

SERCAL'S 15TH ANNUAL CONFERENCE

Restoration's Bigger Picture:

Linking local restoration to regional and global issues

13-16 August 2008

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Conference
Program

California Society for Ecological Restoration

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SESSION 2 **Michael Hogan**
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SESSION 3 **John Brosnan** *Baylands*
Program Manager, Sonoma Land Trust

SESSION 4 **Bill Trush**
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SESSION 5 **Maximiliano Busnardo**
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SESSION 6. **John H. Bourgeois**
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Dr. Vic Claassen *Research Soil Scientist, UC*
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session I

Considering Climate Change

Chair: **Guido Franco** *Technical Lead for Climate Change Research, California Energy Commission*

Tale of Two Hotspots: Restoration in Conservation Response to Climate Change in Madagascar and Lessons for California. *Dr. Lee Hannah, Senior Research Fellow, Climate Change Biology, Center for Applied Biodiversity Science, Conservation International, Washington, DC; Visiting Researcher, Adjunct Associate Professor, Bren School of Environmental Science and Management, UC–Santa Barbara.*

Habitat loss has claimed over 90% of Madagascar's pristine forests, severely compromising the connectivity of habitats needed for conservation of the island's unique biodiversity. Recent analyses of climate change impacts suggest that major restoration efforts are needed to reconnect riverine corridors that serve as passageways for species' range shifts as climate changes and to reconnect heavily fragmented forests that serve as sources or destinations of species' movements. The costs of this restoration represent a major expense of adaptation of conservation efforts to climate change, that must be communicated to international planning efforts for funding of adaptation. California has many contrasts in land use and wealth to

Madagascar, yet commonalities of restoration response to climate change exist.

Climate Change and Its Potential Effect on Vernal Pool Ecosystems. *Niall McCarten, Hydrological Science Program, Department of Land, Air, and Water Resources, UC–Davis 95616, nfmccarten@ucdavis.edu and Restoration Resources, 3868 Cincinnati Ave, Rocklin 95765, n.mccarten@restoration-resources.net*

Climate models predict that climate change can disrupt existing patterns and the amount of rainfall and cause an increase in temperature based on regional location. Changes in precipitation and temperature would affect the water balance of vernal pool wetlands. Vernal pool landscapes have a complex water balance including surface and subsurface water flows and water loss due to subsurface discharge along an aquitard and from evapotranspiration. My research on vernal pool ecohydrology has provided field data to model the water balance of vernal pools and their surrounding watersheds. These data and models are providing interesting

information on the distribution and abundance of plants along a hydroperiod gradient. For example, many native, endemic vernal pool plants have a non-linear and often narrow distribution while non-native, invasive plants often have a linear, broad distribution along a hydroperiod gradient. Predictions for increased or decreased precipitation can be input into the ecohydrology models allowing us to identify potential changes in plant community structure. Similarly, an input to the water balance model of increased temperature would cause higher evapotranspiration rates. This would result in reduced ponding and perhaps more importantly higher rates of soil moisture loss during the peak growing period. Ecological functioning of vernal pools will probably change in many geographic areas. Mitigation for the continued loss of vernal pools through preservation, restoration, enhancement, and creation will need to account for these climatic changes. Analysis of a variety of vernal pool ecosystems is providing management tools for preservation and restoration.

Restoration Genetics in the Context of Climate Change. *Deborah L. Rogers. Center for Natural Lands Management, 215 West Ash Street, Fallbrook 92028, drogers@cnlm.org.*

Restoration decisions should be guided by not only by management objectives and species ecology, but the genetic diversity within the species. Risks of inappropriately or insufficiently considering the genetic issues of plant restoration include contributing to genetic erosion, undermining local adaptations, creating opportunities for ill-fated hybridizations, and even reducing diversity in co-adapted species. The spatial scales and contexts for genetic restoration vary in wide measure from small restoration projects of locally restricted species, to large natural areas where assisted regeneration is considered desirable after an extreme event such as a flood or fire, or a long-term use such as grazing or wood harvesting. In California, genetic information has long been considered in revegetation decisions for commercially significant forest tree species (e.g., Douglas-fir, coast redwood, many pine species). Understory species—such as grasses, ferns, herbs, and shrubs—have had much less attention. Genetic considerations are just as important to restoration success with these species as with their commercial counterparts. In the context of climate change, such decisions are more important than ever, and also require revisiting classic restoration genetic principles. The presentation will provide the genetic principles and links to reference materials that can serve as a basis for sound genetic restoration decisions. I will emphasize appropriate use of genetic tools and interpretation of genetic information, how to work with suitable proxies in the absence of genetic information, and consideration of risks. The nexus with climate change—including effects on invasiveness and disruption of daylength-temperature linkages—will be discussed.

Biological Impacts of Climate Change in California: From Mountain to Marine Species. *Terry L. Root*¹, Kimberly R. Hall². ¹Woods Institute for the Environment, Stanford University, Stanford 94305. ²Forestry Department and Fisheries & Wildlife Department, Michigan State University, East Lansing, MI.*

Between 1750 and 2007, the average global temperature increased by $\sim 0.75^{\circ}\text{C}$ ($\sim 1.3^{\circ}\text{F}$). The rate of warming is expected to continue escalating throughout the 21st century with a minimum increase of 1.1°C (2°F), and, if we are unlucky, to 6.4°C (11.5°F) or more. With “only” $\sim 0.75^{\circ}\text{C}$ increase species are exhibiting strong changes. The higher and faster temperatures increase the larger the number of species will most likely be pushed toward extinction. California is again leading the other states by actively working to ensure the number of species heading toward extinction will be as low as possible. A group of junior interdisciplinary scientists are investigating the Biological Impacts of Climate Change in California (BICCCA) on several different species or communities. The BICCCA studies included: 1) Using the fossil record to help us understand how California mammals may respond to climatic change, 2) Looking at the effects of changes in snowmelt on bumble bee communities in the Sierra Nevada Mountains, 3) Investigating the impacts of climate change on marine invertebrate prey in the California Current, 4) Examining how climate change is shifting bird species from the desert to the mountains in southern California, 5) Assessing carbon sequestration of native and invasive grasses, 6) Determining how acidification of the ocean might impact purple sea urchins, and 7) Examining climate change impacts on grassland biodiversity. Together this cohort of scientists is working to help us understand the importance of climate change on the status and trends of ecological conditions in California.

Climate Change and Grassland Restoration in California: Coping with Climatic and Biological Uncertainty. *Blake Suttle. Department of Environmental Studies, UC–Santa Cruz.*

Restoration of native plants in exotic-dominated grasslands is a major conservation challenge in California. Native grasses and forbs have suffered steep declines in the past century and a half, as annual species from Europe and Asia have come to dominate most of the state’s grasslands. The balance of competition and extent of invasion in grassland ecosystems are strongly governed by temperature and precipitation, suggesting that directional changes in climate will critically influence efforts to restore native plants. I established a large-scale manipulation of rainfall in a protected Mendocino County grassland to evaluate alternative restoration strategies for native perennial bunchgrasses under different climate change scenarios. I added seeds, plugs, and mature tussocks of *Danthonia californica*, *Elymus glaucus*, and *Elymus multisetus* into replicate plots of exotic annual grassland and subjected the plots to one of three experimental precipitation regimes: an intensified rainy season, an extended rainy season, and ambient rainfall. Over the eight-year experiment, responses to rainfall addition varied widely by age class and species and depended heavily on the seasonal timing of precipitation increases. Establishment from seed was rare for all three species and showed little response to water addition, likely due to concomitant changes in the surrounding communities. Production of exotic annual grasses rose markedly following repeated extensions of the rainy season, and while established bunchgrasses benefited despite this change, new plants could not establish into thickening stands of exotic vegetation. In contrast, survival was high for transplanted plugs and tussocks of all three species across all three rainfall treatments. High survival of established bunchgrass plants across a wide range of climatic conditions and competitive environments suggests that restoration approaches focused on plugs and tussocks will be most robust to changing



session 1 Considering Climate Change *continued*

climate. Transplanted individuals can provide a continual source of propagules to surrounding areas that then recruit during years in which conditions in the physical and biological environment are amenable to seedling establishment. The uncertainty surrounding our understanding of climate change and biological response demands that we seek natural resource protection strategies that are robust to a wide range of conditions and adaptable in the face of unexpected changes.

Ecotones and Vegetation Bands: 70 Years of Vegetation Dynamics in the Sierra Nevada. *James Thorne*¹, *Solomon Dobrowski*², *Ryan Boynton*¹, *Sarah Thrasher*¹, *Jackie Bjorkman*¹, *Hugh Safford*³. ¹*Department Environmental Science and Policy, UC–Davis 95616.* ²*Department of Forest Management, College of Forestry and Conservation, University of Montana, Missoula, MT 95812.* ³*USFS, Vallejo 94592.*

The Wieslander Vegetation Type (VTM) survey provides landcover and vegetation plot data from the 1930s for over 50,000 km² of the central and northern Sierra Nevada Mountains. Comparison of the historic data to modern landcover maps and plots permits assessment of vegetation change by area occupied, by elevation of ecotones, by transition of vegetation types, and by estimates change in forest structure. For map-based analyses, we standardized scales between historic and contemporary maps with a 300m grid. For each grid cell we assigned a majority vegetation type in each time period. We sampled historic temperature and precipitation by month to 40-year averages around 1934 and current time and assigned estimated changes in climate to every cell. We also sampled topographic variables and fire frequencies to the same grids. We used map-based changes in vegetation type area extent, ecotone elevation and a transition matrix to identify changes that could be related to climate change. We present upslope

shifts in the lower edge ecotones for vegetation types dominated by *Pinus ponderosa*, *P. jeffreyi*, *Abies magnifica*, Subalpine conifers and mixed hardwood conifers. Upper edge Ecotone advancing shifts for Sierra Mixed Conifer and Montane hardwood conifers, and retracting shifts for Ponderosa pine, are presented. We also present evidence of expansion of hardwoods in their current elevational belt, an expansion consistent with expected future climate conditions. Many changes measured through use of the historic vegetation maps and climate data that are consistent with future expected climate conditions. We examined whether these changes could be corroborated with measurements using vegetation plots from the two time periods. The plots from each time period were used as samples of the landscape, rather than being revisited. Plots were used to examine elevation distributions of species in each time, and to examine changes in basal area, in 4 size classes.



session 2

Forestry & Public Land Issues: The Science, Practice & Regulations

Chair: **Michael Hogan** *Principal, Soil Scientist, Integrated Environmental Restoration Services, Inc.*

The Presidio—10 years of Restoration Lessons. *Michael Chasse^{*2}, Terri Thomas¹ Sue Fritzke². ¹The Presidio Trust, 34 Graham Street, San Francisco 94129. ²National Park Service, Fort Mason, Building 201, San Francisco 94123, michael_chasse@nps.gov.*

The Presidio is a 1500-acre “island” of biodiversity at the edge of the Golden Gate in San Francisco. Fourteen native plant communities with 15 rare plant species constitute some of the last San Francisco natives in the city. Over the last 10 years, a three agency partnership (Presidio Trust, National Park Service and the Golden Gate National Parks Conservancy) have begun to expand relict plant communities with the guidance of a Vegetation Management Plan. This plan recognizes the value of cultural and natural resources across the landscape. It calls for over 200 acres of native plant community restoration. Volunteers have been crucial to the success of this program. This talk will address the following lessons learned in the Presidio: 1) How to best incorporate volunteers and education programs into the

restoration effort, 2) How to address tree removal concerns from the public and the best outreach strategies, 3) How to work with historic and recreation values to ensure an effective ecological restoration that can really happen, instead of being stopped by outside interests, 4) Ways to identify if restoration efforts are successful and how much they cost, 5) How to work with transportation corridors, residents, and tenants (your neighbors) in a productive and sustainable manner. Following this talk, we will cover on the ground lessons of restoration in the Presidio.

Soil Treatments and Amendments for Sustainable Revegetation of Degraded Sites. *Vic Claassen. Soils and Revegetation Lab, Land, Air and Water Resources, UC–Davis 95616, vpclaassen@ucdavis.edu.*

Degraded soils or substrates often have multiple types and degrees of growth limiting conditions. Soil treatments or amendments typically have multiple types and degrees of influences on these growth limiting conditions. How much of

which type of amendment will be able to rehabilitate different types of sites? Actually, we don’t know either, but this presentation outlines how to identify the approaches that are more likely to regenerate a sustainable, erosion-resistant revegetation community.

Implementing the Tahoe Total Maximum Daily Load (TMDL) Program: Potential, Progress and Promise. *Kevin Drake^{*1}, Mark E. Grismer². ¹Integrated Environmental Restoration Services, Inc., PO Box 7559, Tahoe City 96145, kdrake@ierstahoe.com. ²Hydrologic Sciences, UC–Davis 95616.*

Thirty-six years after adoption of the Clean Water Act, over 40% of assessed waters in the U.S. still do not meet the water quality standards that states, territories, and authorized tribes have set for them. This amounts to over 20,000 individual river segments, lakes, and estuaries. These impaired waters include approximately 300,000 miles of rivers and shorelines and approximately 5 million acres of lakes — polluted mostly by sediments, excess nutrients, and harmful

session 2 Forestry & Public Land Issues *continued*

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microorganisms. An overwhelming majority of the population — 218 million people — live within 10 miles of the impaired waters. States, territories and tribes are beginning to address and set standards for the amount of pollutants that can be carried in a water body without impairment. This program, referred to as the TMDL or ‘Total Maximum Daily Load’ program, is challenging from a number of perspectives. Maximum pollutant loads are difficult and expensive to estimate and implementation of pollutant load reduction projects is problematic. A large part of the implementation challenge is based on the dearth of measured (vs. modeled) data available from on-the-ground treatments, which is critical to ascribing credit for implementation projects. Another challenge is the general lack of understanding of the relationship between upland source control projects and in-stream water quality. This presentation discusses work that is being done under an EPA-funded program to address these information gaps and develop a practical framework for implementation of the Lake Tahoe TMDL in forested watersheds. We will discuss the background of the TMDL program, how the Lake Tahoe program is structured, what information and data have been collected thus far and its implications and usefulness to other TMDL programs.

The Presidio—10 Years of Restoration Lessons on the Ground.

*Mark Frey*¹, Lewis Stringer². ¹The Presidio Trust, 34 Graham Street, San Francisco 94129, mfrey@presidiotrust.gov.*

²National Park Service, Ft. Mason, Building 201, San Francisco 94123.

Building on the overview of the first presentation on the broad lessons learned at the Presidio, we will focus on the nitty-gritty of project implementation and management. We will review some of the key restoration projects over the last decade in the Presidio. Our discussion will focus on three broad habitat types: coastal dunes/dune scrub, serpentine grassland, and riparian vegetation. We

will review a handful of projects in each of these three main areas and talk about the successes and failures of each. Our main focus will be the use of an adaptive management strategy to guide restoration work over the short term at a single site and over the medium term between sites. We’ll talk about planting strategies, public use and perception of restoration, and invasive plant control strategies. Some of the projects we will discuss are former remediation sites with their own unique sets of constraints and opportunities.

Forest Fuels Treatment and Erosion in the Sierra: An Adaptive Approach.

Michael Hogan. Principal, Soil Scientist, Integrated Environmental Restoration Services, Inc., PO Box 7559, Tahoe City 96145, mhogan@ierstahoe.com.

Frequency and intensity of forest fires in the arid west have been increasing over the last 50 years. Recent conflagrations, such as the Angora Fire in Lake Tahoe, have pointed out the need to treat overstocked forests in order to reduce forest fuel loading. While a number of techniques are used including pile and broadcast burning, lop and scatter, mastication, tong tosser, feller buncher operations and others, little is known about the impacts of many of these treatments on water quality. A program is underway in the Tahoe-Truckee region to address this important information gap. This program builds on the successful Sediment Source Control Handbook program, sponsored by the State Water Quality Control Board, available online in draft form at: www.waterboards.ca.gov/lahontan/water_issues/available_documents/carec.shtml As we become increasingly engaged in fire/forest fuels reduction treatment and as water quality impairment becomes a top priority throughout California and the US, we need a process or program that can further our understanding of the interaction between these two important environmental issues. We describe a program which is based on a collaborative as well as scientific approach that engages regulatory and fire agencies, land managers and other stakeholders to

define common goals, directly measure sediment movement as well as soil and vegetation responses to treatments, and use this information to determine the most cost- and environmentally-effective treatments for forest fuels reduction. This presentation will describe the program and its background, the adaptive management process used in the program, the facilitated, cooperative process used and the application of program findings in the Tahoe region and beyond.

The Angora Fire: Causes, Responses, Implications.

Michael Vollmer, Vegetation Program Manager¹, Jerry Dion, Ecologist², Mark Grismer³. ¹Tahoe Regional Planning Agency, mvollmer@trpa.org. ²Integrated Environmental Restoration Services, PO Box 7559, Tahoe City 96145. ³Hydrologic Sciences, UC–Davis 95616.*

In 2007, a major fire began in the South Lake Tahoe area and subsequently burned 3,100 acres (12.5 km²), destroyed 242 residences and 67 commercial structures with over \$141 million in damage. Historical fire data suggest that fires are becoming larger in scope and impact. The Angora Fire, rather than representing an anomaly, is considered a relatively inevitable outcome of the combination of overstocked forests, lack of coordination and consistency by regulatory agencies and residential development in wildland/forested areas. Implications of global climate change as well as uneven forest management mandates suggest that continued threat of this type of fire activity is an uncomfortable reality facing the arid west. This presentation discusses the Angora Fire itself, factors leading up to it, fire-fighting efforts and actions taken following the fire to reduce future fire potential. We also discuss the potential to use fires such as this one as living laboratories that can be used to learn more about fire behavior and fire restoration approaches.



session 3

The Economics of Restoration

Chair: **John Brosnan** Baylands Program Manager, Sonoma Land Trust

Delivering a Project: Cost-Effective Synergies and Strategies of the Sears Point Restoration. *John Brosnan. Sonoma Land Trust, 966 Sonoma Avenue, Santa Rosa 95404, john@sonomalandtrust.org.*

In 2004 Sonoma Land Trust purchased 2,327 acres of ranchland and farm fields along San Pablo Bay and set out to restore over 1,000 acres of tidal and seasonal wetlands across the property. The broad stakeholder group and project team have developed creative and innovative strategies by integrated two or more uses in one action, which ultimately seeks to streamline the restoration timetable and reduce overall costs. The land trust's commitment to agriculture in the Sonoma Baylands region led to establishing a project goal to maintain agriculture in a way that enhanced the natural environment. SLT developed watershed and grazing management plans that propose a rotational grazing program to improve and restore habitats,

allowing SLT to achieve its restoration goals while the cattle ranchers' operation is enhanced. Similarly, SLT is proposing to collaborate with farmers to continue oat-hay production on diked Baylands while enhancing native seasonal wetlands. SLT's project team worked with state and federal agencies to develop a lead-contaminated soil clean up plan that allows for on-site reuse of the material and avoids an estimated \$1 million in removal and disposal costs. Public access is being expanded along the bayfront in southern Sonoma County in conjunction with the development of stronger flood control levees.

How to approach the Carbon Offset Market. *Jeff Hohensee*, Hunter Lovins. Natural Capitalism Solutions, P.O. Box 3125, Eldorado Springs, CO 80025, jhohensee@natcapsolutions.org.*

There is a rapidly emerging carbon offset market, with various offset suppliers concentrated between voluntary and

mandatory markets. The purchase of carbon offsets whether voluntary or mandatory should not be the first step for an individual or company to mitigate their climate impact; instead the focus should first be closer to home. The first step should be to implement energy efficiency as much as is practical, to reduce energy use and lower costs as much as possible. The second step should then be to replace as much of the remaining energy consumption with renewable energy. This can constitute Photovoltaic's (PV) on the roof or the installation of any other renewable energy on an individuals' home, place of business or even a neighboring building. Only after all opportunities in the first two steps have been exhausted, should carbon offsets be considered. It is important to realize all carbon offsets are not created equal. Currently, carbon offsets sold in the voluntary market, though widely publicized have been called into question recently on

continued

session 3 The Economics of Restoration *continued*

environmental and economic grounds, as the effectiveness and price of voluntary carbon offsets vary widely. Mandatory carbon markets are the most reliable, transparent and price effective carbon offsets currently available and the preferred carbon offset.

Economic Considerations for Developing Mitigation Banks.

Brian Monaghan. Marketing Department, Wildlands Inc. 3855 Atherton Road, Rocklin 95765, bmonaghan@wildlandsinc.com.

The presentation will provide a brief overview of the concept of mitigation banking and focus on the economic realities bankers must consider when developing a viable mitigation bank projects. Topics will include proper market analysis, site selection, examining site conditions and the cost of restoration versus mitigation credit yield and the “hidden costs” associated with endowments, long-term maintenance, monitoring and management.

Colton Dunes Preserve—Realization of Profit Opportunities in Conjunction with Habitat Preservation. *Douglas W. Sprague^{*1}, Mari (Schroeder) Quillman^{*2}. ¹Vulcan Materials Company, 3200 San Fernando Road, Los Angeles 90065, spragued@vmcmail.com. ²ECORP Consulting, Inc., 1801 Park Court Place, Building B, Suite 103, Santa Ana 92701, mquillman@ecorpc consulting.com.*

A collaborative effort between Vulcan Materials Company, the U.S. Fish & Wildlife Service, and the Riverside Land Conservancy resulted in the preservation of 160 acres within the highly urbanized area of the Inland Empire of San Bernardino County, California. The Colton Dunes Preserve lies within critical habitat for the federally-listed Delhi Sands flower-loving fly. The agreement reached by these organizations in 2005 provided for a 150-acre mitigation bank, a conservation easement covering the 160-acre area, and the restoration of

native habitat on 40 acres impacted by decades of farming. Site preparation for the restoration of buckwheat scrub on the 40-acre farmed area began in 2007. Long-term management and restoration of the Preserve, which was initially secured by bonding, is funded through the sale of mitigation credits. To date, twenty-eight credits in the bank have been sold. This uncommon collaborative effort between private industry, a federal agency, and a conservation group resulted in a benefit to both the environment and private industry. The parties involved in this collaboration effort were awarded the Governor’s Environmental and Economic Leadership Award in 2006.

The Economic Argument for Restoring San Francisco Estuary Tidal Wetlands. *Christina Toms^{*1}, John Brosnan². ¹Wetlands & Water Resources, Inc., 818 5th Ave., Suite 208, San Rafael 94901, christina@swampting.org. ²Sonoma Land Trust, 966 Sonoma Avenue, Santa Rosa 95404, john@sonomalandtrust.org.*

The San Francisco Bay Estuary restoration community is altering its approaches to tidal marsh restoration projects. Goals for these projects are shifting from the concept of restoring marshes to past conditions, to the view point of restoring these wetlands to help mitigate for future changes associated with sea level rise. An increase in sea level rise of over 6 inches in San Francisco Bay has occurred over the last 60 years and this trend is likely to continue into the future. Presently, over 100,000 acres of the Estuary’s Baylands are diked, which require that bayfront landowners maintain stormwater pumping and levee networks. The restoration of these diked Baylands creates new outboard marsh that provides a physical buffer between a bay and adjacent low-lying communities and infrastructure. These projects also offer opportunities to build stronger levee systems that are better designed to adapt to rising sea levels. Sonoma Land Trust’s Sears Point Restoration Project is a multi-benefit project that includes plans for the restoration of almost 1,000 acres of tidal

marsh along San Pablo Bay. The project design achieves numerous ecological and economic objectives, including a larger, stronger levee that provides wildlife habitat, anticipates and mitigates for sea level rise, and provides improved flood protection for local infrastructure.

Maximizing the Benefit to Cost Ratio of Practitioner-Conducted Restoration Experiments: Basic Concepts of Experimental Design.

Mark A. Tucker. Environmental Science Associates, Inc., 9191 Towne Center Drive, Suite 340, San Diego 92122, mtucker@esassoc.com.

As Past President and Region 5 Director of SERCAL, I have the privilege of judging posters each year at the SERCAL annual conference. Over the last few years there appears to be an increase in the number of posters reporting the results of field and greenhouse restoration experiments. The increase in practitioner-conducted experiments is encouraging and welcomed; however the benefits derived from the results of practitioner-conducted experiments relate primarily to the quality of the experimental design. Designs need not be complex but there are some simple principles of experimental design that should be considered when developing restoration research projects of any size. Experiments that incorporate these basic principles of experimental design are more likely to have the project-specific and industry wide validity needed to advance restoration science. This session will review some basic principles and concepts of experimental design including a discussion of experimental units, evaluation units, response variables, controls, replication, single and multiple factors, and parametric and non-parametric tests. Seeking the advice of a statistician during the design phase of any experimental work is recommended to help ensure the effort and results are a good investment of time and money.



session 4

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Physical Processes & Ecological Response in Stream Restoration

Chair: **Bill Trush** River Ecologist, McBain & Trush

Lesson Learned from Urban Stream Restoration. *Shannah Anderson^{*1}, Matt Kondolf[†], Rune Storesund[‡]. ¹Department of Landscape Architecture & Environmental Planning, 202 Wurster Hall, UC–Berkeley 94720-2000, shannah@berkeley.edu. ²Department of Civil & Environmental Engineering, UC–Berkeley 94720.*

Stream restoration in urban areas has increased in recent decades because of heightened awareness and appreciation for environmental values in addition to recreational, aesthetic, and public involvement benefits. Constrained by encroaching floodplain development and urban runoff, restoration on urban streams poses challenges in design and implementation beyond those of rural landscapes. Urban stream restoration projects are also apt case studies for learning from experience, as they are

typically small in scale, interdisciplinary in scope, and they also interface with surrounding land uses and users. We conducted 20 systematic post-project appraisals (PPAs) on San Francisco Bay Area urban streams. Each PPA documented and analyzed success criteria, baseline surveys, design rationale, and design drawings (where available/applicable). We also conducted field surveys to document landscape change and response. Measurements included cross-section and long-profile surveys, pool-riffle composition, bed material composition, vegetative cover, and stakeholder interviews. We investigated if and how the projects accomplished their objectives ranging from flood control to habitat enhancement to public access and interpretation. We also observed trends across the projects relating to scale, design interventions, and monitoring. We

determined that urban stream projects often have conflicting goals; that inadequate baseline monitoring limits the opportunities for determining restoration successes and failures; that restoration interventions are moving away from traditional “hard” engineering approaches; that stakeholder involvement and education are vital components to successful implementation; and that there is a critical need to consider a broad watershed context as well as ecological integrity and sustainability for planning and prioritizing projects in urban settings.

continued



session 4 Stream Restoration *continued*

Altered Physical River Processes and Site Specific Riparian Restoration in the Face of Climate Change. *Tom Griggs, Senior Restoration Ecologist, River Partners, 580 Vallombrosa Ave, Chico 95926, tgriggs@riverpartners.org.*

Riparian restoration along the large rivers of California is a challenging enterprise because of the extreme alterations of physical river processes. Dams cut-off sediment transport and, along with water diversions, modify the river's hydroperiod such that un-natural flow timing is the norm on most rivers. Add to this list the effects of levees and bank stabilization upon channel form and the cessation of channel migration and you have a river ecology that no longer provides the life-history cues in a timely fashion for most plants and animals that are adapted to it. Planning a site-specific riparian restoration under these conditions must, nevertheless, try to fulfill the ecological

requirements of target riparian plant and animal species. Climate change will add to this ecological confusion or dysfunction. This presentation will suggest design and planting strategies that will result in functional vegetation structure as habitat for target wildlife species. These strategies include 1) planting species from both early and late seral stages of riparian plant communities; 2) installing a dense understory that will "weed-proof" the restoration from invasive species; 3) ensuring that local genetic sources are used for planting.

Has Site-specific Riparian Restoration Improved Watershed Functions and Ecosystem Services?

Michael S. Lennox^{1}, David J. Lewis¹, Randall D. Jackson², John Harper³, Stephanie Larson¹, Kenneth W. Tate⁴.*

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We analyzed riparian restoration trajectory in a retrospective, cross-sectional survey of existing projects. Revegetation sites (n=89) located in mixed oak woodland rangelands were site-specific in design and ranged from 4 to 39 years in project age. Non-restored sites (n=13) were also surveyed where they represented local pre-restoration conditions. We evaluated 36 restoration metrics at each site and used project age to quantify plant community and aquatic habitat trajectories. We used a maximum

likelihood model selection approach to compare polynomial and linear fits to these data. Significant trajectories were found for 16 of 21 riparian vegetation and 11 of 15 aquatic habitat attributes, which were indicative of improvements in multiple ecosystem services and watershed functions (i.e. diversity, pollination, sedimentation, trophic dynamics, carbon storage, nutrient cycling, water quality, flood retention, and habitat refugia). Ten riparian vegetation metrics increased curvilinearly with project age, such as native tree and exotic shrub density, while litter and native shrub density increased linearly. Species richness and cover of annual plants declined over time. Improvements in aquatic habitat metrics, such as increasing pool depth and decreasing bankfull width-to-depth ratio, indicate potential greater abundance of anadromous fish populations at restored sites. We hypothesize that native trees function as “ecosystem engineers” in streams at site-scale revegetation projects and recommend vegetation management 10 years after project implementation to enhance understory diversity (i.e. control of exotic shrubs and/or introduce shade-tolerant native species). This presentation will also explore revegetation practices and spatial factors affecting the recovery of native tree populations.

Restoring Physical and Ecological Processes in an Agricultural Setting.

Kevin Mackay, ICF Jones & Stokes, 2841 Junction Ave., Suite 114, San Jose 94134, kmackay@jsanet.com.

Historic changes in land use and management in the Napa River Watershed have resulted in confinement of the river into a narrow channel, loss of riparian and wetland habitats, accelerated channel incision and bank erosion, and reduction in the quality and quantity of instream habitat for salmonids and other native fish. Because of this ongoing degradation, properties along the 4.5-mile Rutherford Reach of the Napa River have been subject to bank instability and failure leading to the loss of valuable vineyard land, and costly repairs. Additionally, streambank erosion has been identified in Total Maximum Daily Load (TMDL) Program developed by the

San Francisco Bay Regional Water Quality Control Board for the Napa River watershed as a significant source of fine sediments. Over the past 5 years, the Rutherford Dust Society has been working collaboratively with neighbors, and local, state, and federal agencies to develop a landowner-initiated plan to address these issues. This presentation will provide an overview of the Rutherford collaborative planning and design process, and will describe major features of the project including: setting back and rebuilding existing earthen berms to create vegetated buffers between the river and adjacent land use; using biotechnical techniques to stabilize actively eroding streambanks and reduce inputs of fine sediments; and excavating inset floodplain benches and installing large woody debris structures to enhance riparian and aquatic habitats.

Archiving of Restoration Project Information, An Invitation to Collaborate with the NRRSS Database. *Rune Storesund^{*1}, G. Mathias Kondolf, Shannah Anderson².*
¹*Department of Civil & Environmental Engineering, UC–Berkeley 94720, rune@berkeley.edu.* ²*Department of Landscape Architecture & Environmental Planning, UC–Berkeley 94720.*

To improve future practice and learn from our collective experience, archiving and access to documentation for all life cycles (planning, design, construction, monitoring) of restoration projects is essential. A prototype web-based clearinghouse for relevant project information has been developed. Collaboration opportunities in the quest of improving the state of practice for river restoration through case studies is solicited. The National River Restoration Science Synthesis (NRRSS) was a four year research effort to systematically collect and archive river restoration activities in the United States, with one node specifically situated in California. The NRRSS effort resulted in the capture of over 37,000 restoration projects nation wide, with information being obtained primarily through synthesis of existing databases as well as surveys and telephone interviews with restoration practitioners. In California, we compiled an extensive

database of over 4000 restoration projects in the state, conducted telephone interviews with project managers for projects randomly selected from the database in selected categories, and conducted detailed post-project appraisals of 40 restoration projects in California for which some minimum information was available (an effort unique to the California NRRSS node).

The San Clemente Dam Removal: modeling fish migration in a step-pool channel. *Matthew Wickland^{*1}, Andrew Collison¹, Sharon Kramer², Seungjin Baek¹.* ¹*Philip Williams & Associates, Ltd. 550 Kearny St, Suite 900, San Francisco 94108, m.wickland@pwa-ltd.com.* ²*H.T. Harvey & Associates, 983 University Ave, Building D, Los Gatos 95032.*

The San Clemente reservoir on the Carmel River is 90% filled with sediment, and poses a hazard to downstream residents. A group of agencies and stakeholders organized by the California Coastal Conservancy seeks to remove the dam and restore a naturally-functioning river around the site, with a focus on restoring migration conditions for steelhead trout and developing a channel that is geomorphically self-sustaining. Because of the expense of removing 2.5 million cubic yards of sediment, the approach taken by the conceptual design is to divert the Carmel River through a low rock divide into San Clemente Creek, a tributary that bypasses most of the stored sediment before rejoining the Carmel River at the dam. The challenge was to design a channel through this mile-long, high-gradient bedrock and boulder canyon that would allow fish passage and be geomorphically-stable. The conceptual design calls for a boulder step-pool system. Fish passage was addressed by analyzing existing fish migration behavior in the Carmel River, and by performing detailed hydrodynamic modeling of conditions in which fish are likely to migrate through the new channel. For complex projects such as dam removals, such sophisticated tools provide insights into fish migration that simpler fish passage assessment methods can overlook.



session 5

29

Linking Watershed-Scale Planning & Ecological Restoration

Chair: **Maximilliano Busnardo** Associate Restoration Ecologist, H.T. Harvey & Associates

Evaluation of Scale, Perspective and Bottlenecks for Watershed

Restoration. *Frederick D. Euphrat, PhD. Principal Consultant, California State Joint Legislative Committee on Fisheries and Aquaculture, Sen. Patricia Wiggins, Chair.*

Watershed restoration is critical for the protection of native fishes and streams of California, many of which are undergoing profound declines. The loss of fisheries affects commercial, recreational and subsistence users, creating significant economic, social and health impacts on those communities. The loss of stream channel characteristics affects adjacent landowners, recreation, water quality, hydropower and fish. Both of these benefits are emergent characteristics of watersheds, and are linked to impacts including dams, changes in hydrologic regimes, runoff constituents, changes in riparian and upland land management, fishery and hatchery management, in-stream mining and invasive species. Watershed-level restoration can reduce or reverse many of these impacts. Evaluation of watersheds requires varying scales and perspectives representing the different communities of the watershed, including the users of fish and streams, the managers of land and water, and the instream fishes themselves. Each user

group has an associated perspective, time and spatial scale, and bottlenecks for survival. Both consensus-based and watershed-level management requires understanding the needs and perspectives of these user groups to allow inventory, restoration and adaptive management to proceed. This presentation will discuss current issues in watershed restoration and management through contemporary case studies from Northern California.

Watershed Restoration for Baseflow Augmentation—An Alternative to Dams.

*Verna M. Jigour^{*1}, Victor M. Ponce². ¹Verna Jigour Associates, 3567 Benton Street #302, Santa Clara 95051, vjigour@sbcglobal.net. ²Department of Civil, Construction & Environmental Engineering, San Diego State University, 5500 Campanile Drive, San Diego 92182-1324, ponce@ponce.sdsu.edu.*

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 through stream-bank storage has been around for two decades, but has seen limited application. The

urgency of the state's water quantity issues is only exacerbated by the threat of impending climate change. Thus, the time for watershed restoration approaches 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 range, among others, is raised significantly, with altered feedbacks on regional climate, relative to native cover. A 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 among other insights.

Watershed Asset Management Planning: A Unifying Framework for Economically-Driven Ecosystem Restoration. *Mike Liquori. Sound Watershed Consulting, 2201 Melvin Road, Oakland 94602, mike@soundwatershed.com.*

Watershed assessment is recognized as a valuable approach to process-oriented restoration practices. Geographic Information Systems (GIS) tools enable scientists to easily collect, compare and interpret large-scale data. Such interpretations of the genetic mechanisms that support the evolution of watershed features helps us to better understand watershed-scale process functions, leading to more effective restoration strategies. To create a motivating economic context for watershed-based management, we've integrated internationally-recognized asset management methods with watershed analysis. This approach begins by defining hierarchical watershed "assets" (e.g. stream reaches, riparian areas, wetlands, etc) that are structured similar to most GIS architectures. Each "asset" is evaluated through a series of objective indicators that characterize its condition within the watershed. Using triple-bottom-line accounting methods, we can use this information for environmental reporting and costing decision-support tools. When combined with an integrated asset risk evaluation, clearly defined stewardship objectives, and cost-of-service factors, this approach provides a rigorous watershed management framework that has a number of compelling advantages. This watershed asset management planning approach can 1) identify priority management areas and costs for achieving defined stewardship (i.e. management) objectives, 2) establish operational and capital cost requirements over long-term planning horizons (e.g. 50-100 years), 3) establish Net Asset Valuation that integrates natural asset values with traditional capital infrastructure values, and 4) compare the cost and benefits of ecosystem restoration against more traditional engineered approaches to infrastructure challenges. This type of watershed asset management framework can provide a compelling tool for justifying the management case for ecosystem restoration.

Achieving Agricultural Conservation, Flood Management, and Riparian Protection in the Pajaro River Watershed. *Carol Presley. Santa Clara Valley Water District, 5750 Almaden Expressway, San Jose 95118, cpresley@valleywater.org.*

The 1300-square mile Pajaro River Watershed in central California presents abundant opportunity for the integration of efforts aimed to benefit riparian rehabilitation, flood management, water quality, and agricultural viability. The vast amount of undeveloped valley floor and floodplain land in this watershed is, or has historically been, in agricultural cultivation. Therefore, some of the best opportunities for habitat improvement exist on or adjacent to actively farmed lands. Flood management concerns have plagued the lower portion of the watershed for decades. Preservation of the floodplain and its stormwater retention function in the upper watershed was determined to be a significant means to reduce flooding in the lower watershed by the flood prevention authority tasked with determining regional flood management solutions. The Carnadero Preserve is a 480-acre agricultural property located within the floodplain of the upper watershed. The Santa Clara Valley Water District purchased the riparian and more flood prone areas of the parcel for riparian mitigation acreage and habitat enhancement opportunities. The remainder of the parcel is now privately owned but subject to an agricultural conservation easement held by a local land trust. The Pajaro River discharges to the Monterey Bay National Marine Sanctuary which developed a water quality program to address nutrient and sediment Total Maximum Daily Loads (TMDLs). To assist agricultural operations with water quality compliance, a Clean Water Act grant was used to install vegetative filter strips adjacent to surface waters on the Preserve.

Restoring to Scale: Using a Watershed Approach in River and Stream Restoration. *Ajay Singh. Kearns & West, 928 2nd Street Suite 300B, Sacramento 95814, Asingh@kearnswest.com.*

Watershed planning can help guide restoration projects by keeping in mind the ecological and social processes that developed current site conditions. This presentation will use examples from the Sacramento Watershed to describe the importance for large-scale assessments prior to small-scale restoration projects.

Watershed Protection, Resource Conservation, and Beyond: Pioneering Sustainable Practices at Fetzer Vineyards. *L. Ann Thrupp, PhD. Manager of Sustainability and Organic Development, Fetzer Vineyards, Ann_Thrupp@b-f.com.*

In recent years, California winegrape growers have become increasingly involved in the implementation of various sustainable practices, including natural resource conservation, water and air quality protection and other environmental stewardship efforts. Fetzer and Bonterra Vineyards are leading pioneers in implementing sustainable and organic methods, and also contribute to education and outreach to others in the industry. In this presentation, I will summarize examples of practices that are being used at Fetzer and Bonterra Vineyards, focusing methods being used for watershed restoration and biodiversity conservation. The presentation will include results from a study that was recently undertaken with university researchers to analyze and quantify the impacts of habitat conservation practices on insect populations, and watershed management projects that have been carried out with the Resource Conservation District. I will also summarize other related practices that Fetzer has been using for over 15 years, including organic viticulture, energy, water, and soil conservation practices, wastewater treatment and reuse, renewable energy. Fetzer is also active in collaboration with regional efforts to promote "green" approaches. The presentation will conclude with lessons learned and potential impact on other farming systems.



session 6

Tidal Wetlands Restoration: Implications of Sea-Level Rise & Regional Case Studies

Chair: John H. Bourgeois Associate Restoration Ecologist, H.T. Harvey & Associates

Climate Change Impacts on Tidal Wetland Vegetation. *John C.*

*Callaway*¹, *V. Tom Parker*², *Michael C. Vasey*³, *Lisa M. Schile*⁴, *Ellen R. Herbert*².

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Climate change is likely to cause significant shifts in salinity regimes and inundation rates of tidal wetlands, resulting in substantial impacts on the plant community. Climate models predict

changes in freshwater runoff to coastal areas due to reductions in snowmelt and increases in rain, leading to seasonal shifts in estuarine salinities. Increases in salinity during the growing season are likely to reduce wetland plant diversity as freshwater and brackish wetlands are converted to salt marsh ecosystems. In addition, as tidal wetlands become subjected to increased salinity stress, overall rates of primary productivity will decrease. Projected increases in sea-level rise will increase tidal inundation rates. Tidal wetlands can counteract increases in sea-level rise through increased rates of sediment accumulation, although there are limits to the amount of sediment that can accumulate. If tidal wetlands can not keep pace with sea-level rise, they may

migrate inland where they are not surrounded by steep topography or developed landscapes. Under high rates of sea-level rise, tidal wetlands are likely to be inundated and converted to unvegetated mudflats. Restoration sites will be particularly vulnerable to climate change given unpredictable sediment inputs and newly established vegetation that will be particularly sensitive to changes in salinity and inundation. Without vegetation in place to stabilize sediments, large areas could be subject to erosion. Another important feedback mechanism associated with climate change is the reduction in primary productivity causing reduced organic matter accumulation belowground, a critical component to sediment

accumulation rates in many tidal wetlands.

Carbon Sequestration in Wetlands: Examples from the San Francisco Estuary. *Stephen Crooks, PhD. Philip Williams and Associates, Ltd., 550 Kearny St., Suite 900, San Francisco 94108, s.crooks@pwa-ltd.com.*

Coastal wetlands provide a wide range of “functions” of support ecology and benefit human society. Particular interest in carbon sequestration has arisen as it offers a potential mechanism to extract Green House Gas (GHG) constituents from global circulation. However, wetlands restoration does not necessarily lead to a direct reduction in atmospheric GHG levels. Carbon storage and the net balance between GHG (notably CO₂, CH₄ and N₂O) sequestration and emission are spatially variable across the landscape; dependant upon salinity, latitude, ecology, drainage and soil conditions on site, and catchment derived nutrient loading. Using examples from across the freshwater to saline estuarine interface I will review the process of carbon sequestration as well as the potential impacts of wetlands destruction and restoration on GHG wetland-atmospheric flux. I will conclude by placing the state of the science, which includes uncertainties, in a context for environmental management.

Historical Ecology of San Francisco Bay. *Robin Grossinger. San Francisco Estuary Institute, 7770 Pardee Lane, Oakland 94621.*

San Francisco Bay remains the largest wetland area on the California coast, but is also one of the most rapidly urbanized estuaries in the world. Historical analysis of the Bay’s wetlands has been integral to setting regional ecological goals and developing local restoration project designs. We found that prior to development, habitat composition varied dramatically around the Bay, forming distinctive subregional mosaics driven largely by local topography and salinity. Local fluvial inputs overlaid these regional patterns, creating a pattern of smaller “mini-estuaries” within the larger Estuary. While about 85% of tidal

marshland has been lost, a number of other significant Bay-margin habitats contributed to habitat complexity and are almost completely unrepresented today. Reclamation trajectories also varied around the Bay so that some marshlands lasted longer than others — this allowed South Bay marshes to be exposed to large mercury inputs from the adjacent watershed. Reclamation has forced terrestrial land use and habitat functions into the former intertidal areas, while the area of open bay has been relatively unaffected. As a result, while there used to be more than twice as much intertidal habitat as deepwater habitat in the Bay (47%: 19%), the proportion of deep water habitat now exceeds the intertidal (25%: 22%). With accelerated sea level rise and shoreline erosion, the Baylands will find themselves further “pinched” from both sides. However, historical trends suggest that some parts of the shoreline have remained depositional; these areas may be important sites for wetland preservation and shoreline protection.

Mapping and Monitoring for Regional Weed Control. *Ingrid Hogle. Monitoring Program Manager, San Francisco Estuary Invasive Spartina Project, 2560 9th Street, Suite 216, Berkeley 94710, ibhogle@spartina.org.*

The Invasive *Spartina* Project (ISP) is using an interactive GIS map, updated daily with field-collected GPS data, to inform and monitor the results of the ongoing eradication of an invasive cordgrass. The ISP is charged with coordinating and supporting efforts to eradicate all invasive *Spartina* from the San Francisco Estuary. This requires surveying over 38,000 acres of potential *Spartina* habitat and accumulating the recorded location data into a format for immediate use for the planning and implementation of control efforts. We map the locations of four non-native *Spartina* species, two of which have hybridized with our native *Spartina* species. Some of these hybrids are difficult to distinguish from the native, so we also collect and map the location of DNA samples which are used to assist with the identification of these cryptic hybrid species. In this presentation I will

demonstrate our interactive GIS map (using ArcGIS) as well as our mapping techniques — both in the field (using ArcPad and TerraSync) and through interpretation of aerial photography (using ArcGIS). I will describe how we use these two tools to both inform and monitor the results of *Spartina* control efforts around the Bay.

Incorporating Subtidal Enhancements and Public Stewardship Into Tidal Wetland Projects- Improving Restoration Project Outcomes from the Bottom Up. *Marilyn Latta. Project Manager, San Francisco Bay Subtidal Habitat Goals Project, Ocean Protection Council/State Coastal Conservancy, 1300 Broadway, Suite 1300, Oakland 94612, mlatta@scc.ca.gov.*

Tidal wetland restoration projects are being implemented near diverse shoreline communities with thousands of residents living close by, at sites that include subtidal habitats that can be enhanced and protected to benefit multiple species. Community-based restoration is a unique approach that is successfully building broad public support for both tidal wetland and subtidal habitat restoration projects locally and around the country. By involving and training members of the surrounding shoreline and watershed communities, many agencies and non-profit groups are maximizing project potential through partnership building with diverse groups, while increasing the labor resources for hands-on stewardship tasks in the field and in the water. The San Francisco Bay Subtidal Habitat Goals Project is an interagency effort working to establish a comprehensive and long-term vision for research, management, and restoration of subtidal habitats in San Francisco Bay. Many practitioners designing tidal wetland restoration projects struggle to find adequate information to incorporate meaningful enhancements to the subtidal areas of their projects, including shallow water habitats, sloughs and channels, and native shellfish and eelgrass beds. We will look at multiple case studies from projects in San Francisco Bay and other national estuaries, and compare project outcomes from both tidal and subtidal restoration



session 5 Tidal Wetlands *continued*

sites that include volunteer involvement versus those without. Learn about how to design and implement tidal restoration projects with volunteers in mind, valuable lessons learned from other projects, and suggested ways to design your wetland project to enhance habitat for multiple species, from oysters to pipefish to Bay Area residents.

Update on the Effort to Eradicate Invasive *Spartina* from the San Francisco Estuary. *Peggy Olofson*^{#1,2}, *Erik Grijalva*², *Drew Kerr*², *Ingrid Hogle*², *Jen McBroom*^{1,2}. ¹*Olofson Environmental, Inc.* ²*San Francisco Estuary Invasive Spartina Project, 2560 9th St., Ste. 216, Berkeley 94710.*

The California Coastal Conservancy initiated the San Francisco Estuary Invasive *Spartina* Project in 2000 to address threats to wildlife habitat and other important tidal marsh functions posed by introduced species of invasive cordgrass (*Spartina* sp.) in the Estuary. With an operating budget of \$1.5-\$2.5 million per year, the project encompasses over 38,000 acres of potential *Spartina* habitat in nine counties, and prepares plans and coordinates grants and

permitting for 12 regional partners. After four years preparing plans and documents for compliance with state and federal environmental regulations, the project began intensive regional control efforts in 2005. By the end of 2007, the population of invasive *Spartina* had been reduced by nearly 75 percent, and many treated areas had begun to revert to native marsh or open mudflat. The project is now on schedule to complete primary eradication by 2012; however, achieving this goal is complicated by the presence of an endangered bird species, by the hybridization of the primary invasive *Spartina* species with the native cordgrass, and by the desire of many dedicated wetland restorationists to move forward with new tidal marsh restoration projects before invasive *Spartina* is eradicated from nearby areas. The *Spartina* Project has taken a number of innovative steps to address these and other potential problems, to ultimately achieve regional eradication of this aggressive invader within a remarkably short period of time. This presentation will highlight control techniques and results, and discuss the project's approach to some of the many challenges it faces.

Planning Wetland Restoration with Sea Level Rise. *Michelle Orr, P.E. Philip Williams & Associates, 550 Kearny Street, Suite 900, San Francisco 94108, m.orr@PWA-ltd.com.*

Restoration planning efforts are increasingly recognizing the importance of anticipating accelerated sea level rise early in the planning process. Recent regional restoration planning in San Francisco Bay focuses on explicitly acknowledging restored habitats as dynamic, evolving in response to sea level rise over time. Since the landward movement of tidal marshes with sea level rise — termed “coastal rollover” — is typically restricted by human development at the landward edge, land acquisition for restoration has prioritized not just immediately restorable areas, but also preservation of the undeveloped upland edge. Current recommendations are to plan for a reasonable rate of sea level rise, and also have a back up plan so restoration is resilient to greater rates of rise should these occur. Adaptive management has become more developed as a key element in managing for resiliency. The most ambitious — and critical — restoration planning efforts

take a regional perspective, treating sediment as a regional resource and managing the shoreline to balance wave sheltering, protection of infrastructure, and healthy erosion for sustainable marsh and mudflat habitats.

Is the Timing Right for the “Invasive *Lepidium* Project”? *Renee O. Spenst, Ducks Unlimited, 3074 Gold Canal Drive, Rancho Cordova 95670, rspenst@ducks.org.*

The high number of non-native species and the scarcity of resources for control elevate the importance of thoughtful invasive species management for preserving the integrity and biodiversity of natural areas. Early control and eradication efforts are essential for

maximizing the likelihood of success, but are typically no longer realistic for well-established invaders. Commonly known as perennial pepperweed, *Lepidium* is a rapidly spreading non-native species that is invading San Francisco Estuary’s tidal wetlands. The Invasive *Spartina* Project has spearheaded an effort to remove invasive *Spartina foliosa* x *alterniflora* hybrids from these habitats and has been highly successful, raising the question of whether a similar approach could be used to control *Lepidium*. The length of time of invasion and species biology and ecology emerge as challenges to this approach. *Lepidium* occurs in every state west of the Rocky Mountains and has been spreading through the Midwest and Northeast. *Lepidium* is a disturbance-associated species with broad

environmental tolerance that is ideally suited to freshwater riparian, seasonal and tidal wetlands. It also proliferates under a more restricted subset of saline conditions. Seeds are highly viable and may remain so after multiple growing seasons. Extremely small root fragments also serve as propagule sources. Species biology and ecology, coupled with the constant influx of propagules from outside sources make large-scale eradication highly unlikely. This suggests that the “Invasive *Lepidium* Project” is best led at a local level where site-specific ecology can be integrated in control efforts, combined with regional cooperation to minimize the threat of reinvasion.



Poster Session

Posters will be on display for duration of conference.

Evaluating the Potential for Spread of an Invasive Forb, *Limonium ramosissimum*, in San Francisco Bay Salt Marshes. Gavin Archbald^{*1}, Katharyn Boyer². ¹Biology Department, San Francisco State University, 1600 Holloway Avenue, San Francisco 94132. ²Romberg Tiburon Center For Environmental Studies, 3152 Paradise Drive, Tiburon 94920.

Invasive species threaten the ecological integrity of San Francisco Bay's remaining salt marsh habitat and the success of salt marsh restoration efforts. In 2007, Algerian sea lavender (*Limonium ramosissimum*), a salt-tolerant forb known to invade marshes in southern California, was discovered in eight restored and disturbed marshes in San Francisco Bay. While this suggests the plant can invade marsh restoration sites, the environmental factors that limit and promote spread, and the plant's capacity to invade undisturbed marshes is unknown. To determine this, I am locating and mapping Algerian sea lavender populations. I am also surveying three invaded marshes to determine where, along an elevation gradient, the invasive plant is found. Results will indicate whether the plant is associated with specific soil properties and where the plant grows and reproduces fastest. In

addition, I will conduct a greenhouse experiment to test how salinity, soil moisture and competition with native plants, three factors known to structure marsh plant communities, impacts sea lavender seedling germination and growth. Finally, because Algerian sea lavender seeds likely spread to new locations via bay water, I will investigate the plant's dispersal potential by testing whether seed germination decreases with exposure to bay-wide salinities over days or weeks. The results of these experiments will help determine if both natural marshes and restored marshes are at high risk of invasion and where, both within marshes and within San Francisco Bay, invasions are most likely to occur.

Vernal Pool Creation, Preservation and Long-Term Management on Northern Vernal Pool Hardpan Soils, Butte County, California. Brook R. Edwards*, Riley Swift, Lucas Piper. Restoration Resources, 3868 Cincinnati Avenue, Rocklin 95765.

To mitigate for impacts caused by the Federal Highway Administration's Butte County Highway Improvement Project, we developed and implemented a vernal pool Habitat Conservation and Development Plan (HCDP) that involved vernal pool preservation and creation, as

well as creation of seasonal and perennial wetland features. Development of the plan involved extensive biological and topographical studies to maximize the hydrologic and biological success of the created pools. Studies included a soils survey to assess depth to hardpan, creation of a one-foot topography map and development of a hydrological model to assess how created vernal pools would potentially alter site hydrology. At each proposed vernal pool creation site a small pit was dug to determine clay content of the soils and depth to hardpan. When the proper soil conditions were found, topsoil was removed and stock piled and the vernal pool basin was then excavated, with the margins graded to match the existing topography. Soil and seed inoculum collected at the impact site was then applied to the created basin and finally stockpiled topsoil was reapplied to the disturbed basin margins. During the course of the project we created 29.08 acres of vernal pools, 5.51 acres of seasonal wetland and 1.06 acres of riparian wetland, and we preserved over 16 acres of natural vernal pool/swale complex, 43.88 acres of seasonal wetland and freshwater marsh, and over 339 acres of upland grassland. In addition, we implemented a long-term adaptive management plan and placed all created and preserved habitats under a conservation easement, protecting the site in perpetuity.

Using a Watershed Plan to Facilitate Restoration and Resource-based Land Use Planning—Alder Creek Watershed Assessment and Management Plan Project. Kim Fettke*, Debra Bishop. EDAW, 2022 J Street, Sacramento 95811, kim.fettke@edaw.com.

The Alder Creek watershed is approximately 40% developed. The City of Folsom and Sacramento County plan to develop the remaining 60%, which will result in the conversion of nearly all the watershed area to urban and suburban land uses. The Alder Creek Watershed Assessment and Management Plan project provides an opportunity to

encourage the use of resource-based land use planning and to incorporate plans for restoring habitats degraded by mining and grazing into project designs. The watershed project is stakeholder driven; it is funded by a DWR grant, the City of Folsom is the lead agency on the project, and Sacramento County and landowners are participants in the preparation of the watershed plan. In addition, the plan is being prepared concurrent with land use plans. This structure and schedule allow a collaborative approach to watershed and restoration planning and provide the opportunity to incorporate restoration and resource preservation recommendations into land use plans. Also, because recommendations included in the watershed plan are not restricted to regulatory standards, the plan provides an opportunity to encourage restoration and development goals that exceed minimum regulatory requirements. These opportunities will minimize the potential for development-related watershed degradation, help restore natural watershed functions and habitat, help improve post-development water quality conditions, and reduce the likelihood that costly watershed restoration efforts will be needed in the future. Example development recommendation: “Preserve natural meanders through waterways, and include an appropriate diversity of geometry and alignment in constructed and/or restored drainage features.”

Use of GPS and GIS Technology to Monitor Regional *Spartina* Eradication.

*Ingrid Hogle, Monitoring Program Manager, San Francisco Estuary Invasive *Spartina* Project, 2560 9th Street, Suite 216, Berkeley 94710, ibhogle@spartina.org.*

The San Francisco Estuary Invasive *Spartina* Project uses global positioning system (GPS) and geographic information system (GIS) technology to map the location and monitor the effects of invasive cordgrass control efforts around the Estuary. We use high-accuracy GPS units in the field to record and relocate *Spartina* populations and permanent monitoring plots. We use GIS in the office to visualize, query, analyze

and map *Spartina* populations and their control. Here we present examples of how we use this technology to meet our project’s mapping and monitoring needs.

Monitoring an Endangered Rail while Restoring Tidal Habitat.

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The San Francisco Estuary, home to the endangered California clapper rail, is threatened by the spread of a non-native hybrid cordgrass, *Spartina alterniflora* x *foliosa*. In 2005, the Invasive *Spartina* Project began a coordinated bay-wide effort to eliminate the invasive weed from the Estuary. To monitor the effects of non-native *Spartina* removal on the California clapper rail, a consortium of five organizations conducted annual breeding season surveys from 2005 to 2008 at 60 sites, spanning six regions in the San Francisco Bay. We indirectly assessed the impacts of *Spartina* treatment on clapper rail populations in the Bay by estimating rail abundances across three years of *Spartina* treatment. Annual abundance estimates were calculated for each site and summed by region. A trend line was calculated for each region and for all sites combined (bay-wide). We found that during the first three years of the study, bay-wide clapper rail populations appeared to be stable or increasing (mean slope = +1.34). However, the call count survey numbers from the most recent season (2008) seem suppressed from previous years. Multiple factors—including an oil spill, an avian cholera outbreak, and a stormy January—may have contributed to this apparent decline. Further analysis and monitoring are required to evaluate the long-term trend of California clapper rail populations during *Spartina* eradication in the San Francisco Bay.

***Ludwigia* Control as a Precursor to Wetland Restoration: Progress and Challenges.** *Julian A. Meisler. Laguna de Santa Rosa Foundation, P.O. Box 7886, Santa Rosa 95407, julian@lagunafoundation.org.*

The aquatic weed *Ludwigia* is an increasing threat in California’s freshwater wetlands and has invaded significant sections of the Laguna de Santa Rosa in Sonoma County, CA. The invasion is symptomatic of watershed-level perturbations including channel modifications, nutrient and sediment loading, summer water runoff, and removal of riparian vegetation. In a collaborative effort with multiple agencies, the Laguna de Santa Rosa Foundation recently completed a three-year effort to control the plant in two of the Laguna’s most heavily infested areas. The program employed herbicide application followed by mechanical removal of the biomass. The results have been mixed and appear to be closely related to water depth and period of inundation. Better understanding of effective control measures is needed before attempting large-scale wetland restoration.

Water Quality and Stream Morphology Monitoring Model.

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The California Regional Water Quality Control Board (RWQCB) has implemented new monitoring requirements for mitigation projects involving the creation of ephemeral stream channels. To better quantify water quality and dynamic equilibrium of created ephemeral stream channels, the RWQCB is implementing 10 year mandatory monitoring periods for applicable projects. Required monitoring parameters include quantification and characterization of channel stability or instability, wildlife habitat suitability within the system, and water quality. To address these new monitoring requirements Dudek has developed a



Poster Session *continued*

Water Quality and Stream Morphology Monitoring Model (WQSM). The WQSM includes adaptable methods of data collection and quantification which apply a classification system of natural rivers. Data are generated through direct physical measurements, water sample collection and testing, and a customized rating scale that is based on RWQCB permit requirements and metrics of individual stream channels. We have successfully applied this WQSM approach, adapting the model to individual projects to meet the new RWQCB monitoring requirements.

A Phytosociological Approach to Comparing the Plant Communities Between Constructed and Natural Vernal Pools at the Wurlitzer Ranch in Chico, CA. *Cristy Owens, Restoration Resources, 3868 Cincinnati Avenue, Rocklin 95765.*

Most vernal pool mitigation criteria are focused on assessing creation success on a whole-pool basis. However, research by Barbour and his associates suggests that each vernal pool houses two or more plant communities and that the combinations of these are locally unique

to a few vernal pool regions. Barbour et al. (2007) created a California statewide vernal pool classification system (SWVPS) based on full floristic inventory. This study aims to compare plant communities between constructed and natural vernal pools at the Wurlitzer Ranch in Chico, California with respect to distribution, relevé characteristics (e.g. native plant richness, total biomass, native plant cover), and the SWVPS. Within-pool samples of plant communities in constructed and natural pools were sorted into six communities and

analyzed for differences in relevé characteristics between constructed and natural pools, between communities, and between local variants of the same statewide association. The results of this study show significant differences in the combinations of constructed and natural relevés among the six plant communities and between certain relevé characteristics of constructed and natural pools. However, the six plant communities fell into three associations of the SWVPS and one locally distinct plant community. Two of these associations were comprised of two variants each that sorted out between constructed and natural relevé dominance. The locally distinct community did not fall into any established association or alliance of the SWVPS and it typically occurred in created pools. Created pools can also contain a community type not previously on site that contain rare taxa (e.g. *Limnanthes floccosa* ssp. *californica*).

Relationship of Soil Duripan Depth to Topography and Geologic Formation in Vernal Pool Complexes at Beale Air Force Base, Yuba County, CA. *Steve Leach¹, Dina Robertson*¹, Jeannie Stamberger¹, Jocelyn Beaudette¹, Jan Novak¹, Lorena Solorzano-Vincent¹. URS Corporation, 1333 Broadway Street, Suite 800, Oakland 94612, Dina.Robertson@urscorp.com.*

Beale Air Force Base (AFB) covers 9,500 ha in the northern Sacramento Valley of California. The AFB contains extensive vernal pool complexes that support special-status species including vernal pool fairy shrimp and vernal pool tadpole shrimp. Vernal pool formation is due in part to a soil duripan layer that restricts water flow and perches water for several months of the year. Several geomorphic types at AFB contain a restrictive soil duripan layer, including the Laguna, Riverbank and Modesto formations. The depth to the duripan layer on these geomorphic formations is relatively unknown, as is the relationship of duripan depth and topography within and adjacent to vernal pool complexes. Having this information would aid the AFB in the design and location of any projects that may encounter the soil duripan, such as the installation of fences and underground cables. Alteration of the duripan could result in changes to vernal pool hydrology and loss of endangered species habitat. This study quantified soil duripan depth in and adjacent to vernal pool complexes on the Laguna, Modesto and Riverbank geomorphic formations at the AFB. Depth to duripan was measured within vernal pools, swales, adjacent uplands and mima mounds. On all three formations, the depth to duripan ranged from 3.6 inches to greater than 47 inches. There was no significant relationship between duripan depth and geomorphic formation type. There was a significant relationship between depth to duripan and location within a vernal pool complex and adjacent upland habitat. Duripan depth, or thickness of overlying soil layer, was deepest on mima mounds and adjacent uplands and shallowest within vernal pool swales and pools.

El Sobrante Landfill Revegetation Project: Experimental *Dudleya multicaulis* Habitat Restoration.

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Ecologically responsible management of post-consumer waste is both a local and a global challenge. RECON Environmental has partnered with Waste Management at the El Sobrante Landfill in Riverside County to both restore native habitat on closed landfill slopes and to recreate habitat for a rare plant, *Dudleya multicaulis*, in the El Sobrante Open Space preserve. Successful landfill slope revegetation will restore habitat for the protected Coastal California Gnatcatcher and Cactus Wren. We are applying an ecosystem-based study of the unique ecology of *Dudleya multicaulis*, including rare plant surveys, site specific seed collection, propagation, plant salvage, restoration site maintenance, and qualitative and quantitative monitoring, to re-establish this endemic species in the El Sobrante preserve.

Ecological Solutions in Solid Waste.

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The landfill environment is traditionally one of the best examples of where society's needs and nature's equilibria collide. Is it possible to reconcile the demands of the native ecosystem with those of increasing urban and suburban populations in a place as cramped for resources as Orange County? Although the primary responsibility of OC Waste & Recycling is to manage solid waste for the residents of the County, through the integration of mitigation requirements, voluntary habitat restoration, and conservation easements, we say "yes." The open spaces, creative minds, and financial and natural resources available in the solid waste industry are not taken for granted at OC Waste & Recycling. In restoring a total of 411 acres countywide, impending landslides have been repaired and replanted with native scrub, sensitive plants have been transplanted to spaces to be preserved in perpetuity, poor soil quality has been addressed through the application of recycled green waste, and wildfires have wiped out mitigation sites only to leave them in a recovery stage more fruitful than the first proactive restoration effort. Biological resource protection, enhancement, and mitigation led by two on-site habitat restoration planners, and supported by landfill operations, exemplifies the thoughtful sensitivity to natural resources that is promised in the department's mission statement: "to meet the solid waste disposal needs of Orange County through efficient operations, sound environmental practices, strategic planning, innovation and technology."

Restoring Native Annual Communities in Burned and Unburned Creosote Bush Scrub.

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Invasive annual grasses are a threat to desert shrublands. Their biomass persists throughout the summer, which increases the potential for fire to carry throughout a stand, and they suppress native plants through direct competition. Treatments such as grass-specific herbicide, grass-specific herbicide plus hand-removal of alien forbs, two levels of carbon addition, and soil raking were applied to burned and unburned creosote bush scrub to control invasive annual grasses and restore the native annual community. Treatments were implemented in the fall/winter of 2004, 2005, and 2007, and vegetation was sampled the following spring seasons after treatment. Four study sites in the Colorado and Mojave Deserts were utilized. While all treatments reduced invasive annual grass abundance, only treatments utilizing the grass specific herbicide showed significant increases in native annuals. In addition, timing and amount of precipitation throughout the growing season and the phenological stage of alien annuals at treatment time had a large affect on treatment performance.