California Institute for Water Resources
Annual Technical Report
FY 2011

Introduction

Across California, the University of California s Division of Agriculture and Natural Resources (UCANR) is an engine for problem solving. Serving as the bridge between local issues and the power of University of California research, our more than 300 campus-based specialists and county-based advisors work to bring practical, unbiased, science-based answers to Californians.

The California Institute for Water Resources (CIWR) is a special program within UCANR, enabled by the federal Water Resources Research Act (WRRA), with the mission of supporting research and extension activities that contribute to the efficient management of California's water resources, in water quality, quantity and reliability.

CIWR brings together federal, state and local stakeholders to identify issues and sources of political and financial support for water-related research. The CIWR mission is to provide leadership to engage with state entities to help identify water priorities in California and help engage existing UC campus-based Water Centers to implement statewide water planning, research, and outreach. The University of California system supports nine additional water-related research centers and two water-related programs with the sustained efforts of approximately 271 UC faculty members on 8 of UC s 10 campuses. The CIWR also engages with non-UC Water Centers and academics interested in California water (e.g., several CSUs, Stanford University and others).

Given the WRRA statutory mission of education and outreach, CIWR is best suited to linking water research to the needs of water managers and users throughout California. The CIWR serves an important linkage niche: science to public policy, science to education and outreach, researchers to State agencies and the public, UCANR initiatives to each other, UC Water Centers to each other, and UC Water Centers to other academic institutions.

CIWR allows individual campus water Centers to continue their research work and focus, as well as provide opportunities to those Centers for greater collaboration. The Institute serves a coordinating function, not competing with existing UC Water Centers for research resources.

The Institute's Director is housed within UCANR to facilitate a statewide focus. The Institute may have affiliate faculty/CE from the different UC campuses and other universities as appropriate to address specific projects.

The Inaugural Director for the CIWR began work on October 3, 2011. Over the past few months the Director has networked with other University of California (UC) and California State University (CSU) Water Centers and individual academics who are engaged in research, education and extension activities related to California water.

In 2011, 50 UC Cooperative Extension (UCCE) advisors comprised UCANR's efforts in executing projects related to water, 97 projects focused on water quality and 26 projects targeted water supply and allocation. Also, 21 Specialists conducted 18 water quality projects and 12 water use projects. Additionally, ANR's Agricultural Experiment Station (AES) faculty conducted 22 water quality and 11 water use projects. All totaled California's ANR researchers conducted 137 water quality projects and 49 water use projects.

Over the past six months, the new Institute Director Douglas Parker has explored the viability of creating two advisory boards. The first board will be an Agency and Stakeholder Board comprised of state and federal agency personnel who can cogently express information needs from their state and national perspectives and who will provide insight as to priority activities for the Institute, and individual stakeholders with statewide

water experience, ideas, and knowledge of potential fund sources. The second board will be an Academic Board comprised of individual faculty or Water Center leaders who are involved in California water issues.

The CIWR Director now serves as a key spokesperson on California water issues; working with federal, state, regional, nonprofit, and campus stakeholders to improve the understanding of water issues through advocacy and outreach programs. CIWR conducts and sponsors conferences, symposia, and other events to increase public awareness of water issues and resource management strategies (see Information Transfer Program).

The Director of CIWR also serves as Leader for UCANR s Strategic Initiative on Water Quality, Quantity and Security. Thus, part of CIWRs mission is to assist UCANR in the management of this Strategic Initiative. As part of that Initiative, CIWR helps to manage UCANR s competitive grants portfolio. Through this partnership, CIWR is developing such strategic themes of importance as irrigation efficiency, ecosystem services, source water production and protection, water policy, drinking water, food safety and water quality (see additional projects funded and cost shared in this proposal).

CIWR has begun to fully integrate water into the UCANR mission and the competitive grant program. In addition, CIWR will start its own competitive grants program in 2012. Working with various advisory panels, we will solicit proposals for California water related research, education and extension projects from academics at qualified institutions statewide to be funded under the 2013 WRRA (contingent on funding).

As the new Director takes the lead, CIWR will be positioned to bring science-based solutions to issues of concern and importance in order to improve the quality of life of Californians and the nation. By extending and delivering timely knowledge to the people who need it, CIWR works to drive California s economy, protect and conserve its natural resources, and encourage thriving communities.

Research Program Introduction

CIWR assists ANR in the water aspects of its competitive grants program and its extension collaborations throughout California.

ANR Grants Programs:

ANR Competitive Grants Program:

ANR invests in research, education and outreach projects that meet the goals of its mission by conducting an internal competitive grants program aimed to support high priority issues, encourage collaboration among ANR representatives and key players from throughout the state, support short-term high-impact projects, continue to strengthen the research-extension continuum, yield policy relevant outcomes, and achieve significant statewide economic, environmental and social impacts in California. To address some of these challenges, ANR developed the Strategic Vision 2025 to identify and meet the statewide scientific, technological, social, and economic demands facing California. As an initial implementation strategy, ANR identified five Strategic Initiatives that are favorably positioned within the Division to achieve maximum results. To attest to the importance of California water research, one of the five grant categories is specifically dedicated to Water Quality, Quantity and Security. The inaugural review panel of distinguished researchers is currently reviewing 34 proposals focused specifically on water issues.

Joseph G. Prosser Trust:

The Irrigation Management Program, funded by the Joseph G. Prosser Trust, supports a broad spectrum of research related to crop irrigation management, focusing on conserving water, improving irrigation efficiency and optimizing yields. Emphasis is placed on research outputs that improve current practices, and on dissemination of information. Some recent projects fully funded by this program include:

Outreach and extension program for co-management of food safety and ecosystem services in fresh produce (Mary Bianchi, UCCE San Luis Obispo County and Karen Lowell, UCSC).

Creek carbon Dynamics of carbon and nitrogen in restored Mediterranean riparian zones (Davis Lewis, UCCE Marin County).

M. Theo Kearney Endowment:

This fund is currently directed to support research in the relations of soil and water to plants through basic physical, chemical, biological, and hydrological research. Studies are targeted at understanding the balancing of multiple ecosystem services and biotic diversity in California's working landscapes. One project is currently fully supported by this fund:

Effect of forest management on water yields and other ecosystem services in Sierra Nevada forests (Kevin O'Hara, Environmental Science, Policy and Management Department, UC Berkeley).

Outreach Collaborations Selected collaborations include:

1,280 farm, ranch, and rangeland owner/operators and managers, allied industry professionals, public agency representatives, and members of the public, participating in water quality education programs, gained knowledge of best management practices for preserving water quality.

60 resource managers and other stakeholders in watershed management issues, participating in sustainable use of fisheries education programs, gained knowledge of strategies and techniques for sustainable use of inland fishery resources.

76 farm owner/operators, allied industry and natural resource professionals, and members of the public, participating in water conservation education programs, gained knowledge of water use and conservation practices.

UC researchers, in cooperation with CALFED and the State Water Resources Control Board, examined the runoff from eight neighborhoods in Sacramento and Orange counties to develop improved landscape management practices related to water. Water runoff samples were collected regularly during the irrigation season and during the first rains of each storm season. The samples were analyzed for 11 pesticides, fertilizers, other pollutants and pathogens. In both counties, UC master gardeners developed activities for homeowners to improve landscape management practices related to water, fertilizer, and pesticide use. The aim was to reduce or eliminate pollution runoff. This data helped water agencies develop customer programs on managing landscapes. Master Gardener outreach improved the landscape practices of homeowners. The flow data also is being used by a team of UC researchers to develop a model for urban planners and developers to reduce water runoff and runoff pollutants in new and existing urban landscapes.

52 farm, nursery, ranch and rangeland owner/operators and managers, allied industry professionals, public agency representatives, and members of the public, participating in water quality education programs, intended to use best management practices for preserving water quality.

Cattle ranchers adopted new grazing practices that improve water use efficiency. UC Cooperative Extension advisors conducted a series of field trials with growers in the intermountain county of Siskiyou to develop a grazing system using winter annual grasses. Yield and forage quality were evaluated for several grass species under actual grazing conditions. Grazing management practices were also studied by cutting to simulate grazing. The results indicated that annual grasses such as triticale could lengthen the forage production season by allowing late fall grazing, early spring grazing and still allow for a hay crop to be produced from the regrowth after grazing. Much of the growing season for winter annual grasses occurs at times of the year when temperatures are cool and rain frequent. Since the amount of water needed per unit of forage is less with this annual grass system than it is with perennial grasses, this system has improved water use efficiency. The advantages are so great that many cattle ranchers are readily adopting the new practices.

Environmental Concerns ANR is also participating in food safety studies that involve the environment, ecological issues, and water quality. Researchers are determining how Cryptosporidium, Campylobacter, E. coli O157:H7, Salmonella, and indicator bacteria move from animal or crop agricultural areas into run-off surface and sub-surface waters. Findings obtained here will enable researchers, managers, and policy-makers to better devise measures to protect such water resources.

Agriculture and Natural Resource Management Research on water management for sustainable agricultural development sought to estimate water demand for cropping systems; compare cropping systems based on total water required for irrigation; evaluation climate change impact on water consumption by agriculture; and evaluate production and water resource management risks associated with climate change. As a result, the SIMETAW program was developed to help water planners and researchers improve their long-term estimates of net crop water requirements. The SIMETAW program can simulate many years of weather data from monthly climate data, and estimate reference evapotranspiration and crop evapotranspiration with the simulated data, which allows one to investigate how climate change might affect water demand. Research was conducted to improve irrigation and nutrient inputs efficiency in vegetable production. As a result irrigation and soil fertility guidelines to improve yield and production efficiency in the processing tomato industry were developed. These identify inputs that either are not needed or that could be replaced by less expensive options.

A further impact is that the success of this vegetable cropping system has encouraged the California Strawberry Commission to participate with UC researchers to develop a grower education program for environmental stewardship.

Aquatic and Terrestrial Wildlife Conservation The viability of fish populations that bisect agricultural and urban areas as freshwater flows to the ocean is a key integrating factor across all natural ecosystems in California. Research was conducted and publications produced to develop a better understanding the factors controlling the resilience and persistence of fish populations in both systems flowing through small streams into the San Francisco Bay as well as into larger rivers flowing into the California Bay-Delta.

Forest Resources Management In the woodlands and forest areas that are typically upslope of the grasslands, research and publications defined how improving wildlife habitats can be integrated into the land management practices of private land managers. In addition, new tools are being developed to identify the occurrence and potential spread of two new sources of hardwood tree mortality, Sudden Oak Death (SOD) in Northern California and Golden Spot Oak Borer (GSOB) in Southern California. The crucial role of water use by forests and the remaining runoff into streams and rivers is also a focus since the impacts of droughts and changing precipitation patterns will have on fish populations and the water supplies that are moved around the state to support agriculture and urban areas.

Improving aquifer storage recovery operation to reduce nutrient load and benefit water supply

Basic Information

Title:	Improving aquifer storage recovery operation to reduce nutrient load and benefit water supply
Project Number:	2007CA195G
Start Date:	7/1/2008
End Date:	6/30/2012
Funding Source:	104G
Congressional District:	17th
Research Category:	Ground-water Flow and Transport
Focus Category:	Water Supply, Water Quality, Nitrate Contamination
Descriptors:	
Principal Investigators:	Andrew Fisher, Marc Los Huertos, Charles Geoffrey Wheat

Publications

1. Papers Presented at Professional Meetings (*student co-authors) *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, 2008. Processes, controls, and potential for in-situ nutrient removal during managed aquifer recharge to a shallow aquifer, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM.
2. *Racz, A., A. T. Fisher, B. Lockwood, M. Los Huertos, C. Schmidt*, J. Lear, 2008. Quantifying the distribution and dynamics of managed aquifer recharge using mass-balance and time-series thermal methods, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM.
3. Papers Presented at Professional Meetings (*student co-authors) *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, 2008. Processes, controls, and potential for in-situ nutrient removal during managed aquifer recharge to a shallow aquifer, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM.
4. *Racz, A., A. T. Fisher, B. Lockwood, M. Los Huertos, C. Schmidt*, J. Lear, 2008. Quantifying the distribution and dynamics of managed aquifer recharge using mass-balance and time-series thermal methods, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM.
5. *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, The magnitude and controls on denitrification during managed aquifer recharge into a shallow, unconfined aquifer in a coastal groundwater basin, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM, 14-18 December 2009.
6. *Racz, A., A. T. Fisher, B. Lockwood, M. Los Huertos, C. Schmidt*, J. Lear, Spatial and temporal variations in seepage during managed aquifer recharge, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM, 14-18 December 2009.
7. *Schmidt, C., A. T. Fisher, A. Racz, C. G. Wheat, J. Sharkey, B. Lockwood, Processes and controls on rapid nutrient removal during managed aquifer recharge, 27th Biennial Groundwater Conference, Abstracts with programs, Sacramento, CA, October 6-7 2009.
8. Papers Presented at Professional Meetings (*student co-authors) *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, 2008. Processes, controls, and potential for in-situ nutrient removal during managed aquifer recharge to a shallow aquifer, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on

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11. *Racz, A., A. T. Fisher, B. Lockwood, M. Los Huertos, C. Schmidt*, J. Lear, Spatial and temporal variations in seepage during managed aquifer recharge, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM, 14-18 December 2009.
12. *Schmidt, C., A. T. Fisher, A. Racz, C. G. Wheat, J. Sharkey, B. Lockwood, Processes and controls on rapid nutrient removal during managed aquifer recharge, 27th Biennial Groundwater Conference, Abstracts with programs, Sacramento, CA, October 6-7 2009.
13. *Racz, A. J., A. T. Fisher, C. I. Schmidt*, B. Lockwood, and M. Los Huertos, 2011, The spatial and temporal dynamics of infiltration during managed aquifer recharge, as quantified using mass balance and thermal methods, Ground Water, accepted for publication (pending minor revision).
14. *Schmidt, C. I., A. T. Fisher, A. J. Racz*, M. Los Huertos, and B. Lockwood, 2011, Rapid nutrient load reduction during infiltration as part of managed aquifer recharge in an agricultural groundwater basin, Hydrol. Proc., accepted for publication (pending minor revision).
15. *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, Managed aquifer recharge as tool for sustainable management of ground water quantity and quality in agricultural basins, in Towards Sustainable Groundwater in Agriculture, Groundwater Resources Association of California, June 15-17, 2010 San Francisco, CA, p. 154.
16. Langridge, R. and Fisher, A. T., Climate Change, Agriculture and Sustainable Groundwater Management: Groundwater Reserves as a Hedge Against Climate Change and Drought, Eos Trans Am. Geophys. Union, Fall Meet. Suppl., San Francisco CA, H51G-03 (invited), Abstracts on CD-ROM.
17. *Schmidt, C. M.., *Russo, T. A., Fisher, A. T., *Racz, R. J., Wheat, C. G., Los Huertos, M., Lockwood, B. S., Mitigating agricultural impacts on groundwater using distributed managed aquifer recharge ponds, Eos Trans Am. Geophys. Union, Fall Meet. Suppl., San Francisco CA, H53A-0984, Abstracts on CD-ROM.
18. Papers Presented at Professional Meetings (*student co-authors) *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, 2008. Processes, controls, and potential for in-situ nutrient removal during managed aquifer recharge to a shallow aquifer, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM.
19. *Racz, A., A. T. Fisher, B. Lockwood, M. Los Huertos, C. Schmidt*, J. Lear, 2008. Quantifying the distribution and dynamics of managed aquifer recharge using mass-balance and time-series thermal methods, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM.
20. *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, The magnitude and controls on denitrification during managed aquifer recharge into a shallow, unconfined aquifer in a coastal groundwater basin, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM, 14-18 December 2009.
21. *Racz, A., A. T. Fisher, B. Lockwood, M. Los Huertos, C. Schmidt*, J. Lear, Spatial and temporal variations in seepage during managed aquifer recharge, Am. Geophys. Union, Fall Meet. Suppl., Abstracts on CD-ROM, 14-18 December 2009.
22. *Schmidt, C., A. T. Fisher, A. Racz, C. G. Wheat, J. Sharkey, B. Lockwood, Processes and controls on rapid nutrient removal during managed aquifer recharge, 27th Biennial Groundwater Conference, Abstracts with programs, Sacramento, CA, October 6-7 2009.
23. *Racz, A. J., A. T. Fisher, C. I. Schmidt*, B. Lockwood, and M. Los Huertos, 2011, The spatial and temporal dynamics of infiltration during managed aquifer recharge, as quantified using mass balance

and thermal methods, Ground Water, accepted for publication (pending minor revision).
24. *Schmidt, C. I., A. T. Fisher, A. J. Racz*, M. Los Huertos, and B. Lockwood, 2011, Rapid nutrient load reduction during infiltration as part of managed aquifer recharge in an agricultural groundwater basin, Hydrol. Proc., accepted for publication (pending minor revision).
25. *Schmidt, C., A. T. Fisher, M. Los Huertos, B. Lockwood, Managed aquifer recharge as tool for sustainable management of ground water quantity and quality in agricultural basins, in Towards Sustainable Groundwater in Agriculture, Groundwater Resources Association of California, June 15-17, 2010 San Francisco, CA, p. 154.
26. Langridge, R. and Fisher, A. T., Climate Change, Agriculture and Sustainable Groundwater Management: Groundwater Reserves as a Hedge Against Climate Change and Drought, Eos Trans Am. Geophys. Union, Fall Meet. Suppl., San Francisco CA, H51G-03 (invited), Abstracts on CD-ROM.
27. *Schmidt, C. M.., *Russo, T. A., Fisher, A. T., *Racz, R. J., Wheat, C. G., Los Huertos, M., Lockwood, B. S., Mitigating agricultural impacts on groundwater using distributed managed aquifer recharge ponds, Eos Trans Am. Geophys. Union, Fall Meet. Suppl., San Francisco CA, H53A-0984, Abstracts on CD-ROM.
28. *Racz, A. J., A. T. Fisher, C. I. Schmidt*, B. Lockwood, and M. Los Huertos, 2011, The spatial and temporal dynamics of infiltration during managed aquifer recharge, as quantified using mass balance and thermal methods, Ground Water, doi: 10.1111/j.1745-6584.2011.00875.x.
29. *Schmidt, C. M., A. T. Fisher, A. J. Racz*, C. G. Wheat, M. Los Huertos, and B. Lockwood (2011), Rapid nutrient load reduction during infiltration as part of managed aquifer recharge in an agricultural groundwater basin: Pajaro Valley, California, Hydrol. Proc. , 10.1002/hyp.8320.
30. *Schmidt, C. M., A. T. Fisher, A. J. Racz*, B. Lockwood, and M. Los Huertos (2011), Linking denitrification and infiltration rates during managed groundwater recharge, Env. Sci. Tech., dx.doi.org/10.1021, es2023626.
31. *Racz, A. J., Fisher, A. T., *Schmidt, C. M., Lockwood, B. S., Los Huertos, M., Modeling the spatial and temporal dynamics of infiltration during managed aquifer recharge, Eos Trans Am. Geophys. Union, Fall Meet. Suppl., San Francisco CA, H41E-1077, Abstracts on CD-ROM. (Awarded Outstanding Student Presentation Award)
32. *Russo, T. A., Fisher, A. T., Hanson, R. T. and Lockwood, B. S., Spatial Analysis of Suitability for Managed Aquifer Recharge in a Groundwater Basin in Central Coastal California, Eos Trans Am. Geophys. Union, Fall Meet. Suppl., San Francisco CA, H13E-1259, Abstracts on CD-ROM. (Awarded Outstanding Student Presentation Award)
33. Fisher, A. T., *Schmidt, C., *Racz, A., Los Huertos, M. Lockwood, B., Dynamic Variations and Improvement to Water Supply and Quality during Managed Recharge, 28th Biennial California Groundwater Conference, Groundwater Resources Association of California, Sacramento, CA (invited), Abstracts with Programs.
34. *Russo, T. A., Fisher, A. T., Los Huertos, M., *Jacuzzi, N., Spatial Analysis of Suitability for Managed Aquifer Recharge in Central Coastal California, 28th Biennial California Groundwater Conference, Groundwater Resources Association of California, Sacramento, CA, Abstracts with Programs.
35. Fisher, A. T., *Schmidt, C., *Racz, A., Los Huertos, M. Lockwood, B., Dynamic Variations and Improvement to Water Supply and Quality during Managed Recharge, a presentation to the Pajaro River Watershed Council, 10/13/12.
36. Fisher, A. T., *Schmidt, C., *Racz, A., Los Huertos, M. Lockwood, B., Dynamic Variations and Improvement to Water Supply and Quality during Managed Recharge, a presentation to the South Bay Region of the Groundwater Resources Association of California, 11/11/12.

Our research project focuses on how improvements can be made to water supply and water quality during managed aquifer recharge. We are collaborating on this research with a local water agency, researchers at other academic institutions and the U.S. Geological Survey, and numerous regional stakeholders. The review period included in this summary of results includes the second half of the 2011 water year and the first half of the 2012 water year. The first several years of this project focused on a MAR pond operated by a regional water agency. This pond that is used to recharge fresh water into a shallow, perched aquifer. This water is used by local growers in lieu of pumping groundwater from a regional aquifer that is impacted by overdraft and resulting seawater intrusion. The water put into the pond is diverted from a nearby wetland system during the wet (rainy) season, when flows are sufficient high and water quality is good.

The first three years of this effort focused on this MAR system, but in the last year, we extended these results to two additional settings: an additional recharge basin established by a local farmer to capture stormwater, and a field site owned by the State of California being considered for managed recharge using recycled waste water. We are also extending our work regionally through use of a Geographic Information System (GIS) and a sophisticated regional groundwater model. At field sites, our work involves monitoring the rates of shallow infiltration using mass balance techniques, and determining rates of infiltration at specific locations using heat as a tracer. This last technique involves innovative use of time-series analysis to resolve changes in diurnal temperature changes in shallow soils below the pond. We also monitor groundwater levels and quality using local monitoring wells. We have deployed water content, pressure, and thermal sensors in each project year, allowing us to assess rates of infiltration at different locations. We sampled shallow soils before each recharge season and are sampling these materials again at the end of each recharge season to evaluate the influence of recharge on soil grain size, soil carbon content, and hydraulic properties.

In past year, we focused on write up and publication of several papers in top-tier journals resulting from work at our initial field site. Full pond inflitration rates were typically 1–5 m/day during the initial 2–3 weeks after the MAR pond was filled, but decreased rapidly to 0.2–0.4 m/day and remained at this rate for the next 6–8 weeks. In addition, we documented large spatial and temporal variations in infiltration rates that shifted during a 6–8 week period. The greatest rates of infiltration were initially at the northwestern end, but the center of the highest rate of infiltration swept across the pond to the southeast, as the magnitude of infiltration rates decreased with time. Grain size analyses of samples collected before and after each recharge season suggest that initial periods of infiltration caused the loss of fine grained material from the upper 50 cm of the subsurface. Later in the season, a thin layer of fine sediment accumulated at the base of the pond, causing a reduction in hydraulic conductivity. The net result is that the overall rate of infiltration slowed, and the extent of saturation decreased in the shallow subsurface because the rate of inflow could not keep up with the rate of drainage from below.

Evaluation of fluid chemistry showed that there was a 30-60% load reduction during the passage of water from the pond through the upper 1 m of subsurface soils, and low nitrate water arrived at the monitoring wells surrounding the recharge pond at different times as

a function of distance and direction. Nitrate isotopic analyses showed that the primary mechanism of nitrate removal was denitrification. Comparison of denitrification rates apparent from our data, based on combined chemical and thermal results, are at the high end of denitrification rates detected in soil and groundwater systems in other settings. It may be that this system is especially efficient at denitrification because of the high availability of organic carbon in the diverted fluids, and the availability of particulate carbon in subsurface soils. We have also found that high rates of denitrification were maintained even at some of the greatest infiltration rates, but that eventually (at the highest infiltration rates), we see the expected decrease in denitrification efficiency.

In the last project year, we instrumented a new field site in the southern Pajaro Valley, a three-acre infiltration basin designed to capture stormwater runoff from a 122 acre area. We deployed sediment collection systems, pressure gauges, a rain gauge, and thermal probes. We are collecting these instruments to download data later today, and should have results available from this study in the next 6-8 months.

Information Transfer

We have presented results of this work at numerous public meetings and, as a result, there is growing interest regionally in applying what we have learned to other settings.

Invited presentations were made during the reporting period to the following groups, including scientific and engineering personnel and the public at large:

• University of California, Center for Information Technology Research in the Interest of Society (CITRIS), Program Review presentation, Berkeley CA
• Pajaro Valley Water Management Agency, Board of Directors, Watsonville CA
• Three meetings of the Pajaro Valley Water Dialog
• American Geophysical Union Fall Meeting

We were interviewed by the following media groups, generating stories that were published in major newspapers and/or broadcast on the radio:

• Santa Cruz Sentinel (newspaper), Santa Cruz, CA
• Register-Pajaronian (newspaper), Watsonville, CA

Students supported with NIWR and associated funds, in part, during the project period:

Calla Schmidt, Ph.D. Fall 2011 (CA SeaGrant Postdoc, just accepted offer for tenure track position with the University of San Francisco)
Andrew Racz, Graduate Student (anticipated graduation in Fall 2012)
Tess, Russo, Graduate Student (anticipated graduation in Summer 2012)
Katie Earp, B.S., Spring 2011
Susanna Bird, B.S., Spring 2011 (Env. Chemistry)
Devon Stewart, B.S. Spring, 2011
Christina Richardson, Undergraduate Student (anticipated graduation in Spring 2012)
Barbara Montgomery, Undergraduate Student (anticipated graduation in Winter 2013)

Award No. G09AC0001 Monitoring and Forecasting Climate, Water and Land Use for Food Production in the Developing World

Basic Information

Title:	Award No. G09AC0001 Monitoring and Forecasting Climate, Water and Land Use for Food Production in the Developing World
Project Number:	2008CA262S
Start Date:	10/1/2008
End Date:	9/30/2013
Funding Source:	Supplemental
Congressional District:	
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	

Publications

1. Husak G, J Michaelsen, and C Funk, 2007. Use of the Gamma Distribution to Represent Monthly Rainfall in Africa for Drought Monitoring Applications. International Journal of Climatology, 27: 935-944.
2. 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(1): 47-66.
3. 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, 113, D14112.
4. Verdin, J, G Galu, R Choularton, G Husak, 2008. Integrating Seasonal Forecasts into Food Security Outlook Analyses. Submitted to Food Security and Environmental Change (ENVR 2008): April 2008.
5. Husak G, J Michaelsen, and C Funk, 2007. Use of the Gamma Distribution to Represent Monthly Rainfall in Africa for Drought Monitoring Applications. International Journal of Climatology, 27: 935-944.
6. 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(1): 47-66.
7. 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, 113, D14112.
8. Verdin, J, G Galu, R Choularton, G Husak, 2008. Integrating Seasonal Forecasts into Food Security Outlook Analyses. Submitted to Food Security and Environmental Change (ENVR 2008): April 2008.
9. Husak GJ, J Michaelsen, P Kyriakidis, JP Verdin, C Funk, G Galu. The Forecast Interpretation Tool a Monte Carlo Technique for blending climatic distributions with probabilistic forecasts. International Journal of Climatology, in press

10. Wandiga, S., M. Opondo, D. Olago, A. Githeko, F. Githui, M. Marshall, et al. 2010. Vulnerability to epidemic malaria in the highlands of Lake Victoria basin: the role of climate change/variability, hydrology and socio-economic factors. Climate Change, 99: 473-497.
11. Marshall, M.T., et al. 2010. Assimilation of Surface Reanalysis and Remote Sensing Data for Monitoring Evapotranspiration. (under review Remote Sensing of Environment)
12. Marshall, M. (2010), Agricultural Drought Monitoring with Land Data Assimilation and Remote Sensing, in Remote Sensing of Drought: Innovative Monitoring Approaches, edited by M. Anderson and J. Verdin, p. 270, Taylor and Francis, London, United Kingdom.
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Meeting, Washington DC.
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The Climate Hazards Group (CHG) at the Department of Geography, University of California Santa Barbara has developed a nearly decade-long relationship with the US Geologic Survey (USGS) and Famine Early Warning Systems Network (http://www.fews.net/) investigating and monitoring the physical and social variables affecting food security in the developing world. The outcomes of this research have had profound effects on decision making regarding relief efforts to the developing world, practices for rainfall monitoring both internationally and domestically, as well as supporting ten graduate students in their pursuit of advanced degrees over the course of the project.

The CHG is currently composed of a team of one professor, four field scientists sitting in various parts of Africa and Central America, four researchers/specialists, three computer technicians, four graduate students, one undergraduate, and two USGS employees who sit in our group. This team is tasked with developing new techniques for monitoring food security in the developing world in an effort to provide advanced information to FEWS NET regarding their relief activities. This work is primarily done through leveraging remotely sensed data to monitor rainfall, crop conditions, and hydrologic and climate information to accurately depict ground conditions. When possible, field scientists validate the remotely sensed assessments with field visits (photo of maize conditions in Kenya shown below).

Activities supported under this agreement have resulted in directly informing food security outlook publications which are used by decision makers to determine need-based relief. Additionally, they have resulted in peer-reviewed articles, professional presentations, web-based tools and stand-alone software.

Optimizing efficiencies and economics of solid-set subsurface drip and overhead mechanized systems with flat-planted cropping systems

Basic Information

Title:	Optimizing efficiencies and economics of solid-set subsurface drip and overhead mechanized systems with flat-planted cropping systems
Project Number:	2011CA274B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	44
Research Category:	Climate and Hydrologic Processes
Focus Category:	Irrigation, None, None
Descriptors:	None
Principal Investigators:	Jeff Mitchell

Publication

1. Mitchell, Jeffrey P., Purnendu N. Singh, Wesley W. Wallender, Daniel S. Munk, Jon F. Wroble, William R. Horwath, Philip Hogan, Robert Roy and Blaine R. Hanson. 2012. No-tillage and high-residue practices reduce soil water evaporation. California Agriculture. April June 2012. Volume 66(2):55-61.

While various forms of subsurface drip irrigation (SDI) have largely replaced surface irrigation methods in a number of cropping contexts throughout the San Joaquin Valley's (SJV) Westside region in recent years (Personal communication, T. Turini and D. Munk), interest also exists throughout the area in the potential of overhead mechanized irrigation systems to further enable precise water application, provide labor savings from reduced maintenance and repair needs commonly associated with drip, and permit automation. Overhead irrigation (OH) is currently the most prevalent form of irrigation nationwide (NASS, 2008), and recent surveys in Nebraska, a region similar to California in terms of the general need for irrigation for crop production, indicate that precision overhead systems and recent technological advances in overhead equipment are now rapidly and completely replacing gravity irrigation because of the ability that these systems provide to apply precise water amounts and to increase productivity (Pfeiffer and Lin, 2009). The possible benefits of overhead for SJV systems have been recognized by a number of farmers in recent years throughout the area (Warnert, 2011) as a means for sustaining profitability, increasing competitiveness, and preserving the productive capacity of the region.

The goals of this proposed project are:

1. To compare flat-planted minimum tillage cropping systems under overhead mechanized irrigation and solid-set subsurface drip irrigation in terms of water use efficiency, profitability, soil salinity, and drainage volumes,
2. To determine the effects of tillage and surface residues on soil evaporation, and
3. To extend information developed by this project widely throughout California's production regions

The goals of this project have been to evaluate the potential of mechanized overhead irrigation as an alternative to subsurface drip irrigation for no-till cotton production in California's San Joaquin Valley (SJV) and to characterize management benefits and issues of the overhead irrigation system as a potentially cheaper, water use efficient alternative to both surface and drip irrigation. The project is being conducted in an 8 acre field at the University of California West Side Research and Extension Center in Five Points, CA, in western Fresno County. The first cotton experimental crop was grown in 2011 and the second crop has recently emerged. The study is laid out in a randomized complete block design with four replications of each irrigation treatment as shown in Figure 1.

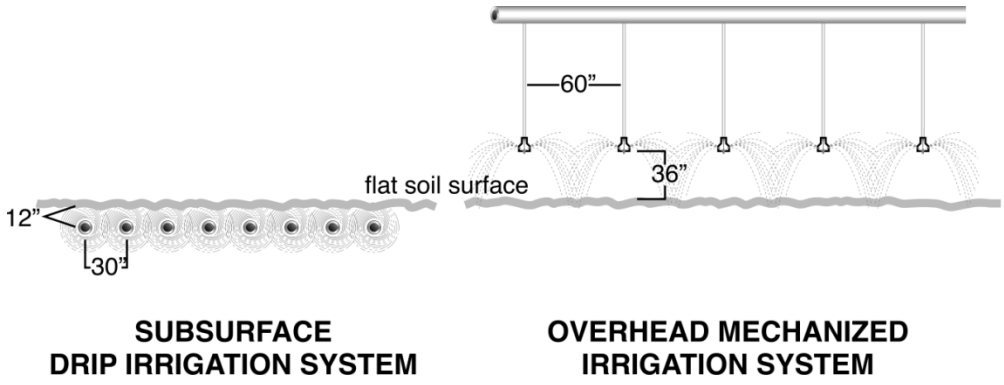

Figure 1. Schematic description of solid-set subsurface drip and overhead mechanized irrigation systems with emitter and nozzle spacings

In conjunction with this study, we have also been quantifying the relative amounts of soil water under residues relative to under bare soil. A publication stemming from this work was recently published in the University of California's *California Agriculture* April – June 2012 (Volume 66:2) issue (http://ucce.ucdavis.edu/files/repositoryfiles/ca6602p55-93537.pdf). This work indicated that over an estimated summer crop season, the use of no-till and surface residues may serve to reduce soil evaporation losses by about 4 inches, or 13% of the ET for a typical summer crop in the SJV.

Major preliminary findings from our first year (2011) work include the following:

1. Similar amounts of irrigation water (about 24") were applied to both systems in 2011
2. There were no significant differences in light interception, indicating that canopy development was similar for both treatments.
3. Overhead had significantly more moisture ($p<0.0001$) than SDI, both in and between rows, consistently throughout the season.
4. OH significantly more chlorophyll ($p<0.05$) than SSDI on 6 of 9 sampling dates.
5. SDI had a significantly higher ($p<0.0001$) temp 6 inches deep, in row on all 10 sampling dates
6. There was an average of 37 mites per leaf in SDI compared to 1 mite per leaf in OH. This was a statistically significant difference ($p<0.0001$). Figure 2.
7. Significantly more weeds ($p<0.05$) in OH than in SDI. Figure 3.
8. No significant differences between the treatments in yield

This study is significant, we believe, because it is coupling two potentially quite promising crop production technologies: overhead mechanized irrigation and no-tillage planting techniques. In the coming year, we will continue the field comparison work and also integrate an economic analysis of the production costs associated with these alternative irrigation and water use efficient tillage systems.

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Information Transfer

This project has provided the backdrop for an ambitious extension education program during the course of our work. On September 8, 2011, we held a public, evening open house event at the site that attracted over 120 participants and was also featured in a press release that was distributed to news outlets throughout the Central Valley. We also filmed a half-hour video segment, 'Rainmakers,' that was aired on KAIL (Channel 59) in the Fresno area, that involved aspects of this work and that also included experts and farmer research partners on this work. One of the students working on this project, Joy Paloutzian, also made a presentation based on her MS thesis work associated with this work at the 2012 California Weed Science Society Conference and received the Society's award for "top student paper' for her effort. Because of the 'new' nature of this work and the fact that overhead irrigated no-till production approaches are not at all widely currently used in the San Joaquin Valley, we also host many informal visitor groups at the study field throughout the year. This work will also be featured as part of our 2012 Twilight Overhead Irrigation and Conservation Agriculture Systems extension education event in September.

Links for examples of outreach associated with our September 8, 2011 public event are provided below.

http://ucanr.org/sites/ct/?blogasset=14128&start=6

http://ucanr.org/sites/ct/?start=11&blogasset=14128

Jeffrey P Mitchell

Conservation tillage allows growers to plant directly into fields that contain residue from prior crops.
Above, tomatoes are transplanted into cover crop residues (triticale, rye and pea) in Five Points.

Sustainable irrigation management of drainage impaired area with 'Natural Drainage'

Basic Information

Title:	Sustainable irrigation management of drainage impaired area with 'Natural Drainage'
Project Number:	2011CA275B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	44
Research Category:	Ecological Processes
Focus Category:	Irrigation, None, None
Descriptors:	None
Principal Investigators:	Wesley W Wallender

Publications

There are no publications.

The absence of adequate drainage due to topographic and environmental constraints has forced the western San Joaquin Valley to tackle problems of shallow water tables with high salinity in general and specific toxic trace elements in particular. The Bureau of Reclamation, under Court Order, is to provide drainage service to the area so as to maintain a long-term, sustainable salt and water balance in the root zone of irrigated lands, sufficient to ensure sustainable agriculture in the region. In March 2007, the Bureau of Reclamation decided to implement a combination of drainage reduction measures, drainage water reuse, evaporation ponds and land retirement in what it calls the In-Valley/Water Needs Land Retirement Alternative. The retirement of irrigated agriculture lands is one of the main components of the plan. In response to concerns about the lack of scientific data to identify potential benefits and impacts of retiring land from irrigated agriculture, a multi-agency team consisting of representatives from the Bureau of Reclamation (USBR), United States Fish and Wildlife Service (FWS), and the Bureau of Land Management (BLM) completed a five-year, large scale Land Retirement Demonstration Project (LRDP) at two drainage–impaired sites on the west-side of the San-Joaquin Valley. Based on the five years of field data from the LRDP, Singh et al. (2009) developed a comprehensive theoretical and numerical modeling framework to evaluate the specific site conditions required for a sustainable land retirement outcomes based on natural drainage. The works of Singh et al. (2009) show the pathway to reducing the salinity levels without the encroachment of the shallow water table in the root zone. The results can be applied more broadly to the drainage management of drainage impaired lands. If the crop and irrigation is managed for salt balance such that leaching is constrained to match the natural drainage rate (defined as the downward flux from the shallow water table to the lower aquifer), the danger of rising water table is avoided. Singh et al. (2009) proposed a ‘natural drainage approach’ to sustainable land management for drainage impaired areas. With this approach it is feasible to design a sustainable land use regimen for drainage impaired lands in general and retired lands in particular. The key to the natural drainage approach is a priori knowledge of the relationship between the natural drainage rate and the depth to the water table from ground surface.

The proposed study aims to use the 'natural drainage approach' for sustainable irrigation management of drainage impacted areas. With an aim to achieve the goals, the main objective of this study is to:

a. Improve and update the numerical modeling framework of Singh et al. 2009 to simulate major processes occurring in the land phase of the hydrological cycle.

b. Evaluate and recommend sustainable irrigation management strategies for the drainage impacted area with 'Natural Drainage" approach.

The drainage impaired sites are characterized by the presence of a barrier layer which divides the perched water layer from the unsaturated flow zone below the barrier layer. We are evaluating five processes occurring in the land phase of hydrologic cycle. The processes that are modeled include the evapotranspiration, unsaturated and saturated flow and the downward flux through the barrier layer. Solute transport in both the unsaturated and saturated zone is also evaluated to quantify the changes in soil salinity in the vadose zone.

The relation between the bottom flux and the groundwater head is the tool that allows one to estimate the natural drainage rate for the given site. The natural drainage rate is the main parameter that impacts the management option for the sustainable land use of the drainage impaired lands. The land use and water application practices are two of the main variables which can be changed to make sure that water table depth never rises above a predetermined level and the root zone salinity levels are maintained within a permissible level. To achieve these two objectives, the following options may be pursued during the simulation exercise, a) change in the land use, crop type, b) growing crops in only a part of the area each year, and c) intersperse dry land farming with other farming activities.

The evaluated natural drainage rate can be used to develop a sustainable irrigation management of drainage impaired area. The developed model and its use will be shared with the concerned stakeholders such as Bureau of Reclamation (USBR), United States Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), Land Retirement Demonstration Project, and the concerned water districts.

Information Transfer Program Introduction

See Project 2011CA273B (CWRRI - Information Transfer Program University of California, Agriculture and Natural Resources)

CWRRI - Information Transfer Program University of California, Agriculture and Natural Resources

Basic Information

Title:	CWRRI - Information Transfer Program University of California, Agriculture and Natural Resources
Project Number:	2011CA273B
Start Date:	3/1/2010
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	44
Research Category:	Water Quality
Focus Category:	Water Quantity, Water Supply, Education
Descriptors:	
Principal Investigators:	Doug Parker

Publications

1. University of California, California Institute for Water Resources, CIWR Supports Water-Related Research , Fact Sheet, 2 pages, February, 2012.
2. University of California, Agriculture and Natural Resources, Healthy Crops, Safe Water , Fact Sheet, 4 pages, February, 2012.
3. UC Delivers showcases unique ways UC ANR is making a difference in California (http://ucanr.edu/delivers/). During 2010-11, UC Delivers reported on six Water Quality outreach efforts (ranging from urban runoff to educating youth on water issues), and seven projects on Water Resources (examples include the coordinating and collaborating with the University of Baja and the State of Baja California to educate growers on water efficiency in the region, practical methods for vineyard irrigation management and how to reduce pollution with proper fertilizer timing).

The CIWR's mission includes research, education and outreach. It is through outreach or information transfer that scientific results become implemented in ways that improve our quality of life. Each of CIWR's projects has some information transfer component. These are listed in the individual projects' reports.

In addition to project information transfer, CIWR engages stakeholders in ways that transfer water based knowledge. This may be through direct presentations or meeting participation, through organizing and sponsoring conference and workshops, or through organizational actions that allow other scientist to engage better with stakeholders. CIWR has begun work on its website and branding. These products will help us become a recognized source of scientific based information concerning California water.

The new Director of CIWR has been working with UC ANR faculty and administrators to form and guide the Water Initiative Panel as it seeks to set leadership for ANR's water programs. The Panel consists of 11 ANR Academics from a variety of disciplines that represent the 3 ANR campuses along with several counties in the state. The Panel has held several meetings and conference calls to begin crafting a vision for a water program. In addition, the CIWR and the ANR Water Initiative organized a 1 ½ day workshop for ANR academics working in water and nutrient management. This meeting resulted in over 20 project proposals at the ANR competitive grants program's Letter of Intent stage.

The CIWR Director has made several presentations to audiences on California water issues, the Clean Water Act, and nitrate pollution in California's groundwater basins. The Director has participated in discussions on management of the Colorado River Basin, environmental services markets, and groundwater nitrate pollution.

The overarching theme of the Rosenberg Forum is to reduce conflict in the management of water resources. Specific sub-themes are chosen by the Advisory Committee for each individual Forum. The primary objective is to facilitate the exchange of information and experience in the management of water resources. The problems of managing and husbanding water are surprisingly common around the world. However approaches and solutions may differ depending upon the available financial resources as well as social and cultural norms. Discussion of alternative approaches and identification of what works and what does not work are intended to aid in devising more effective and efficient water management schemes.

There are two sub-objectives which provide specificity and support in achieving the main objective and in addressing the overarching theme. The first is to emphasize the role of science in making of water policy and in the management of water resources. The second, and related subjective, is to promote exchange and interaction between scientists and policy-makers for the purpose of facilitating the use of science as a basis for the making of water policy. Participants at each Forum are a mix of scientists and policy makers. The presentations and discussion focus equally on illumination of the pertinent science for policy making and on the experience with different policies in different settings around the world.

The Director of CIWR serves as a member of the Rosenberg International Forum's steering committee. The steering committee met in Amman, Jordan in late January to plan the program for its 8th international conference which will be held in Aqaba, Jordan in late September 2012. The theme of this

year's conference will be water management in semi-arid environments. We have secured participation and presentations from Jordanians in Academia and Government.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	3	3	0	4	10
Masters	5	3	0	3	11
Ph.D.	4	3	0	10	17
Post-Doc.	2	3	0	2	7
Total	14	12	0	19	45

Notable Awards and Achievements

Project # 2011CA274B

We believe that in significant ways, the overall innovative nature of this work is quite significant and notable. The coupling of no-till with overhead automated precision irrigation has not been demonstrated before in the SJV and to date, we have had success with this merging of these promising technologies based on our outcomes in 2011 and our initial experiences so far in 2012. In addition, our work investigating the potential of no-till, high residue systems to reduce soil water evaporation is also of note.

Project # 2007CA195G

We have developed multiple spin-off and technology transfer projects in collaboration with the Santa Cruz County Resource Conservation District and several stakeholder groups. Development of a new basin management plan has begun, and our GIS map of MAR suitability is being used as part of that project. We have discussed with staff of the Regional Water Quality Control Board the importance of drafting new agricultural water quality requirements so that they do not prohibit the use of MAR approaches to improve water quality, including commentary on proposed agricultural runoff regulations, and have positively influenced those regulations. We have submitted a proposal to the U.S. National Science Foundation for continuation and extension of this work, and are pursuing additional funding options.

Other Achievements

In collaboration with the California Farm Bureau Federation, CIWR is hosting half-day forums for growers, dairy operators, agency representatives, agricultural commissioners, policymakers and other community members to discuss management of agricultural nitrogen. The two community forums to explore solutions to nitrate in groundwater and the role of policy are being hosted by the UC California Institute for Water Resources and the CDFA Fertilizer Research and Education Program. UC Cooperative Extension specialists will describe methods of managing nitrogen on dairies and cropland. Members of the agricultural industry and representatives of statewide and regional programs will discuss the practical aspects of adopting nitrogen management practices.

Researchers and educators from the University of California and California State University have received funding for joint projects on priority issues such as urban residential water demand and estimating alfalfa's impact on nitrogen and nitrate leaching in the Central Valley. Leadership of California's higher education systems made the funding available to jointly address issues in agriculture, natural resources and human sciences. Project criteria include collaborative research, teaching, or course development; development of student internship opportunities; and workshops, conferences, and symposia. Eight projects totaling more than $79,500 were selected from 30 proposals submitted. Researchers involved in this year's projects are from UC Davis, UC Berkeley and California State University campuses at Chico, Fresno, Humboldt, Pomona, Sonoma, San Marcos and San Luis Obispo.

The Western Extension Directors Association gave the 2012 Awards of Excellence to the Rangeland Watershed Program for its outstanding work with water quality and grazing issues on California s rangelands. Melvin George, UCCE Specialist at UC Davis coordinated multidisciplinary teams (microbial ecologists, veterinary epidemiologists, fishery biologists, hydrologists, soil scientists, plant ecologists, range scientists, farm advisors and more) to work with The California Rangeland Conservation Coalition, a band of 100 diverse environmental, ranching and policy-making groups committed to protecting the state s diminishing rangeland, to use innovative approaches to develop a toolbox of management practices that ranchers and regulators could use to minimize microbial contamination of surface and groundwater connected

with livestock production.

The Russell L. Rustici Rangeland and Cattle Research Endowment announced that it will fund eight University of California research and outreach projects to address beef cattle and rangeland management issues. One water-related project is the statewide coordination of scientific research information regarding livestock grazing and microbial water quality (Edward R. Atwill, UC Davis School of Veterinary Medicine). The goal of this program is to promote collaboration and strengthen the continuum between range cattle producers, Cooperative Extension specialists and other research faculty, and county-based Cooperative Extension advisors.

The advisory panel for the water strategic initiative has been appointed, announced Doug Parker, initiative leader and director of the California Institute for Water Resources. The advisory panels work with the initiative leaders to develop a five-year plan of action for implementing each strategic initiative. If you have suggestions for shaping the plan of action for any of the strategic initiatives, share them with the appropriate initiative leader or panel members.

Professor James Wilen, Department of Agricultural and Resource Economics, UC Davis, was honored at the recent inaugural meeting of the Association of Environmental and Resource Economists (AERE) in Seattle. Wilen's publication, co-authored with Frances Homans (University of Minnesota), was selected as AERE's Publication of Enduring Quality for 2010, as a paper judged to have seminal value and a lasting impact on the profession. Entitled A Model of Regulated Open Access Resource Use, the paper appeared in the Journal of Environmental Economics and Management in 1997, and it showed how the dynamics of resource exploitation are driven by the interplay between biological mechanisms, economic incentives, and regulatory behavior. Nominees noted that the paper turned discussion of fisheries policy on its head, directing attention away from biology and toward the main driver of the status of fisheries, economic incentives operating within a regulatory framework. The award applauded the paper for surprising conclusions that change the prevailing view, together with an elegant explanation for the mechanisms at work that lead to new views about important policy issues.

The Ornamental & Environmental Horticulture, Nurseries & Master Gardener program team and the Water Resources program team have formed project teams that are interested in applying for grants in the next round of the ANR competitive grants program, and to discuss and propose new positions in response to the upcoming ANR call for new positions.

Shelley Murdock and Carole Patterson, UC Cooperative Extension community development advisors launched discussions with five adjacent counties to the Delta to participate in the community water conversations to learn about water policy ptions in the state. These facilitated discussions provided the Delta residents an opportunity to discuss water issues in-depth and share their knowledge and point of view with experts and policymakers. Through models like the Conversations Program, agencies and communities can exchange information and ideas, creating the potential for more innovative approaches to management. To summarize their findings, they produced a short report and a 13-minute video containing some of the comments made at the meetings. They can be viewed at http://ucanr.org/sites/CAH2OConversations.

Ken Tate and Rob Atwill, UC Davis Cooperative Extension specialists, received the Outstanding Achievement Award for Research/Academia at the Society for Range Management s Annual Meeting in February, 2011. The Outstanding Achievement Award is presented by the Society for Range Management for outstanding achievement to members and other qualified individuals and groups working with rangelands. Tate and Atwill are recognized as national and international leaders in the science and management of surface water quality of rangelands. They have compiled an unequaled record of collaborative research leading to a better understanding of surface water pollution on rangelands and practices that ameliorate pollution.