Center for Water Resources
Annual Technical Report
FY 2007

Introduction

The UC Center for Water Resources is a multi-campus research unit and a special program within the University of California's Division of Agriculture and Natural Resources. The major function is to support research and extension activities that will contribute to the efficient management of water resources within the state. Meeting the needs of the urban, agricultural and wildlife sections from both water quality and quantity considerations is a goal of the Center. The Center has linkages to faculty on all UC campuses in the UC system and to extension personnel in each of the 58 counties. The Center can be reached by email at cwres@ucr.edu and our web site can be accessed at http://waterreseources.ucr.edu.

The Water Resources Center funded 22 new projects and continued 11 projects for a total of $995,008 with nearly every UC Campus participating.

Research Program Introduction

Investigation of Groundwater Flow in Foothill and Mountain regions using Heat Flow measurements

Fogg, Graham E., and Trask, James C. Hydrologic Sciences Program, Dept. of Land, Air, and Water Resources UC Davis

Temperature in the shallow and deep subsurface was measured at numerous locations in the Tahoe Basin region, using monitoring devices buried in the soil and high-resolution thermometers lowered down wells. A wide range of soil temperatures and well temperature profiles were observed, which are coupled to areal differences in subsurface heat and groundwater flow. Results indicate that infiltration in the mountain-block and at the mountain-front contributes significantly to recharge of adjacent valley aquifers.

Understanding the Spatial and Temporal Patterns of Wetland Evapotranspiration and Primary Production

Michael Goulden Department of Earth System Science University of California, Irvine

Both scientists and the public recognize the importance of wetlands, but understanding of the ecological processes that control the functioning of California wetlands is lacking. We are working at UCI's San Joaquin Freshwater Marsh to understand the ecological controls on wetland carbon, energy and water vapor exchange, and to explain why the marsh's vegetation varies dramatically from one year to the next.

Quantitative PCR Assays for Specific Host Sources of Fecal Pollution in Watersheds

Kathryn M. Ivanetich Department of Pharmaceutical Chemistry, University of California, San Francisco, and Department of Chemistry and Biochemistry, California State University at Chico

The purpose of this study is to develop Quantitative PCR assays for host specific and reference targets and apply the assays to the San Pedro Creek Watershed in Pacifica, CA in order to identify sources of fecal pollution. Year 2 of the project has demonstrated significant progress in assay development and the application to watershed samples. In addition, several sites in the San Pedro Creek Watershed with highly elevated levels of fecal pollution have been identified, and strong collaborative ties for and progress toward remediation efforts have been established.

Nutrient deposition and food web alteration in high Sierran lakes: microbial community response

Dr. John M. Melack, Professor Department of Ecology, Evolution and Marine Biology UC Santa Barbara

Growing evidence for ecosystem-scale impacts to remote lakes of the Sierra Nevada by nutrient deposition and fisheries manipulations demands an understanding of the role of microbes in these systems. Our initial research indicates a remarkably active and diverse natural bacterial community in lakes throughout the region. Landscape analyses of fourteen lake chains have identified how bacterial communities change as water flows through catchments. Using this spatial survey approach, we have successfully defined linkages between bacterial species composition and a host of physical and chemical parameters, including catchment vegetation cover, elevation, and the composition of dissolved organic matter.

Modeling non-point source contributions of host-specific fecal contamination in San Pablo Bay

Stefan Wuertz, Ph.D. and Fabián A. Bombardelli, Ph.D. Department of Civil and Environmental Engineering, University of California at Davis

The present project focuses on coupling microbial source tracking, pathogen analysis, and validated ultrafiltration technology with a solid 3-D modeling approach for a case study of San Pablo Bay. A major outcome of the research project is to provide a tool for decision makers to maximize financial resources.

Nitrate Groundwater Pollution Hazard Index - Provides information for farmers to voluntarily target resources for management practices that will yield the greatest level of reduced nitrogen contamination potential for groundwater by identifying the fields of highest intrinsic vulnerability.

Water Quality Program

The UC Cooperative Extension Water Quality Program seeks to reduce the need for restrictive regulation and, in a manner that maintains agricultural productivity, avoid economic hardship and sustain an economical, safe supply of food and fiber.

Provides modest funding for extension activities related to water quality. Interacts with water quality coordinators in other states. Provides communication linkage between federal water quality officials and farm advisors. Accumulates and publishes activities carried out by farm advisors on water quality throughout California.

On Water Blog at http://blogs.lib.berkeley.edu/wrca.php

Features news, research, and current events on all aspects of water resources. Brought to you by the Water Resources Center Archives and the Center for Water Resources, University of California.

the California Department of Water Resources collaborates with the institute and provides funding with a Master Agreement which currently provides funding for 3 projects throughout California:

1. To prepare a study to prevent reverse osmosis and nanofiltration membrane scaling in the San Joaquin Valley for a total of $198,750.00 with Dr. Cohen at UCLA.

2. To further develop the current Watershed Analysis Risk Management Framework - San Joaquin River model to include the reach from Friant Dam to Lander Anvenue and to develop a free-standing version of the model that can be used for real-time water quality forecasting for a total of $144,495.00 with Dr.Quinn and Dr. Harmon at UC Merced.

3. To further investigate the effects of fertilization and brine shrimp harvest on Selenium (Sd) on drainage water at the pilot-scale drain water system at Red Rock Ranch for a total of $200,000.00 with Dr. Hristova at UC Davis.

Special project for the agricultural water management research program supported by the Prosser Trust. The task force supervised by the Director of the Center, will revisit the leaching requirement for irrigation of the arid zone soils.

Water For Food: Quantity and Quality in a Changing World

World's Faire EXPO2008, Zaragoza, Spain,

The primary objective of the Rosenberg International Forum on Water Policy is to facilitate the exchange of information and experience in the management of water resources. The problems of managing and husbanding water are common problems but approaches and solutions may differ depending upon the financial resources available to address the problem as well as social and cultural norms. Discussions of

alternative approaches and identification of what works and what doesn't should aid in devising more effective and efficient water management schemes.

Institutional Re-arrangements: forging smart use water policy coalitions at the intersection of geo-technical engineering with urban open space

Basic Information

Title:	Institutional Re-arrangements: forging smart use water policy coalitions at the intersection of geo-technical engineering with urban open space
Project Number:	2004CA110G
Start Date:	9/1/2004
End Date:	6/30/2007
Funding Source:	104G
Congressional District:	48
Research Category:	Social Sciences
Focus Category:	Law, Institutions, and Policy, Hydrology, Recreation
Descriptors:	
Principal Investigators:	Helen Ingram

Publication

1. No reports or articles were published during this period.
2. Callon, M. (1986). Some elements of a sociology of translation: domestication of the scallops and fishermen of St. Brieuc Bay. Power, Action and Belief: A New Sociology of Knowledge. J. Law. London, Routledge: 196-233.
3. Latour, B. (1986). The powers of association. Power, Action, and Belief: A New Sociology of Knowledge? J. Law. London, Routledge: 264-280.
4. Latour, B. (2005). Reassembling the Social: An Introduction to Actor-Network-Theory. Oxford, UK, Oxford University Press.
5. Law, J. (1992). "Notes on the Theory of the Actor-Network: Ordering, Strategy, and Heterogeneity." Systems Practice 5(4): 379-393.
6. Law, J. (1999). After ANT: Complexity, Naming and Topology. Actor Network Theory: And After. J. Law. Oxford, UK, Blackwell.
7. Wessells, Anne Taufen. 2007. Constructing Watershed Parks: Actor-Networks and Collaborative Governance in Four U.S. Metropolian Areas. School of Social Ecology, University of California, Irvine. 270 pages.

Principal Investigator: Dr. Helen M. Ingram, University of California, Irvine

This project was conducted to investigate and characterize water policy and urban open space coalitions in four western cities (Denver, Colorado; Los Angeles, California; Phoenix, Arizona; and San Jose, California).

The following talks were based on this research, and given during the reporting period by project staff Anne Taufen Wessells:

Constructing Watershed Parks: Actor-Networks and Collaborative Governance in Four U.S. Metropolitan Areas. Invited Talk, Center for Public Administration and Policy, School for Public and International Affairs, Virginia Polytechnic Institute and State University, Blacksburg, VA, December 4, 2007.

Actor-Networks and Watershed Park Planning. Invited Talk, Seminar Series of the Department of Planning, Policy and Design, School of Social Ecology, University of California, Irvine, November 29, 2007.

Plans as Organizing Actants in the Network-Building of Urban Landscapes. Individual Presentation, Association of Collegiate Schools of Planning conference, Milwaukee, WI, October 18-21, 2007.

Reflections on Organizational Research: Working in Progress. Invited Talk, Capstone Seminar, Center for Public Administration and Policy, School for Public and International Affairs, Virginia Polytechnic Institute and State University, NCR, Alexandria, VA, October 17, 2007.

The Creative Work of Collaborative Governance: Actor-Networks and Watershed Park Planning. Individual Presentation, American Political Science Association conference, Chicago, IL, August 30-September 2, 2007.

Coalitions, Cooperation, and Institutional Change: The Urban Watershed Park. Individual Presentation, "Negotiating Landscapes" Council of Educators in Landscape Architecture conference, Pennsylvania State University, August 14-19, 2007.

Bridging Possibility and Plausibility in Watershed Park Planning. Individual Presentation, Theorizing Ways of Knowing: Beyond Interest conference, Virginia Polytechnic Institute and State University, National Capital Region, Alexandria, VA, May 18-19, 2007.

One student, Anne Taufen Wessells, was supported through funding from this research project. Dr. Taufen Wessells received her Ph.D. from the University of California, Irvine in December 2007, and has accepted a tenure-track position in Urban Sustainability at the University of Washington, Tacoma. Anne Taufen Wessells was awarded the Don Owen Water Science and Policy Fellowship by the Urban Water Research Center at the University of California, Irvine, in Spring 2007. This award was based on the progress of research undertaken as part of this grant project, and resulted in the successful completion and defense of Dr. Taufen Wessells' dissertation, in Fall 2007.

Model Development for Conjunctive Use Planning and Aquifer Protection in Semi-arid Regions

Basic Information

Title:	Model Development for Conjunctive Use Planning and Aquifer Protection in Semi-arid Regions
Project Number:	2005CA137G
Start Date:	9/1/2005
End Date:	8/31/2008
Funding Source:	104G
Congressional District:	30
Research Category:	Ground-water Flow and Transport
Focus Category:	Nitrate Contamination, Management and Planning, Models
Descriptors:	None
Principal Investigators:	William W-G. Yeh

Publication

1. Tu, M-Y, F. T-C. Tsai and W. W-G. Yeh, 2005, "Optimization of Water Distribution and Water Quality by Hybrid Genetic Algorithm," Journal of Water Resources Planning and Management, ASCE, 131 (6): 431-440.
2. McPhee, J. and W. W-G. Yeh, 2007, Groundwater Management using Model Reduction via Empirical Orthogonal Functions, to appear in Journal of Water Resources Planning and Management.
3. McPhee, J., Yeh, W. W-G., Groundwater Management using Model Reduction via Empirical Orthogonal Functions, Journal of Water Resources Planning and Management, ASCE, 134(2): 161-170, March 2008.

Project summary:

In the semi-arid region of the Southwestern U.S., population and economic growth are making increasing demands on the water supply. For example, almost 40% of the water supply in Southern California is from groundwater. To protect groundwater from over-pumping and contamination, there is a critical need to develop surface water and groundwater management tools that can be used to predict water level variations and solute concentrations in the aquifer under different management scenarios. By controlling the total water resources of a region, conjunctive use planning can increase the efficiency, reliability, and cost-effectiveness of water use, particularly in river basins with spatial and temporal imbalances in water demand and natural supplies.

Typical of Southern California, the Warren groundwater basin, located in San Bernardino County, has seen sustained population growth and increased water demands since the 1950's. Since groundwater is the only local source of water supply available, water levels experienced a steady decline of up to 300 ft in some areas between 1956 and 1994. In 1995, the Hi-Desert Water District (HDWD) implemented a recharge program using imported State Water Project (SWP) water and two recharge pond sites. As a consequence, water levels rose up to 200 ft in some areas. However, nitrate concentrations increased drastically, from a baseline level of approximately $10\,mg/l$ to values in excess of $100\,mg/l$. A study conducted by the USGS showed that the increase in nitrate concentrations is due to entrainment of seepage from septic tanks and irrigation, previously stored in the unsaturated zone, by the artificially elevated water table.

The goal of this research is to develop a decision support system (DSS) for sustainable groundwater management, including conjunctive use planning of surface water and groundwater, and aquifer protection. The proposed DSS will encompass a management framework that links simulation to optimization. We will use the geological information and historical data collected by the USGS for the Warren groundwater basin for the development of the simulation model. The developed simulation model will be linked to an optimization model for conjunctive use planning and aquifer protection. Additionally, we will develop algorithms for parameter structure identification, model reliability analysis, data sufficiency evaluation and monitoring network design.

Currently, we have completed the calibration of a flow and transport simulation model for the Warren groundwater basin as well as the development of a management model. The management model is linked with the simulation model by the response matrix and convergence is obtained by iteration. The initial results obtained are quite promising. The simulation-optimization model provides an optimal pump and recharge strategy for conjunctive use of surface water and groundwater for the purposes of removing the high nitrate concentration while maintaining the groundwater levels at desired elevations at specified locations as well as meeting the water demand. We are now collecting more data to test our methodology.

Award No. 04HQAG0001 Spatially Explicit Modeling and Monitoring of Hydroclimatic Extremes: Reducing the Threat to Food Security in the Developing World

Basic Information

Title:	Award No. 04HQAG0001 Spatially Explicit Modeling and Monitoring of Hydroclimatic Extremes: Reducing the Threat to Food Security in the Developing World
Project Number:	2005CA187S
Start Date:	10/1/2003
End Date:	6/30/2009
Funding Source:	Supplemental
Congressional District:	
Research Category:	Climate and Hydrologic Processes
Focus Category:	Drought, Management and Planning, None
Descriptors:	
Principal Investigators:	Andrew Chang, Katheryn Ivanetich

Publication

1. Funk, C. and Brown,. M., 2006, A maximum-to-minimum technique for making projections of NDVI in semi-arid Africa for food security early warning, Int. J. of Remote Sensing. 101. 249-256.
2. Verdin J., Funk C., Senay, G., Choularton, R., 2005. Climate Science and Famine Early Warning, Philosophical Transactions of the Royal Meteorological Society, B. 360. 2155-2168.
3. Husak, Gregory. Methods for Statistical Evaluation of African Precipitation. Ph. D. Dissertation, Geography, University of California, Santa Barbara, Santa Barbara, CA.
4. Freund, Jeremy, Aids for Estimating Crop Area and Production in Kenya: A Multi-Temporal Remote Sensing Approach, M.A. Thesis , Geography, University of California, Santa Barbara, Santa Barbara, CA.
5. Funk, Chris, Jeremy Freund, Mike Budde, Elijah Mukhala and Tamuka Magadzire, 2006, Analysis of MODIS -NDVI for 2000 through 2006. FEWS NET Report. ftp://hollywood.geog.ucsb.edu/pub/AnalysisOfMODIS_NDVIforZimbabwe_JTF4.zip. 8 pages.
6. Funk, C. and J. Michaelsen, 2004: A simplified diagnostic model of orographic rainfall for enhancing satellite-based rainfall estimates in data poor regions, Journal of Applied Meteorology, V43. October, 2004
7. Funk, C., J. Michaelsen, J. Verdin, G. Artan, G. Husak, G. Senay, H. Gadain, and T. Magadazire, 2003: The Collaborative Historical African Rainfall Model: Description and Evaluation. International Journal of Climatology, 23, 47-66
8. Brown, M. & Chris Funk, 2008, Early Warning of Food Security Crises in Urban Areas: the Case of Harare, Zimbabwe, 2007. Submitted.
9. Funk, C., Ederer, G., Pedreros, D. (2008) The Tropical Rainfall Monitoring Mission, NIDIS Knowledge Assessment Workshop: Contributions of Satellite Remote Sensing to Drought Monitoring, Feb 6-7, Boulder, CO, Extended Abstract

10. Funk C. & M. Budde, (2007) National MODIS NDVI-based production anomaly estimates for Zimbabwe, Crop and Rangeland Monitoring Workshop, Nairobi, March 2007. Extended Abstract.
11. Funk, C., Husak, G., Michaelsen, J., Love, T. and Pedreros, D. (2007) Third generation rainfall climatologies: satellite rainfall and topography provide a basis for smart interpolation, Crop and Rangeland Monitoring Workshop, Nairobi, March 2007, Extended Abstract.
12. Husak, G.J. and Funk, C., 2007. SPI Forecasting in the Conterminous United States. American Association of Geographers Annual Meeting: San Francisco, California.
13. Husak GJ, MT Marshall, J Michaelsen, D Pedreros, C Funk, G Galu, 2008. Crop Area Estimation Using High and Medium Resolution Satellite Imagery in Areas with Complex Topography. Journal of Geophysical Research. (Accepted, 2008)
14. Funk, C., Brown, M., Choularton, R., Verdin, J., Dettinger, M., (200-), FEWS NET Climate Change Impact Report, Special Report for USAID (accepted)
15. Husak, G., Michaelsen, J., Funk, C., (2007) Use of the Gamma Distribution to Represent Monthly Rainfall in Africa for Drought Monitoring Applications, Int. J. of Clim. 27(7): 935-944.
16. Brown, M.E., Funk, C.C., Galu, G. and Choularton, R. (2007). Earlier Famine Warning Possible Using Remote Sensing and Models. EOS, Trans. Am. Geo. Union, 88(39): 381 382.
17. Funk, C., Budde M., (2008) Phenologically-tuned MODIS NDVI-based production anomaly estimates for Zimbabwe, Rem. Sens. Env. (accepted, 2008)
18. Brown, M and Funk, C., (2008) Food security under climate change, Science, (319): 580-581.

The Famine Early Warning System Network (FEWS NET) efforts at UCSB this past year have focused on monitoring some of the most food insecure regions of the developing world. In addition to research personnel at UCSB critical scientific contributions and have been performed by the team of foreign scientists stationed in Central America, Africa and Afghanistan.

Significant effort under this grant was used to develop cropped area estimates for Ethiopia, Niger Zimbabwe, Northern Nigeria and Afghanistan where questions about the amount of area being planted and harvested creates large uncertainty in food production estimates and ultimately the number of people facing food insecurity. The cropped area assessments were created using manually interpreted high-resolution satellite imagery along with physical variables such as elevation, slope and precipitation which dictate cropping patterns in these countries. Much work has also been done to develop long-term rainfall climatologies for Central America which can be used with real-time satellite estimates to create gridded rainfall estimates which are used to drive hydrologic and crop models.
Work under the FEWS NET umbrella also supported the development of new computational tools such as the GeoWRSI, which utilizes crop-specific parameters and environmental information to estimate crop yield by assessing how well the crop's growing requirements are being met.
Finally, many resources in this project have been used to perform GIS and remote sensing trainings, and other forms of capacity building in our regions of interest. These efforts have resulted in improved understanding and distribution of FEWS NET monitoring products by placing well-qualified people at national agencies. These people have a working understanding of the impacts that the scientific efforts of our team can have, and they are familiar with our foreign staff, resulting in easy communication with stakeholders and decision-makers in the developing world.

The FEWS NET project at UCSB represents a successful system to develop new scientific tools, have them implemented in a meaningful way, and get the results distributed to influential parties in a timely manner. Our team of domestic and international researchers, and the support of agencies such as the US Geological Survey, the US Department of Agriculture and others, create an environment where new science and applications can have an impact on reducing food insecurity, maintaining farmer incentive, and ultimately saving lives.

Determining factors for Eurasian watermilfoil (Myriophyllum spicatum L.) spread in and around Lake Tahoe, CA-NV

Basic Information

Title:	Determining factors for Eurasian watermilfoil (Myriophyllum spicatum L.) spread in and around Lake Tahoe, CA-NV
Project Number:	2007CA189B
Start Date:	3/1/2007
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	43
Research Category:	Biological Sciences
Focus Category:	Ecology, None, None
Descriptors:	None
Principal Investigators:	Bruce Kendall

Publication

1. Chandra, S. and Wittmann, M., 2007. Invading Lake Tahoe: Dangers of invading organisms. Keep Tahoe Blue News: Summer Newsletter: pg 2.
2. Delong, Jeff. 2007. Tahoe invaders: Non-native species threaten lake. Reno Gazette, 5/5/2007.
3. Wittmann, Marion E., Recreational boating as a vector for invasive species dispersal, Western Aquatic Plant Management Society 27th Annual Meeting, Tahoe City, CA 3/08.
4. Wittmann, Marion E., Pathways for Invasions by Aquatic Species, Invasive Species Workshop, Incline Village, NV 5/07.
5. Wittmann, Marion, E. Boater mediated dispersal of Myriophyllum spicatum in CA-NV. Western Aquatic Plant Management Society, San Diego, CA, 3/06.
6. Wittmann, Marion E., Boater mediated dispersal of an invasive aquatic macrophyte, Eurasian Watermilfoil (Myriophyllum spicatum) in and around the Lake Tahoe Basin, CA-NV. ESA Ecology in an Era of Globalization. Merida, MX, 1/06.
7. Researchers from the USDA Agricultural Research Service assisted with this study: Bob Blank (Soil Science Lab) provides sediment quality analysis; Lars Anderson (Aquatic Plant Research Lab) has provided survey data and culture tanks. The UC Davis--Tahoe Environmental Research Center provided data, facilities, field assistance, and instrumentation. UN Reno researchers provided field assistance.

Rivers, lakes and reservoirs are among the most invaded environments in the world; recreational boaters are a major source of non-native species introduction both within and between fresh water bodies. Boaters use California's waterways intensely, and create significant potential for the spread of non-native species such as Eurasian watermilfoil (*Myriophyllum spicatum*). New aquatic nuisance species (ANS, such as the Quagga mussel) regularly appear in neighboring states, so California's waters are at constant risk of further invasion.

This research investigates patterns of Eurasian watermilfoil spread within Lake Tahoe, as well as to water bodies connected to Lake Tahoe via recreational boating. Lake Tahoe receives a high amount of boat traffic, and is centrally located in proximity to a number of popular lakes in California and Nevada. Eurasian watermilfoil is estimated to have arrived along the south shore of Lake Tahoe during the 1960's and has since spread to numerous locations around the lake.

We are exploring the following: (1) What are the processes of spread within a lake; i.e., is watermilfoil limited by available habitat or by dispersal mechanisms? (2) What other water bodies are Lake Tahoe boaters using? Do they act as potential sources of aquatic invasion? (3) Are there recognizable travel patterns for boaters in this region? What impact do these patterns have on invasion risk? (4) Are boaters aware of damages associated with invasive species?

During the 2005-2006 boating seasons approximately 800 boater interviews were carried out at 7 Lake Tahoe boat launch facilities, collecting information regarding lakes visited before and after present use, travel within Lake Tahoe, invasive species awareness, boat cleaning habits, and vessel inspections for vegetation caught on boats and equipment. A survey of Lake Tahoe for Eurasian watermilfoil and Curly pondweed was carried out with the USDA Exotic and Invasive Plant Unit. Additionally, sediment and water quality testing of 13 popular boating destinations assessed habitat appropriateness for potential colonization. In 2007, similar sediment and water quality assessments were carried out at the top 10 visited water bodies in CA and NV as indicated by the 2005-06 boater interviews. These assessments also included surveys for other high risk invaders such as the New Zealand Mudsnail, Asian Clam, Quagga mussel, and Curly leaf pondweed at waterbody access points.

Findings of these efforts include: Lake Tahoe boaters originate from all over California and Nevada (Figure 1); travel a wide range of distances to use Lake Tahoe and other water bodies (Figure 2); surveyed boaters have previous use on lakes and reservoirs with known aquatic invasive species (Figure 3); 15% of boats leaving lake Tahoe carry invasive plant species fragments on equipment; habitats within Lake Tahoe that are not yet invaded by Eurasian watermilfoil are not significantly different from those that are--suggesting that the invasion is still in progress; Eurasian watermilfoil and Curlyleaf pondweed continue to spread in Lake Tahoe; a majority of Lake Tahoe boaters *never* conduct visual inspection of boats or boating equipment for ANS. For lakes and reservoirs other than Lake Tahoe: a number of California and Nevada lakes contain ANS that have not been previously discovered or reported; at the top used waterways in Northern California and Nevada there are no inspections or barriers to entry for infected boats; sediment and water quality characteristics vary greatly between the 13 sampled waterways—but all surpass minimum thresholds for Eurasian watermilfoil growth as described by the literature; light availability is not limiting factor in any of the surveyed waterways; preliminary analysis suggests that the rate of annual water elevation decrease may prohibit

watermilfoil establishment in some reservoirs. This information has been presented to homeowner's associations, science and management consortiums and published in local newspapers. This work has been mostly carried out by a doctoral student within the School of Environmental Science and Management at the University of California and is in preparation to file as part of a dissertation and for publication within peer-reviewed journals.

Figure 1. County Originations for Boaters Coming to Lake Tahoe

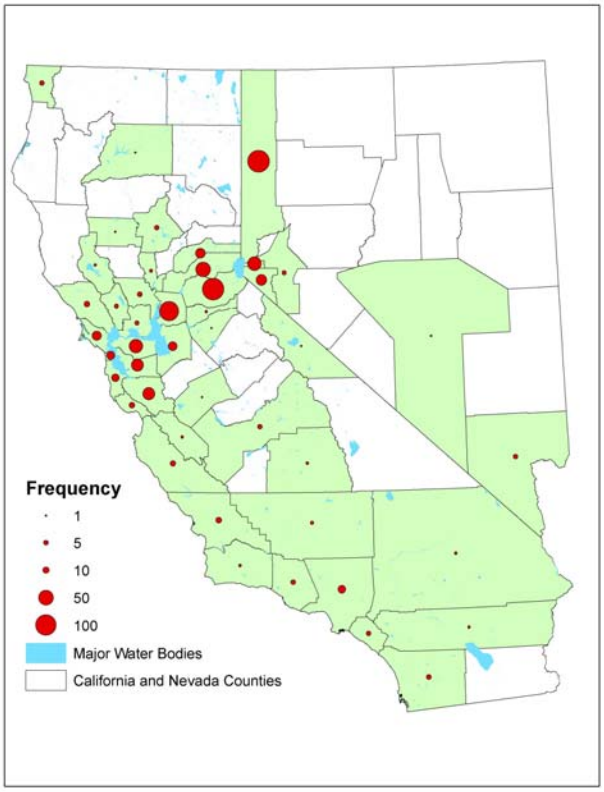
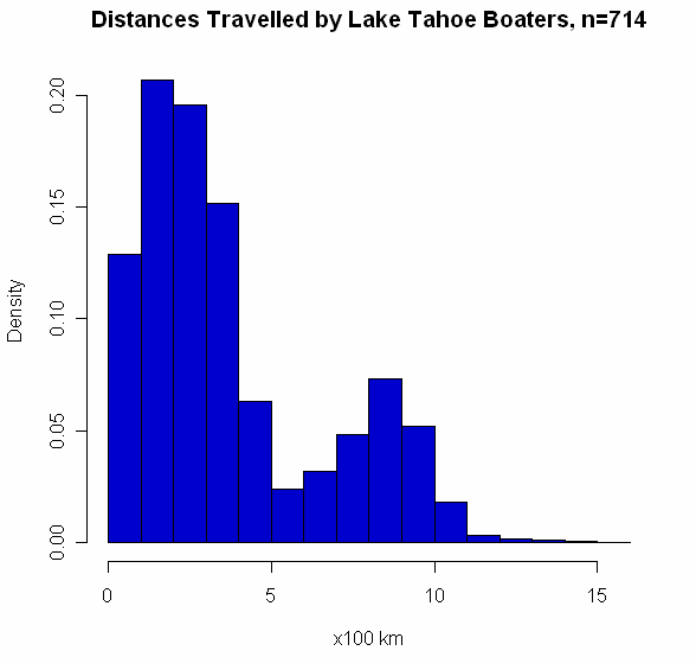


Figure 2.



Investigating the Role of Large Woody Materials to

Basic Information

Title:	Investigating the Role of Large Woody Materials to
Project Number:	2007CA190B
Start Date:	3/1/2007
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	43
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Climatological Processes, None
Descriptors:	None
Principal Investigators:	Gregory B Pasternack

Publication

1. Senter, Anne E. and Gregory B. Pasternack. 2007. Investigating Large Woody Materials to Aid River Rehabilitation in a Regulated California River. University of California Center for Water Resources, University of California at Davis, Davis, CA, 2 pages.
2. Senter, Anne E. and Gregory B. Pasternack. 2006. Investigating the Geomorphic and Ecologic Functions of Wood in Relationship to Habitat Type and Salmonid Redds on a Regulated California River (poster). In Eos Transaction, American Geophysical Union,
3. Senter, Anne E. and Gregory B. Pasternack. 2007. Geomorphic and Ecological Interactions of Large Wood, Pacific Salmonid Reds, and Hydraulic Habitat Units on a Regulated California River (poster). In Eos Transactions American Geophysical Union, 88(52), Fall Meeting Supplement, Abstract H53B-1230.
4. Senter, Anne E. and Gregory B. Pasternack. 2008. Geomorphic and Ecological Interactions of Large Wood, Pacific Salmonid Redds, and Habitat Units in the lower Mokelumne River, California (oral presentation). In The 26th Annual Salmonid Restoration Conference Proceedings, Abstract on page 96.

Methylmercury (MeHg) is a potent neurotoxin that affects both human health and wildlife, and its formation in the anoxic sediments of wetlands has led to mercury contamination in aquatic ecosystems. Elevated levels of mercury, which exists primarily as MeHg in biota, are responsible for over 75% of the fish consumption advisories issued in the United States. Mercury is of special concern in California due to elevated concentrations caused by historical mining practices. The primary objective of this research project is to develop a novel method of restoring and constructing wetlands that will minimize MeHg production in wetland sediments without sacrificing natural habitat potential.

Since the 1780's, California has lost an estimated 91% of its wetland acreage, and it has only been over the past few decades that policy and management decisions have been made to reverse this trend (e.g., the proposed restoration of over 15,000 acres of salt marsh within the San Francisco Bay). Wetlands are extremely beneficial ecosystems to California as they serve as essential habitat for a variety of wildlife species, including the federally endangered California clapper rail, offer flood protection, and improve water quality. However, wetlands support high levels of MeHg production, and as a result, the restoration of these essential habitats may exacerbate the mercury problems that already exist within the food web.

This project is studying a method of reducing mercury methylation rates by addition of ferrous iron to wetland sediments to control the availability of sulfide. As sulfide concentrations decrease, sulfate-reducing bacteria produce less MeHg because the concentration of dissolved, bioavailable mercury descreases. In a previous research project, we showed that this approach decreases net MeHg production in sediment slurry systems. This project will test the efficacy of iron addition under more conditions more closely approximating those encountered in wetlands using laboratory microcosms collected from tidally influenced estuarine wetlands around the San Francisco Bay. In addition to studying the effect of the iron amendment on MeHg production, we are also evaluating the role that certain species of wetland plants play in MeHg production by altering the conditions of the sediments surrounding their roots, and how plant/sediment interactions are affected by iron amendment. The results of this study will determine if an iron amendment has the potential to be an effective control of MeHg production in wetlands, as well as to illustrate if certain plant species can be selected for in the restoration of wetlands to help reduce the potential exacerbation of the MeHg problem.

During the period from March 1, 2007 to February 28, 2008 we designed and tested a microcosm system to assess the effects of iron addition on mercury methylation under operating conditions that simulate tidal cycles. Two potential field sites were identified and sediment cores with intact plant systems were collected for preliminary microcosm testing. In September 2007, 12 sediments and plants were collected from the Gambinini Marsh, which is located along the Petaluma River in Sonoma county. The samples contained Pickleweed (*Salicornia virginica*), a halophytic salt-marsh plant that is common in San Francisco Bay weltands. A total of 12 microcosms were grown and monitored over several months after amendment with three different doses of iron. Preliminary results from the experiments indicate that the medium (0.36 kg/m^2) and high (0.72 kg/m^2) doses of iron reduced methymercury formation and export by approximately 80 to 90%. Research is being continued to assess changes in the geochemistry of the sediments and the effect of different plant species on the efficacy of iron additions.

The results obtained on this project to date are encouraging because they may provide a basis for restoring wetlands without exacerbating methylmercury formation and bioaccumulation.

Control of Mercury Methylation in Wetlands Through Iron Addition

Basic Information

Title:	Control of Mercury Methylation in Wetlands Through Iron Addition
Project Number:	2007CA191B
Start Date:	3/1/2007
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	43
Research Category:	Biological Sciences
Focus Category:	Ecology, Wetlands, None
Descriptors:	None
Principal Investigators:	David L Sedlack

Publication

Project Summary

Methylmercury (MeHg) is a potent neurotoxin that affects both human health and wildlife, and its formation in the anoxic sediments of wetlands has led to mercury contamination in aquatic ecosystems. Elevated levels of mercury, which exists primarily as MeHg in biota, are responsible for over 75% of the fish consumption advisories issued in the United States. Mercury is of special concern in California due to elevated concentrations caused by historical mining practices. The primary objective of this research project is to develop a novel method of restoring and constructing wetlands that will minimize MeHg production in wetland sediments without sacrificing natural habitat potential.

Since the 1780's, California has lost an estimated 91% of its wetland acreage, and it has only been over the past few decades that policy and management decisions have been made to reverse this trend (e.g., the proposed restoration of over 15,000 acres of salt marsh within the San Francisco Bay). Wetlands are extremely beneficial ecosystems to California as they serve as essential habitat for a variety of wildlife species, including the federally endangered California clapper rail, offer flood protection, and improve water quality. However, wetlands support high levels of MeHg production, and as a result, the restoration of these essential habitats may exacerbate the mercury problems that already exist within the food web.

This project is studying a method of reducing mercury methylation rates by addition of ferrous iron to wetland sediments to control the availability of sulfide. As sulfide concentrations decrease, sulfate-reducing bacteria produce less MeHg because the concentration of dissolved, bioavailable mercury descreases. In a previous research project, we showed that this approach decreases net MeHg production in sediment slurry systems. This project will test the efficacy of iron addition under more conditions more closely approximating those encountered in wetlands using laboratory microcosms collected from tidally influenced estuarine wetlands around the San Francisco Bay. In addition to studying the effect of the iron amendment on MeHg production, we are also evaluating the role that certain species of wetland plants play in MeHg production by altering the conditions of the sediments surrounding their roots, and how plant/sediment interactions are affected by iron amendment. The results of this study will determine if an iron amendment has the potential to be an effective control of MeHg production in wetlands, as well as to illustrate if certain plant species can be selected for in the restoration of wetlands to help reduce the potential exacerbation of the MeHg problem.

During the period from March 1, 2007 to February 28, 2008 we designed and tested a microcosm system to assess the effects of iron addition on mercury methylation under operating conditions that simulate tidal cycles. Two potential field sites were identified and sediment cores with intact plant systems were collected for preliminary microcosm testing. In September 2007, 12 sediments and plants were collected from the Gambinini Marsh, which is located along the Petaluma River in Sonoma county. The samples contained Pickleweed (*Salicornia virginica*), a halophytic salt-marsh plant that is common in San Francisco Bay weltands. A total of 12 microcosms were grown and monitored over several months after amendment with three different doses of iron. Preliminary results from the experiments indicate that the medium (0.36 kg/m^2) and high (0.72 kg/m^2) doses of iron reduced methymercury formation and export by approximately 80 to 90%. Research is being continued to assess changes in the geochemistry of the sediments and the effect of different plant species on the efficacy of iron additions.

The results obtained on this project to date are encouraging because they may provide a basis for restoring wetlands without exacerbating methylmercury formation and bioaccumulation.

Influence of Bacterial Pathogen Condition on Cell Transport in Groundwater Environments: Implications of Extracellular Polymeric Substances (EPS) Production and Composition

Basic Information

Title:	Influence of Bacterial Pathogen Condition on Cell Transport in Groundwater Environments: Implications of Extracellular Polymeric Substances (EPS) Production and Composition
Project Number:	2007CA192B
Start Date:	3/1/2007
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	43
Research Category:	Water Quality
Focus Category:	Water Quality, None, None
Descriptors:	None
Principal Investigators:	Sharon L Walker

Publication

1. Kim, H.N., and Walker, S.L., 2008 Escherichia coli transport in porous media: Influence of cell strain, solution chemistry, and temperature Colloids and Surfaces B: Biointerfaces (under review)
2. Chen, G., Bedi, R., Beving, D, Yan, Y., and Walker, S.L., 2008, The antimicrobial effect of zeolite surfaces on bacterial deposition in a parallel plate flow chamber Environmental Science and Technology (under review)
3. Bolster, C.H., Haznedaroglu, B., and Walker, S. L., 2008, Diversity in cell properties and transport behavior among 12 environmental Escherichia coli isolates Journal of Environmental Quality (in press)
4. Haznedaroglu, B., Bolster, C.H., and S. L. Walker, 2008, The role of starvation on bacterial adhesion and transport in saturated porous media Water Research 42:1547-1554
5. Walker, S.L, Evaluation of Bacterial Fate and Transport: Biological and Experimental Considerations presented at University of Utrecht, October 15, 2007, Utrecht, The Netherlands
6. Walker, S.L, Mechanisms of Bacterial Adhesion and Transport in Aquatic Systems presented at University of Sheffield, April 4, 2007, Sheffield, England
7. Walker, S.L, Mechanisms of Bacterial Adhesion and Transport in Aquatic Systems University of California, Davis February 26, 2007, Davis, CA
8. Haznedaroglu, B.Z. and Walker, S.L. Fate of Pathogenicity and Transport Characteristics of Salmonella and E. coli O157:H7 in Groundwater poster presented at the Gordon Research Conference, Environmental Sciences: Water, Holderness School, June 22-27, 2008, Plymouth, NH.
9. Kim, H.N. and Walker, S.L. Escherichia coli O157:H7 transport in saturated porous media: Coupled role of solution chemistry and surface macromolecules poster presented at the Gordon Research Conference, Environmental Sciences: Water, Holderness School, June 22-27, 2008, Plymouth, NH.
10. Kim, H. N., Bradford, S. A., and S. L. Walker Escherichia coli O157:H7 transport in saturated

porous media: role of solution chemistry and surface macromolecules presented at the American Chemical Society 82nd Colloid & Surface Science Symposium, June 15-18, 2008, Raleigh, NC.

11. Chen, G., Beving, D.E., Bedi, R.S., Yan, Y. and Walker, S.L. "The Antifouling Effect of Zeolite Surfaces on Bacterial Deposition in a Parallel Plate Flow Cell" presented at the American Chemical Society 82nd Colloid & Surface Science Symposium, June 15-18, 2008, Raleigh, NC.
12. Haznedaroglu, B.Z., and S. L. Walker, 2008. Monitoring the Pathogenicity and Transport Behavior of Escherichia coli O157:H7 and Salmonella enterica spp. in Packed Bed Column Systems , The 108th General Meeting of the American Society for Microbiology, June 1-5, 2008, Boston, MA, USA.
13. Gong, A.S., Benavides, M., and Walker, S.L. "Extraction and Analysis of Extracellular Polymeric Substances: Comparison of Methods and EPS Levels in Salmonella sp.", 108th General Meeting of the American Society for Microbiology, June 1-5, 2008, Boston, MA
14. Haznedaroglu, B.Z. and S.L. Walker Establishing the influence of starvation upon the transport of environmental Escherichia coli isolates to be presented at the Joint American Chemical Society and American Institute of Chemical Engineers Spring Meeting, April 6-10, 2008, New Orleans, LA.

Project Summary Statement: A systematic and extensive examination of the *physiological and environmental factors* controlling bacterial adhesion and transport is actively being pursued. Currently we are investigating the role that extracellular polymeric substances (EPS) exuded by cells plays in controlling the fate of pathogenic bacteria in aquatic environments.

Rationale: Due to California's continuing population growth driving demand for an increased municipal water supply and political pressures for decreased reliance on Colorado River water, there is a vital need to ensure groundwater protection and quality. In the Santa Ana Regional Water Quality Control Board, a region of only approximately 2,800 square miles and a population approaching 6 million people, reclaimed wastewater is increasingly utilized for ground-water recharge. Additionally, non-point source pathogen pollution is a mounting problem due to sources such as dense dairy farming and urban run-off. For water quality professionals such as those in the Santa Ana Region and beyond, the capacity to determine the transport and source of bacterial pathogens is essential to safeguard drinking water supplies. Therefore, the ability to predict the fate of human pathogens in the environment is critical, and a mechanistic understanding of bacterial transport in the subsurface environment is imperative for assessing the environmental impact of groundwater contamination from sources including urban runoff, septic tank/leach field systems, and animal manure from agricultural operations. Additionally, such information is vital for effective design of water quality technologies including riverbank filtration, wastewater reclamation, and recharge into aquifers.

Experimental Approach: A systematic and extensive examination of the *physiological and environmental factors* controlling bacterial adhesion and transport in subsurface environments is actively being pursued. Currently we are investigating the role that extracellular polymeric substances (EPS) exuded by bacterial pathogens plays in controlling the adhesive nature of the cells – expressly analyzing the composition of the EPS and adhesion trends in a flowing environment as a coupled phenomenon. This novel approach of investigating the dynamic surface chemistry of bacterial cells and the extent of adhesion will provide a more complete understanding of bacterial pathogen transport mechanisms.

The project is conducted in two core areas. The first is the development of methodologies to extract and analyze the composition of the EPS. These methods were developed in the past; however, the various methods have limitations of efficiency, detection, and reproducibility that need to be worked out and optimized for analyzing EPS of groundwater-borne pathogens. Work to date has involved testing extraction methods involving ethanol, lyophilization (or freeze-drying), and sonication. The compositional analysis involves traditional spectroscopic quantification techniques; however other methods are currently being explored. The EPS extraction and analysis methods have been tested on a variety of relevant organisms being utilized in the lab including *E. coli* (strains including O157:H7, D21g, XL1, and numerous natural isolates), *Salmonella enterica* serovar pullorum *Burkholderia cepacia* G4g, and *Halomonas pacifica* g. The ability to extract and analyze the EPS of *E. coli* isolates from dairy cattle and humans, as well as the *Salmonella* strain, is being tested for cells that have been stressed through starvation (0, 6, 12, and 18 hours). Additionally, a study is ongoing looking into the influence of solution chemistry (artificial groundwater at varying ionic strengths) and exposure time on *Salmonella* EPS production. The EPS data collected as part of this portion of the study have been utilized in manuscripts currently under review, as well as a paper on the relevance of each of the EPS extraction methods is in preparation.

The second area of research involves the investigation of cell adhesion and transport in aquatic environments. This work is conducted in three experimental systems: 1) a packed bed column, 2) a radial stagnation point flow (RSPF) flow cell, and 3) a parallel plate (PP) flow cell. Both systems simulate transport of bacteria within porous media. The packed bed column is a macroscopic approach of quantifying cell transport; whereas, the RSPF and PP systems are microscopic methods for observing cell adhesion to a surface. Experiments in both systems are conducted under solution chemistry and hydrodynamic conditions simulating the subsurface environment. Experiments in the packed bed have been conducted utilizing *E. coli* (strains including O157:H7, D21g, XL1, and numerous natural isolates) and *Salmonella enterica* serovar pullorum (manuscripts recently published and others under review). *Burkholderia cepacia* G4g and *Halomonas pacifica* g have been used in the RSPF system (publication resulting). Recent work has utilized the PP system to evaluated biofouling with novel antimicrobial surface coatings and a manuscript is under review based upon this work Both methods allow for a quantification of cell transport. To fully analyze the trends in cell transport, the surface chemistry of the bacterium requires consideration. The EPS composition and content provides considerable insight into this surface chemistry. Hence, EPS analysis (as described above) has been compared to the transport data. To date the trend observed, regardless of cell type or environmental condition, is that the charge on the cell surface (as determined through measurement of zeta potential) and the ratio of sugars to proteins within the EPS provides an indication of the type of interaction forces that will result between the cells and the surfaces (aquifer sand in the column or quartz surface in the RSPF). Ongoing work will provide further insight into the applicability of this trend and whether this may provide a future predictive tool.

The overall goal for this project is that this fundamental research will provide a greater understanding of how environmental conditions influence cell fate in groundwater environments; and hence, lead to more effective water management and re-use practices in the future.

Overall research program: Walker's research is in the area of particle adhesion and transport in aquatic environments including aquifers, beach sediments, filters, and more recently on engineered surfaces. This work encompasses the fate of bacterial pathogens in groundwater, fecal indicator and biofilm forming bacteria in marine systems, as well as inert colloids and nanomaterials in engineered systems. Through a combination of colloid, bacterial, and surface science analytical techniques, she investigates the nano-scale physical and chemical interactions occurring at interfaces. Ultimately, her work determines rates of attachment of these problematic biotic and abiotic particles onto surfaces under a range of relevant environmental or operating conditions, providing quantitative and qualitative insight into their fate. This is a valuable tool in the assessment of water quality, including domestic water treatment design, groundwater and marine/coastal systems management, and the design of antifouling/antimicrobial materials.

Distribution, Movement, & Outmigration of Juvenile Coho Salmon in the Shasta River: Relationships with Environmental Factors and Irrigation Water Management

Basic Information

Title:	Distribution, Movement, & Outmigration of Juvenile Coho Salmon in the Shasta River: Relationships with Environmental Factors and Irrigation Water Management
Project Number:	2007CA193B
Start Date:	3/1/2007
End Date:	2/28/2008
Funding Source:	104B
Congressional District:	43
Research Category:	Biological Sciences
Focus Category:	Water Supply, Water Quality, Water Use
Descriptors:	None
Principal Investigators:	Lisa C Thompson

Publication

1. Thompson, L.C., D. Lile, M. McFarland, T. Pustejovsky, K. Vandersall, and K. Weaver. 2006. Eagle Lake Rainbow Trout Spawner Migration Study 2006: Report to the Pine Creek CRMP, 15 November 2006. Lassen County Publication. 13 p.
2. Thompson, Lisa C. 2007. Restoring rangeland watersheds & fisheries: Pine Creek watershed & Eagle Lake rainbow trout. University of California Center for Water Resources. University of California Riverside. Riverside, CA. 2 p.
3. Thompson, Lisa C., Gerard Carmona Catot, Teresa Pustejovsky, and David Lile. 2007. Pine Creek and Eagle Lake Rainbow Trout Study 2007: Spawner Migration, Upper Watershed Habitat and Rearing Survey, and Bogard Spring Creek Brook Trout Removal Experiment. Report to the Pine Creek Coordinated Resource Management Planning Group. 30 November 2007. Lassen County Publication. 22 p.

Project Information Summary

This is the first year of a study to test whether the numerous watershed restoration activities conducted during a 20-year effort in the Pine Creek watershed (Lassen County) have provided conditions under which Eagle Lake rainbow trout can complete their natural life cycle. Results will help to answer the question, for this and other rangeland watersheds, "How much restoration is enough?" Our main objectives are to: (1) Track the upstream migration of Eagle Lake rainbow trout, and relate movement to environmental factors such as water temperature and flow, and (2) Test the ability of Eagle Lake rainbow trout to spawn and rear following temporary removal of competing non-native brook trout.

Problem and Research Objectives, Methodology and Principal Findings and Significance

The purpose of this project is to test whether the numerous watershed restoration activities conducted during a 20-year effort in the Pine Creek watershed have provided conditions under which a proportion of Eagle Lake rainbow trout (ELRT, *Oncorhynchus mykiss aquilarum*), a Species of Special Concern, can complete their natural life cycle. Results from this project will help us to answer the question, for this and other rangeland watersheds, "How much restoration is enough?" Pine Creek watershed has historically provided critical spawning and rearing habitat for the ELRT. Over the past 100+ years, modification of Pine Creek and its watershed has resulted in the decoupling of the ELRT from its native stream habitat, and barriers have prevented ELRT from attempting their natural spawning migration of over 20 miles. The fishery is now supported entirely by hatchery production.

The approach we are taking is a comparative field survey including habitat, and fish migration and rearing, followed by a stakeholder workshop to share the new information. We are working at a watershed scale to determine the management actions necessary for the restoration of spawning and rearing of ELRT. Our main objectives are to: (1) Track the upstream migration of ELRT spawners from the mouth of Pine Creek, and relate movement to environmental factors such as water temperature and flow, and (2) Test the ability of ELRT to spawn and rear in Bogard Spring Creek, a tributary of Pine Creek, following temporary removal of brook trout, non-native fish that prey upon juvenile ELRT.

In 2007 we conducted a habitat survey to determine conditions during ELRT spawning migration, spawning, and rearing. We sampled 9 monitoring stations monthly from spring to fall for in-stream physical habitat, flow, temperature, dissolved oxygen, overhead cover, spawning substrate size, and water transparency and quality. In spring 2008 we will use passive integrated transponder (PIT) antennas to track the upstream movement of ELRT spawners, and relate this to environmental factors (flows in 2007 were very low and precluded this part of the study). We will capture a sample of ELRT at the barrier near the mouth of Pine creek during the spring spawning migration period. A sample of 100 fish, spread out over the time span of the spawning run, will be anesthetized and surgically implanted with PIT tags. After a recovery period, fish will be released upstream of the passage barrier. Upstream migration of ELRT will be monitored in the lower, middle and upper sections of Pine Creek with channel-spanning stationary PIT antennas. Water and air temperature will be monitored with loggers near the passage barrier on lower Pine Creek, in spawning habitat in upper Pine Creek, and at antenna sites along the length

of Pine Creek. Flow will be measured weekly during the spring migration period at a fixed location in lower Pine Creek.

We are also studying the rearing of ELRT juveniles with and without non-native brook trout in the spawning and rearing habitat of the upper Pine Creek watershed, and testing methods to decrease the competition and predation that juvenile ELRT face from brook trout. In spring 2007 we conducted a pilot test in which we transported a small sample of PIT tagged ELRT spawners to the upper Pine Creek watershed to allow them to spawn. In 2008 we will transport 100 PIT tagged ELRT spawners to the upper watershed to allow them to spawn in Bogard Spring Creek and a comparison area, the mainstem reach of Pine Creek near Stephen's Meadows. In August 2007 we electrofished all of Bogard Spring Creek to decrease the density of brook trout. We will conduct summer snorkel surveys of Bogard Spring Creek and the non-electrofished mainstem reach of Pine Creek to determine the spawning and rearing success of ELRT in relation to the electro-fishing treatment.

The results of this study will assist resource agencies to determine the management actions necessary to restore natural spawning and rearing of ELRT, and to sustain the trophy ELRT fishery and the economic benefits it provides to Lassen County.

Information Transfer Program Introduction

None.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	31	6	0	5	42
Masters	14	3	0	2	19
Ph.D.	10	5	0	1	16
Post-Doc.	8	6	0	2	16
Total	63	20	0	10	93

Notable Awards and Achievements

January, 2007 Salinity Drainage Book Project Collaboration Meeting, Davis, CA

Purpose of this meeting was to coordinate the group of people writing the chapters for the Salinity Book. The book is to summarize the research that has been done for the past 20 years in California's Central Valley.

April 2007 Water Resources Coordinating Conference, Woodland, CA

The purpose of the WRCC is to provide a "big picture" view of water issues facing California and discuss how the University of California fits into that picture. Four perspectives were provided on Water Resource Issues and Presentations were given on Urban and Ag Water Conservation.

April 2007 Food Safety and Water Quality Conference, San Luis Obispo, CA

Conference was co-sponsored by the Regional Water Quality Program.

May 2007 National Salinity Technology Transfer Workshop, Lake Arrowhead, CA

The workshop is jointly planned and sponsored by the UC Center for Water Resources, USDA Agricultural Research Service, USDA Natural Resources Conservation Service, USDI Bureau of Land Management, and USDI Bureau of Reclamation. The objective of this Technology Transfer Workshop is to describe state of the art information, tools and technology for managing saline irrigation water and salt affected soils.

June 2007 Water Education Foundation Tour, Bay-Delta, CA

This was important because it came at a time when the pumping was shut down from the Delta to protect the smelt. This affected the water supply for agriculture in the Central Valley and for the cities in Southern California that depend on the California Aqueduct.

2008 Water Resources Coordinating Conference put the spotlight on the variety of water-related centers and programs in the University of California system and how they relate to water issues in California. The overview of UC water center roles and focus areas gave attendees (from Cooperative Extension offices across the state, UC campuses, and state agencies) a greater understanding of the breadth of project activity across the state and spurred conversations to discuss ideas for future collaborative efforts. This forum to bring together the directors of the water centers was the first of its kind not only to have them share their efforts and successes with a general audience, but also to share information among themselves. The UC Center for Water Resources will use this event as a springboard to foster ongoing communication and collaboration among the directors of the various UC water centers.

2004CA110G, Dr. Ingram

Project staff Anne Taufen Wessells was awarded the Don Owen Water Science and Policy Fellowship by the Urban Water Research Center at the University of California, Irvine, in Spring 2007. This award was based on the progress of research undertaken as part of this grant project, and resulted in the successful completion and defense of Dr. Taufen Wessells' dissertation, in Fall 2007.

2005CA137G, Dr. Yeh

Principal Investigator William Yeh was elected a member of the National Academy of Engineering in February 2008, For the development of methodologies for optimizing the management of water resources, and for inverse methods of estimating subsurface parameters.

2007CA189B, Dr. Kendall

The Ph.D. student supported by these funds received a scholarship from the California Lake Management Society for work carried out on this project.

2007CA191B, Dr. Pasternack Science projects may provide new fundamental insights, but often transfer to practical usage follows many years later, if at all. In this case not only have such new insights been obtained, but they were immediately put to use to build a logjam on the Mokelumne River through engagement of local stakeholders. The logjam is being used as rearing habitat by juvenile fish.

2007CA193B, Dr. Thompson Funding from this grant was instrumental in the overall feasibility of the project, and allowed us to leverage additional funding of approximately $75,000 from the University of California. Details regarding this grant are as follows: Title: Restoring Rangeland Watersheds & Freshwater Fisheries. Funding Agency: UC Division of Agriculture and Natural Resources. Amount(s): $73,870. Duration of project: March 2007 April 2009

UC System-wide additional funding received as a result of Institute funding:

Fogg, Graham UCD $210,800.00 Fong, Peggy UCI $194,000.00 Goulden, Michael UCI $1,050,000.00 Hogue, Terri S. UCLA $105,000.00 Ivanetick, K UCI $890,000.00 Jay, Jennifer A. UCLA $100,000.00 Melack, John UCSB $457,667.00 Olson, Betty H. UCI $200,000.00 Pasternack, G. UCD $25,663.00 Thompson, Lisa C. UCD $73,870.00 Walker, Sharon L. UCR $100,000.00 Wuertz, Stephan UCD $219,709.00 Cohen, Yoram UCLA $372,750.00 Harmon, Thomas C. UCM $547,501.00

Dr. Michaelson, Dr. Chris Funk and Dr. Greg Husak.

02/2008 Climate change research featured on BBC 02/2008 Climate modeling/human impacts analysis accepted by PNAS 01/2008 Funk invited panelist at NIDIS Workshop 01/2008 Science Perspective on Food Security Under Climate Change 01/2008 AAAS Symposium on Food Security and Climate Change in Africa 01/2008 Forecasting featured in Applied Climatology presentation at AMS 10/2007 Attended NAS Workshop on US Priorities for the Climate Change Science 10/2007 EOS article on famine warning 08/2007 Funk invited speaker at ESRL meeting on Climate Change and Predictability 05/2007 Funk joined NASA Precipitation Science Team 04/2007 Analysis of NDVI promoted early action in Zimbabwe

Publications from Prior Years