functioned historically and the fundamental anthropogenic geomorphic and hydrologic changes that have occurred over the past century. We shall describe opportunities that provide a foundation for restoration in Cache Slough, which include: availability of expansive areas at elevation suitable for vegetation colonization; Available sediment supply; beneficial design approaches to benefit target species, and capacity to restore wetlands resilient to sea level rise. Set against these opportunities are significant constraints on restoration, including: impacts to upstream flood management; energetic wind-wave dynamics associate with large open water bodies with implications for levee erosion and ecosystem evolution; dissolved organic carbon associated with wetland restoration; and response of the Cache Slough channel to large-scale hydraulic change. We shall conclude with conceptual descriptions of potential futures for Cache Slough system.

CALFED Statement of Relevance

This presentation focuses on opportunities and constraints for the restoration of the cache slough system. We will touch upon several of the key themes of the conference including - habitat and ecosystems, flood management, physical processes and integrating science and management. As well as drawing upon local studies we shall draw upon lessons and analysis developed derived other parts of the globe of relevance to restoration and flood management in the Delta

Williamson¹, K.S., R. Phillips², B. May³

¹NOAA Fisheries, NW Fisheries Science Center, Seattle, WA 98112

²Washington St. Univ., Vancouver, 14204 NE Salmon Crk. Ave., Vancouver, WA 98686

³University of California at Davis, One Shields Ave., Davis, CA 95616

Kevin.Williamson@NOAA.gov

Characterization of a Chromosomal Rearrangement Responsible for Producing "Apparent" XY-female Fall-Run Chinook in California

Our goal was to elucidate the chromosomal mechanism responsible for producing 'apparent' XY-female fall-run Chinook salmon. Evaluating the chromosomal changes incurred by XY-females should remove uncertainty regarding whether these fish negatively impact population genetics and persistence and if they are a symptom of genotoxicity experienced by Chinook populations due to exposure to environmental contaminants. Fluorescence in situ hybridization (FISH) and segregation analysis of microsatellites derived from rainbow trout were used to identify the X and Y chromosomes of offspring produced by normal and 'apparent' XY-females. Comparison of FISH staining patterns between the offspring produced by normal and 'apparent' XY-females revealed that the 'apparent' XY-female examined transmitted a "Y-like" chromosome. This result suggests that XY-females are not the result of a Y chromosome to autosome translocation. We were unable to differentiate between two alternative explanations for 'apparent' XY-females, namely, recombination of markers between the sex chromosomes, or a Y chromosome with a dysfunctional or missing sex determining region. The scientific implications of these findings suggest that there is still a great deal to learn about Chinook sex chromosome morphology and that until the salmonid sex-determining locus is identified on the Y chromosome, the specific mechanism responsible for producing XY-female fish will remain elusive. Management implications of the findings suggest that the 'Y-like' chromosome transmitted by XY-female fall-run Chinook salmon does not likely pose a threat to subsequent generations. However, uncertainty still remains regarding whether exposure to environmental contaminants during early development influences reproductive, immunological, or physiological performance at some later life history stage.

CALFED Statement of Relevance

Our project facilitated implementation of the CALFED goal of understanding the relative importance of chemical stressors on population viability and genetic diversity of Chinook. By providing information regarding the impact XY-females have on reproduction, genetics, and thus population persistence, uncertainties influencing management and development of performance measures could be addressed.

Wood, D.M., P.L. Johnston, C.D. McClain, A.E. Holt
Department of Biological Sciences, California State University, Chico, CA 95929
dmwood@csuchico.edu

Long Term Monitoring of Willow and Cottonwood Establishment on Point Bars along the Middle Sacramento River

Riparian forest is a dynamic vegetation type shaped by a complex interaction between fluvial and ecological processes. Channel movement and sediment deposition initiate a succession sequence that begins with the establishment of woody pioneers such as willows and cottonwoods on point bars. However, early establishment does not necessarily lead to mature forest. Fluvial geomorphic forces such as scouring flows and channel migration can eliminate young vegetation from a developing point bar and reset the succession clock. Long term monitoring is thus essential to document the net effect of vegetation establishment and removal over time on point bars. In this field study, willow and cottonwood establishment and relative elevation were monitored in eighteen 1m-wide belt transects at 6 point bar sites along the middle Sacramento River between river miles 172 and 233. Within each site, there was an upstream, midstream, and a downstream transect on the bar. Transect beginning and end points were marked with survey-grade GPS to permit accurate resampling of the same transect across years. Sampling occurred in 2002, 2003, and 2008. Results showed that colonization rate differed among sites, by relative elevation above the river, and by position on the point bar. Most colonization occurred in locations where the relative elevation above the low-flow river was between 1.0 and 1.7m. Downstream transects had a higher colonization rate than did midstream or upstream transects. Narrow-leaved willow, Goodding's black willow, Fremont cottonwood, and arroyo willow were the dominant species. Comparisons among years suggest that removal of vegetation through erosion is significant, although some pockets of early establishment in 2002 have developed into mature willow and cottonwood forest.

CALFED Statement of Relevance

The establishment of pioneer woody vegetation such as willows and cottonwoods on point bars is essential to maintaining a healthy riparian forest ecosystem. Long term monitoring of establishment along the Sacramento River will help river managers in developing a sustainable flow regime.

Workman¹, M.L., J.E. Merz², W. Heady³

¹East Bay Municipal Utility District, 1 Winemasters Way Ste. K2, Lodi, CA 95240

²Cramer Fish Sciences, 636 Hedburg Way, Suite 22, Oakdale, CA 95361

³Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Long Marine Lab, 100 Shaffer Rd, Santa Cruz, CA 95060

mworkman@ebmud.com

Comparison of Wild and Hatchery Origin Steelhead Migration Patterns on the Mokelumne River using Acoustic Telemetry

Steelhead are perhaps the most abundant and widespread native salmonid in California. They are successful because they have adapted to a wide variety of habitats and have flexible life history patterns including both resident and anadromous forms being found within the same populations. Unlike Pacific salmon, steelhead may survive spawning and make repeated migrations. Furthermore, they are relatively easy to propagate, making them one of the most popular planting fish in the state. Even so, many populations have seen dramatic declines over the past half-century and are now listed under the endangered species act. Steelhead once ranged throughout many of the tributaries and headwaters of the Central Valley (CV). Today, the majority of CV steelhead are restricted to nonhistorical spawning and rearing habitat below dams. Naturally spawning steelhead populations have been found in the upper Sacramento River and tributaries below Keswick Dam; Butte, Mill, and Deer creeks; and the Feather, Yuba, American, and Mokelumne rivers. Recent monitoring programs have found steelhead in additional streams, such as Auburn Ravine, Dry Creek, and the Stanislaus River. However, much of the available data suggest that the natural population is continuing to decline and that hatchery steelhead dominate the catch entering the Bay-Delta region. Steelhead are difficult to monitor because they often migrate and spawn during periods of high, turbid waters, over protracted periods and at relatively low densities. Furthermore, juveniles often migrate at larger sizes, making them less susceptible to the most common monitoring techniques. In this study we employed acoustic radio telemetry to compare movement and macro habitat use of Mokelumne River steelhead of wild and hatchery origin and various life stages (>160 mm FL). In winter 2007, we tagged 57 hatchery smolts and released them within the tidal delta. We also tagged 7 hatchery kelts and released them adjacent to the hatchery. Concurrently, we collected 64 wild and residual hatchery steelhead by boat electrofishing, and released them at original capture locations throughout the non-tidal Mokelumne River (within 20 km of Camanche Dam). In the second phase of this study (January through May 2008), we implanted tags in 12 actively-migrating wild and hatchery steelhead captured by rotary screwtrap near Mokelumne River Tidewater. Here, we report information recovered on ten receiver stations deployed from the base of Camanche Dam through tidal Mokelumne River and the station grid located throughout the Sacramento San Joaquin Delta and Estuary.

CALFED Statement of Relevance

Steelhead are important biological components of the Central Valley ecosystem and their abundance is used to judge its ecological health. Our ability to accurately track steelhead behavior, migration, and survival and assess production origin on these parameters has biological, regulatory and operational implications throughout the Bay-Delta system.

Workman, M.L., C. Del Real
East Bay Municipal Utility District, 1 Winemaster Way Suite K, Lodi, CA 95240
mworkman@ebmud.com

Using Acoustic Telemetry to Evaluate Release Strategies on Migration Patterns of Mokelumne River Hatchery Steelhead Smolts

The Mokelumne River Fish Hatchery (Hatchery) has released over 2.8 million smolt steelhead, *Oncorhynchus mykiss*, in the lower Mokelumne River and San Pablo Bay since 1995. However, fewer than 1000 adults have returned to the Hatchery since 1996. We used acoustic tracking of Hatchery *O. mykiss* smolts in an effort to determine if changes in release strategy would encourage survival, ocean migration, and return of these fish to the Hatchery. In 2007, 57 hatchery steelhead smolts were acoustically tagged and released at New Hope Landing in the Mokelumne River Delta. Preliminary results from this effort suggest that the practice of releasing steelhead smolts at New Hope Landing in February may result in low survival. In 2008, acoustic tracking was again implemented to evaluate movements and survival of fish released at alternate locations and to see if type of feed affected migratory behavior. Sites were divided into bay, delta and river releases to provide information on the effects of hatchery smolt release location on survival, straying, and life history strategy (anadromy or residualization). We tagged 100 hatchery smolts and 10 reconditioned hatchery kelts. Thirty-five acoustically tagged smolts were planted with a hatchery release group in San Pablo Bay (Bay), 35 with a hatchery release group at Antioch (Delta), and 30 smolts with a volitional hatchery release and 10 reconditioned kelts in the Mokelumne River near Camanche Dam (River). The volitional release smolts were split into two feeding groups. One group was fed a saltwater ready diet (BioOregon) and the other group was fed regular feed (SilverCup). Data from the existing network of approximately 220 hydroacoustic receivers located within the Sacramento-San Joaquin River system, Delta and San Francisco Bay estuary will be used to determine movement patterns, and survival of the hatchery produced *O. mykiss* from the Mokelumne River.

CALFED Statement of Relevance

This project provides an opportunity to accurately track hatchery steelhead migration paths, and survival. Results of this study could have biological as well as potential regulatory and operational implications throughout the Bay-Delta system.

Wydzga, M.^{*}, L. Harrison, C. Legleiter, T. Dunne
University of California, Santa Barbara, Department of Earth Science; Webb Hall;
BLDG 526, Santa Barbara, CA 93106-9630
wydzga@umail.ucsb.edu

Predicting Bed Mobility in a Simple River Channel: Implications for River Management and Restoration

Two common assumptions of river restoration practice are that: 1) restored riverbed reaches are significantly more mobile than unrestored riverbeds, and; 2) frequent riverbed mobility is essential to a healthy riverine ecosystem. To test these assumptions we must be able to predict the frequency and spatial pattern of bed mobility and the response of aquatic organisms that live on, over, or within the riverbed surface. We developed and tested a bed mobility model in both unrestored and restored reaches of the Merced River. Developing the bed mobility model included four steps: 1) Construction of a hydraulically calibrated 2-D flow model (MD_SWMS) to calculate the patterns of tractive forces exerted on the riverbed surface during various magnitude floods; 2) Measurement of the local resistive forces affecting entrainment of grains composing the riverbed surface such as local grain size distributions, local microtopography, and local riverbed properties (e.g. coarse grains embedded and reinforced by adhesive fine sediments); 3) Placement and survey of painted neon rock tracers ranging with grains ranging in size from 22.6 to 128 mm on the riverbed surface before and after floods; and, 4) Testing the accuracy of our bed mobility model. During a flood with a one year recurrence interval, our results show that the overall modeled tractive forces are lower in the unrestored than the restored reaches (UR: 0.05% of riverbed area local shear stress > 35 Pa; R: 9.5% of riverbed area local shear stress > 35 Pa) and that the resistive forces are higher in the unrestored than the restored reaches (e.g. UR: 45.5% of the local D50's weigh > 2 kg; R: 6.3 % of the local D50's weigh > 2 kg), resulting in a prediction that the unrestored reach will be immobile and the restored reach will be both partially and fully mobile in some areas. The painted rock tracers confirm our predictions and show that the unrestored reach was essentially immobile while the restored reach was somewhat mobile (93%, 7%, and 0% of the unrestored bed area and 65%, 35%, and 5% of the restored bed area was fully immobile, partially mobile, and fully mobile, respectively). Our study not only highlights the abiotic differences between the restored and the unrestored reaches, but does so within a context of a mechanistic understanding of significant bed mobility parameters. Along with tightly coupled biotic studies of benthic macroinvertebrate response and salmonid spawning patterns, our work provides the scientific basis for predicting the impact of channel and flow alteration on riverine abiotic and biotic response.

Zlomke¹, B.E., J.T. Koehler¹, P.D. Blank¹, C.W. Edwards¹, F.N. Knapczyk¹, J.S. Kobor²

¹Napa County Resource Conservation Dist., 1303 Jefferson St., Napa, CA 94559

²DHI Water & Environment, 319 SW Washington St., Suite 614, Portland, OR 97204

bob@naparcd.org

Water for Fish and Farms

This project aims to study the relationships between water use, stream flow, and local steelhead populations, and to work with farmers and biologists to improve low flow conditions for steelhead trout in Napa River tributaries by altering the timing of water withdrawals. Three study streams were selected based on presence of agriculture and steelhead populations. We located six telemetric stream gauging stations at key locations on each stream, to provide real-time low flow information to water users via telephone and internet. We built a comprehensive hydraulic model of one creek watershed to explore changes in timing of surface water withdrawals. We used fisheries monitoring and modeling to explore the relationship between incremental flow changes and fish habitat. We are working with a technical and community advisory committee, consisting primarily of fisheries biologists and land/water management practitioners, to plan community outreach. The telemetric stream gauge sites were successfully established and rated for discharge at low flows in the spring of 2008 and a webpage constructed to display the data on the WICC (Watershed Information Center & Conservancy of Napa County) website. A comprehensive hydraulic model of Carneros Creek, built using the MIKE SHE software, was calibrated using existing flow data and interviews with water users; it was used to explore three scenarios to quantify the effect of current creek pumping and the effects of possible changes in timing of withdrawals. A PHABSIM model of Carneros Creek was used to quantify the habitat value associated with various low flow levels. Our preliminary conclusions are that the current timing of withdrawals for agricultural use is concentrated in the rainy season and appropriately so, since springtime flows are uncertain. Rural residential riparian use may be more significant for fish during low-flow periods and will be addressed in project outreach.

CALFED Statement of Relevance

This project addresses the interface between two of the four CALFED program objectives, water supply and ecosystem restoration. Restoration of the salmonid fishery in the Bay-Delta system requires water, and this project explores the potential for improving fish habitat while preserving water supply for other beneficial uses.