Idaho Water Resources Research Institute
Annual Technical Report
FY 2009

Introduction

The Idaho Water Resources Research Institute (IWRRI) is housed at the University of Idaho. IWRRI is dedicated to supporting and promoting water and water−related research, education, and information transfer throughout Idaho. IWRRI collaborates with researchers and educators from all Idaho state universities; staff of local, state, and federal agencies; and private water interests.

The IWRRI is the only mechanism in the state that provides an autonomous statewide source of support for water research and training without regard to specific topic or discipline area. This is important because Idaho's water problems cross multiple topics and disciplines and compartmental approaches to these problems are less effective. IWRRI is relied upon by state and federal agencies and private water interests to provide the objective expertise to address the needs of the state and region.

The Institute has been a strong proponent of education and outreach for both youth and adult audiences. It is through education that the public can make informed public policy decisions concerning water. It is also through education that individual citizens become engaged in the process through adjustments of their own attitudes and lifestyles.

Research Program Introduction

The Idaho Water Resources Research Institutes research program is comprised of the following objectives: (1) To work with state and federal agencies and non−government organizations to identify water research needs of the state and region; (2) To promote water−related research relevant to state and regional needs; (3) To stimulate, coordinate, and provide leadership for water resources research within Idaho universities and collaborate with sister institutions in adjoining states; (4) To cooperate with and assist state and federal agencies and non−governmental organizations for the benefit of the citizens of Idaho and the region; (5) To encourage and facilitate public involvement in water resource programs within the state; (6) To promote water education within the state at the K−12, undergraduate and graduate levels; and (7) To develop funding for needed research and encourage cooperation with other research organizations.

The projects funded during the 2009 104B Program Fiscal Year spanned the range of water issues facing the State of Idaho. This includes projects that investigate: how wetlands can be used to mitigate the impacts of contamination from past mining activities in Idaho's water bodies; a novel approach to reducing phosphorous contamination in lakes; methods to improve the estimates of key components of the Snake River Plain's hydrology; and linkage between Idaho's energy and water infrastructure in the Snake River.

Wetlands as Sinks for Metal(loid)s in Mining-contaminated Coeur d'lene Basin Soils

Basic Information

Title:	Wetlands as Sinks for Metal(loid)s in Mining-contaminated Coeur d'lene Basin Soils
Project Number:	2007ID72B
Start Date:	3/1/2007
End Date:	9/30/2010
Funding Source:	104B
Congressional District:	First
Research Category:	Water Quality
Focus Category:	Geochemical Processes, Wetlands, Water Quality
Descriptors:	
Principal Investigators:	Matthew Morra

Publications

There are no publications.

Project Summary

Mining activities within the Coeur d'Alene (CDA) Basin have resulted in large areas of metal contamination far beyond the designated Bunker Hill Mining and Metallurgical Superfund Site, contaminating the CDA River and CDA Lake. It will be impossible to remove and dispose of contaminated sediments within the CDA Basin and Lake CDA, and thus management decisions that protect the environment and human health are required. Our recent investigations indicate that continuously reduced sediments of ponds located in CDA River flooplain tailings contain soluble metal(loid) concentrations far less than similarly contaminated lake sediments experiencing active redox cycling. Analyses of plant tissues obtained from aquatic macrophytes within these ponds have confirmed that this stable redox environment decreases metal(loid) bioavailability. However, in preliminary investigations we observed that seasonal redox changes occurring in surrounding agricultural fields appear to mobilize metal(loid)s such that pond waters experience severe contaminant inputs during the spring. We propose that ponds strategically placed with respect to hydrologic gradients might be used as sinks to sequester metal(loid)s released from contiguous agricultural fields, thus decreasing contaminant mobility and bioavailability. Our objective is to determine the potential for ponds located within the floodplain of the CDA River to act as a sink for Cd, Zn, As, Cu, and Pb mobilized during seasonal changes in soil redox. We will achieve this goal by characterizing changes in soluble metal concentrations in ponds located in the contaminated floodplain during the course of one calendar year.

Our overall goal is to suggest management strategies for contaminated floodplain soils that will decrease the mobility and bioavailability of harmful metal(loid)s. We ultimately wish to 1) determine if wetlands in metal(loid)-contaminated areas can be used as contaminant sinks, 2) delineate spatial and temporal variables that control the extent of metal(loid) sequestration, and 3) elucidate the responsible biogeochemical processes. Our studies will help in determining if the creation of wetlands might be used to sequester metals, thereby preventing their further dispersal in the environment.

Total metal(loid) concentrations in the sediment of two contaminated ponds within the Coeur d'Alene Basin were determined on sediment digests using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES). We confirmed that pond sediments are similar in contamination levels as those in Lake CDA and elevated substantially relative to an uncontaminated control pond (Table 1).

Table 1. Elemental sediment concentrations of Lake Coeur d'Alene and an uncontaminated pond in the Coeur d'Alene Basin.

	Element ($\mu mol\ g^{-1}$ sediment)						
	As	Cd	Fe	Mn	Pb	S	Zn
	Lake Coeur d'Alene contaminated sites (Toevs et al., 2006)						
Range	1.2-6.0	0.13-0.39	652-2077	148-436	7.8-31.3	3.5-201	35.0-62.4
Median	2.1	0.23	1441	269	19.9	115	51.5
Mean	2.6	0.24	1473	283	19.4	107	50.5
	Uncontaminated control pond						
Range	0.21-0.29	0.022-0.033	285-344	2.9-4.5	0.072-0.63	2.3-5.8	0.88-2.2
Median	0.25	0.024	326	3.0	0.18	2.6	1.2
Mean	0.25	0.025	320	3.0	0.22	2.9	1.3

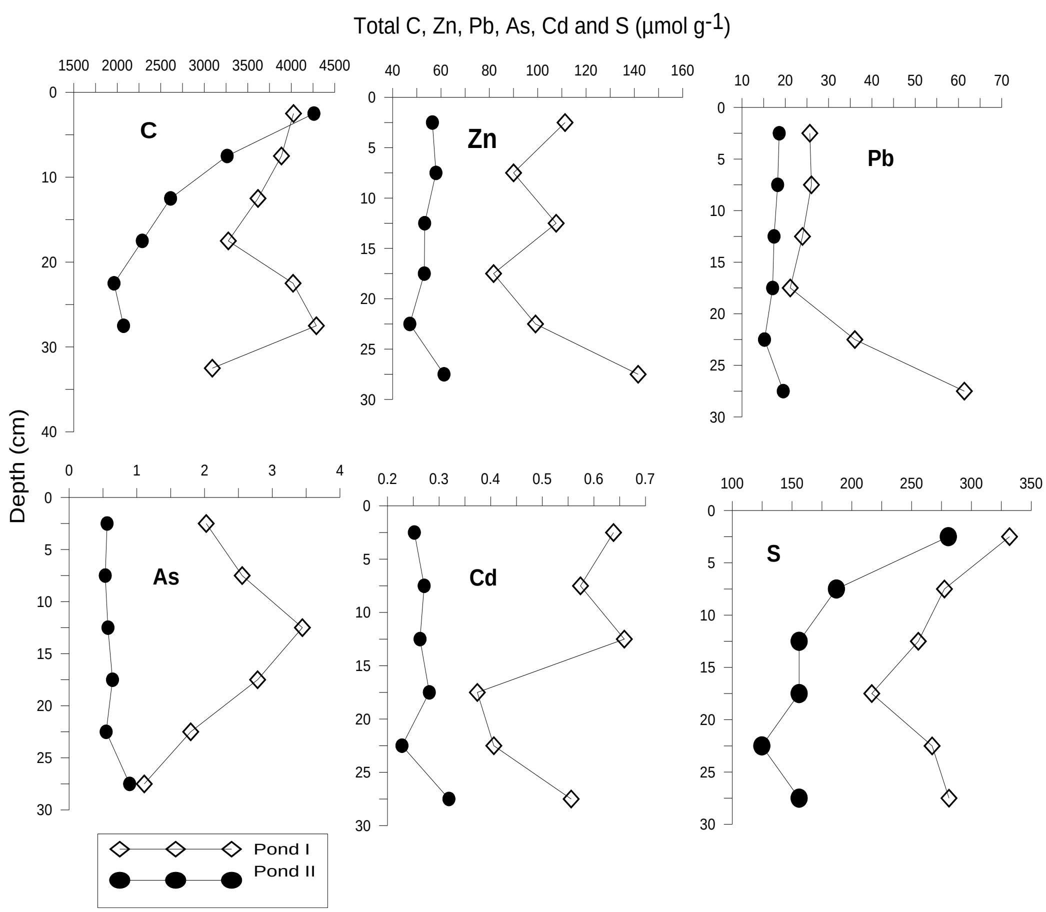


Fig. 1. Elemental concentrations in sediments of two contaminated ponds sampled in the Coeur d'Alene Basin.

Pond waters from two contaminated ponds were obtained at time intervals spanning one year and analyzed for common anions including SO_4^{2-}, PO_4^{3-}, and NO_3^- using ion chromatography (IC). Total dissolved metal(loid)s including As, Cd, Cu, Hg, Ni, Pb, and Zn in the waters were quantified using ICP-AES (Fig. 2). Obvious from Fig. 1 is the huge range in soluble Zn concentrations. The trend is for a very large release of Zn during the least biologically active time of the year, with minimums occurring during the warmest and most biologically active months. The observed release of Zn in February and March most likely results from oxidation of sulfidic precipitates as occurs with decreased microbial activity. This is confirmed by data for SO_4^{2-} that show a corresponding increase during that same time period (Fig. 3).

Shown in Fig. 2 are changes in soluble Pb concentrations in both of the sampled ponds. The trends are similar to those for Zn, but the relative changes in Pb concentration are not as extreme. The formation and oxidation of sulfidic Pb precipitates as with Zn, is the most likely explanation. The data also show the difference in concentration between the bottom and top waters of the ponds indicated, with the highest Pb concentrations measured in the bottom waters (Fig. 2). This indicates a sediment origin for the Pb in contrast to Zn that displays equivalent or higher concentrations in the surface waters.

Our conclusions from the data collected to this point indicate that ponds may be used to reduce soluble metal concentrations in these contaminated environments, but that seasonal changes greatly influence the stability of insoluble complexes responsible for metal(loid) sequestration. Management plans incorporating reduced aquatic environments such as ponds must ensure that seasonal redox changes are minimized in order to maintain low soluble metal(loid) concentrations.

Undergraduate and Graduate Student Researchers supported on the project

Meghan Carter is an M.S. student in the new Water Resources degree program working on the project concurrently as she pursues a J.D. degree. Abu Mansaray is a Fulbright Fellow from Sierra Leone who is also working on the project. He is completely supported by Fulbright funds. An undergraduate student named Kevin Ryan will also start working on the project in June of 2010. Kevin is participating in the NSF program entitled “Environmental Research Experiences for Students from Groups Underrepresented in Science and Engineering”.

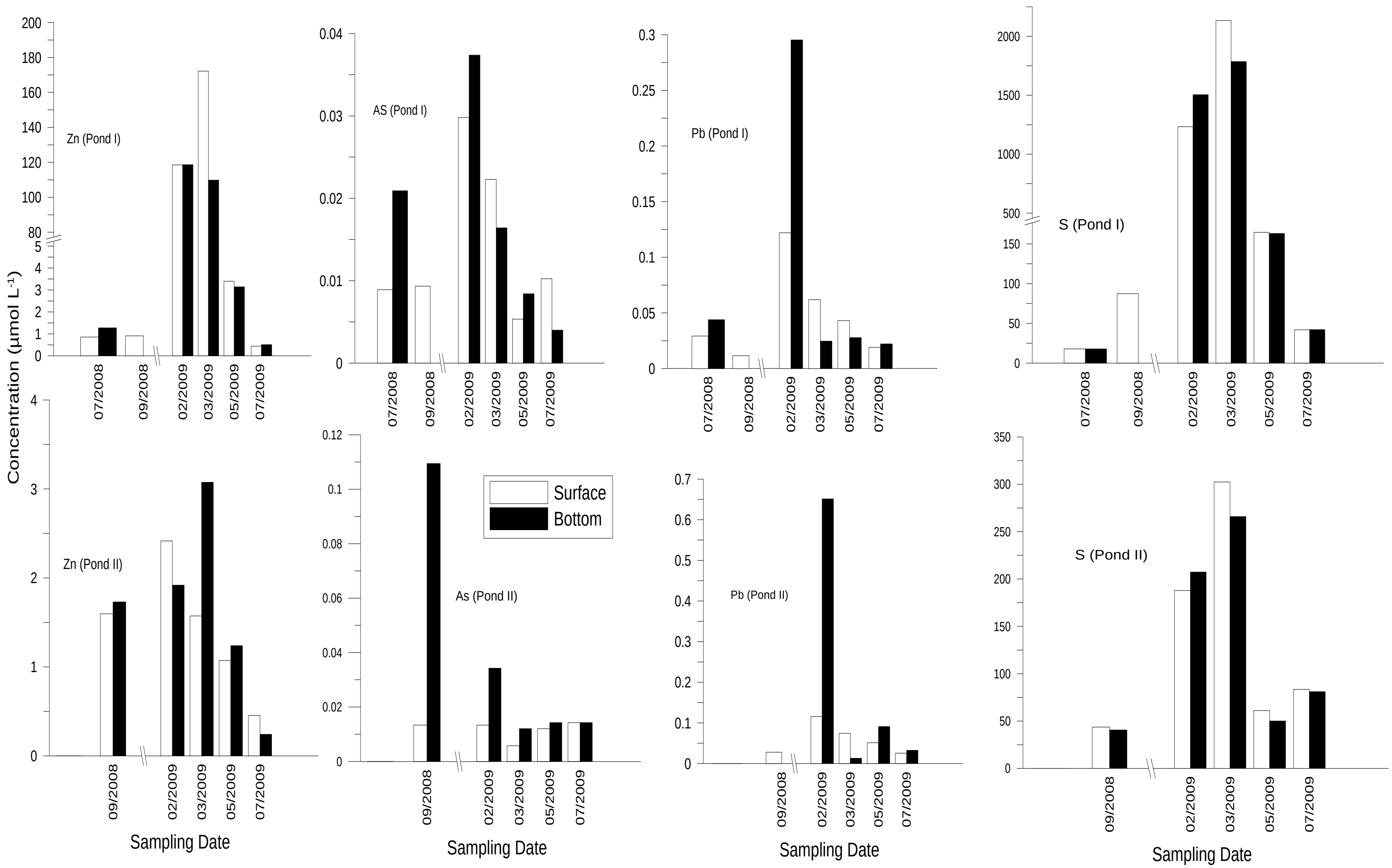


Fig. 2. Total dissolved metal(loid)s in surface and bottom water samples of two contaminated ponds sampled in the Coeur d’Alene Basin.

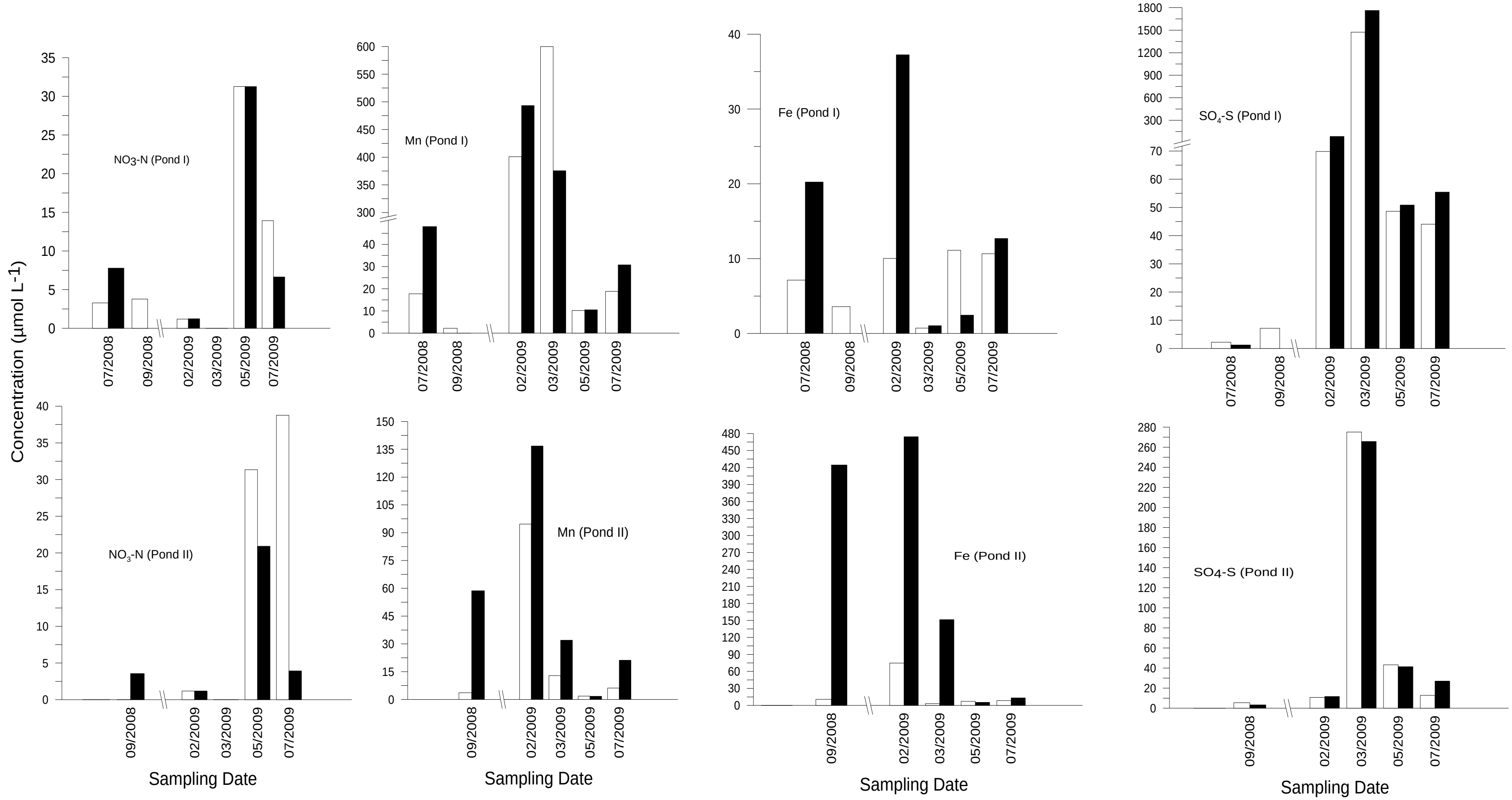


Fig. 3. Dissolved constituents in surface and bottom water samples of two contaminated ponds sampled in the Coeur d'Alene Basin.

Developing Tools to Minimize Jurisdictional Barriers to Achievement of Fishery and Water Resoures Goals in Lapwai Creek, Idaho

Basic Information

Title:	Developing Tools to Minimize Jurisdictional Barriers to Achievement of Fishery and Water Resoures Goals in Lapwai Creek, Idaho
Project Number:	2008ID103B
Start Date:	3/1/2008
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	First
Research Category:	Social Sciences
Focus Category:	Law, Institutions, and Policy, Methods, Ecology
Descriptors:	
Principal Investigators:	Brian Kennedy, Barbara Cosens

Publications

There are no publications.

The PIs for project 2008ID 103B were not able to provide me with an annual report by the reporting deadline. The Institute Director is working with them to complete this report as soon as possible and ensure that the work is completed.

Investigating Mechanisms by Which Long Distance Circulation (LDC) Enhances Surface Water Quality

Basic Information

Title:	Investigating Mechanisms by Which Long Distance Circulation (LDC) Enhances Surface Water Quality
Project Number:	2008ID129B
Start Date:	3/1/2008
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	First
Research Category:	Water Quality
Focus Category:	Toxic Substances, Surface Water, Water Quality
Descriptors:	None
Principal Investigators:	Frank Wilhelm

Publications

1. Wilhelm, F. M., and Adams, C. J. 2009. Quarterly progress report #3 for Monitoring water quality in Willow Creek Reservoir in 2009 and obtaining in- and outflow samples to determine the nutrient mass balance . Submitted to US Army Corp of Engineers, Portland District. 4p.
2. Adams, C. J., and Wilhelm, F. M. 2009. Quarterly progress report #2 for Monitoring water quality in Willow Creek Reservoir in 2009 and obtaining in- and outflow samples to determine the nutrient mass balance . Submitted to US Army Corp of Engineers, Portland District. 4p.

2008ID 129B Frank Wilhelm, University of Idaho

Project Summary

In 2009 we installed large-scale exclosures (Figure 1) to cordon off 'untreated' areas of the reservoir, because the entire reservoir was treated by the installation of eight large solar powered SolarBee circulators. SolarBee made the decision to treat the entire lake in early 2009. To examine the effect of this treatment on the water chemistry, and the phytoplankton and zooplankton communities in lake, we excluded a part of the lake from treatment, to determine potential differences between treated and untreated areas.

Figure 1. 1Large-scale (3 m diam. 10 m deep) enclosures installed in Willow Creek Reservoir in 2009.

Enclosures were installed in early June 2009, and sampled every 2 weeks until early November when they were removed for the winter. Water chemistry in the enclosures showed the same patterns as in the lake, however, the concentration was slightly lower in the enclosures compared to the lake. This pattern remained consistent for the entire duration for which the enclosures were deployed, except for sampling date. An unexplained increase in TP occurred on or around July 20, resulting in a spike in the TP concentration in the lake. A concomitant rise in temperature was also recorded in the lake in the thermal profile as well as in a thermistor string deployed in the lake. Thus we believe this be related to a runoff event that occurred in the watershed. The spike was not noted in the enclosures as they were isolated from the lake. Because the enclosures were not sealed on the bottom, zooplankton, and fish could migrate upward into the enclosures, while phytoplankton settling out of the water column were not retained. We captured zooplankton on all dates, and small (10-14 ind) schools of fish were observed in enclosures on several occasions during the summer. After the lake was strongly stratified and hypolimnetic oxygen was lost, the bottom parts of the enclosures became anoxic and fish ceased to enter them. We also believe that zooplankton exchange with the lake ceased after anoxia. This was the intended design, as zooplankton would be restricted vertically in the lakes as well.

The TN:TP ratio in the lake and enclosures also showed the same patterns except for the above noted date. Overall, at the start of the experiments in June, the TN:TP ratio was 6.3 in the lake and 6.4 in the enclosures. This should have favored the cyanobacteria. At a mass ratio of < 10 P is considered to be in excess and nitrogen limiting for phytoplankton growth. However, as the season progressed, the ratio increased to >10 in both the lake and the enclosures indicating P limitation. Thus from a stoichiometric perspective, cyanobacteria should not have been favored in 2009.

Analysis of phytoplankton from the lake and enclosures showed that cyanobacteria were

present in the lake during the entire summer. Incidentally, the lake suffered a severe cyanobacteria bloom in mid September, while the enclosures remained unaffected. We had predicted that the untreated enclosures would show bloom conditions while the lake would remain unencumbered from cyanobacteria blooms over the course of the year. Thus, it is unclear if long distance circulation can prevent the formation of cyanobacteria blooms in Willow Creek.

A confounding factor may have been the weather. In 2009, the average air temperature was lower compared to 2008, and the volume weighted average temperature of the epilimnion was approximately 1.5 °C lower. As well, water withdrawl for irrigation purposes caused the lake to drop more rapidly in 2009 compared to 2008. Thus, it is unclear if the lack of a summer-long bloom or delayed onset of a bloom in Willow Creek reservoir was related to the SolarBee circulators, or the cooler water temperature in the epilimnion. The bloom in September may have been induced by light limitation at the end of the growing season. Because cyanobacteria can regulate their buoyancy, they may have been able to reduce light deficiencies in early fall and thus generate a bloom.

Zooplankton data are being finalized in the next month, however, preliminary results indicate that large *Daphnia* (herbivores) were present in the enclosures as well as the lake. Thus, zooplankton may also have contributed to the onset of an early cyanobacteria bloom in Willow Creek Reservoir.

Firm conclusions regarding the efficacy of long distance circulators at preventing harmful blooms of cyanobacteria can not be reached at this time given the data on hand. However, overall water movement has been suggested as a method to mitigate against cyanobacteria. We hope to continue experiments this summer, to attempt to eliminate confounding factors and eliminate competing hypotheses.

We consider the deployment of the large-scale enclosures 2009 a success, and plan to continue investigations in 2009. Additional grant funding is being sought, two attempts at a federal earmark (collaboration between industry, university researchers, and federal entity - USACE) have been undertaken but not been successful to this point. A recent (June '10) USACE grant to Wilhelm to undertake additional monitoring on Willow Creek as well as examine fine-scale water movements around the circulators is a direct result of this grant. To date one (1) graduate student (MS) and three undergraduate students, as well as three undergraduate volunteer students have been involved with the research. An additional MS student will join the project this summer on the new grant.

Publications Resulting from the Project

Conference presentation and published abstracts:

Adams, C. J., and Wilhelm, F. M. (Accepted) 2010. Implications of solar powered circulation of an epilimnion for cyanobacteria control on the zooplankton populations within Willow Creek Reservoir, Oregon. Annual joint meeting of the American Society for Limnology and Oceanography and the Norht American Benthological Society. Santa Fe, NM, June 6-11.

Adams, C. J., and Wilhelm, F. M. 2009. The vertical and horizontal distribution of zooplankton populations in response to a mechanical whole-lake management strategy. Annual meeting of the North American Lakes Management Society. Hartford, Connecticut,

USA. October 27-31.

Reports:

Wilhelm, F. M., and Adams, C. J. 2009. Quarterly progress report #3 for "“Monitoring water quality in Willow Creek Reservoir in 2009 and obtaining in- and outflow samples to determine the nutrient mass balance”. Submitted to US Army Corp of Engineers, Portland District. 4p.

Adams, C. J., and Wilhelm, F. M. 2009. Quarterly progress report #2 for "“Monitoring water quality in Willow Creek Reservoir in 2009 and obtaining in- and outflow samples to determine the nutrient mass balance”. Submitted to US Army Corp of Engineers, Portland District. 4p.

Wilhelm, F. M., and Adams, C. J. 2009. Willow Creek 2008 data review. Interim progress report prepared for SolarBee Inc. and US Army Corps of Engineers, Portland District. 4p.

Undergraduate and Graduate Student Researchers supported on the project

Susan Bury (REU) student. Working on undergraduate degree at Moorehad State University, MN. Currently studying aborad for last semester at Waikato University in New Zealand. Completed a side project to this grant that is currently being prepared for publication.

Notable Achievements or Awards

Climate Change Impacts on the Snake River Plain's Surface & Ground Water Resources

Basic Information

Title:	Climate Change Impacts on the Snake River Plain's Surface & Ground Water Resources
Project Number:	2008ID99B
Start Date:	3/1/2008
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	First
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Surface Water, Groundwater
Descriptors:	None
Principal Investigators:	Russell J. Qualls

Publications

There are no publications.

Project Summary

Introduction. Over 3 million acres of farmland are irrigated across the Snake River Plain in southern Idaho. The Snake River Plain encompasses about one-half of the irrigated acreage in the Pacific Northwest. Irrigation demands total some 12 million AF of diversions, and are quite stable from year to year. Irrigated agriculture occupies a significant fraction of the region's economy. Climate change is likely to manifest itself most significantly in changes to the region's water supply. Irrigated agriculture therefore may be one of the region's most vulnerable economic sectors to the impacts of climate change.

More than half of the water supply for the Snake River Plain has its source in the mountains on the eastern edge of the Snake River Plain. Therefore, previous and proposed snowmelt runoff research focuses on the Upper Snake River, which has also been listed in the "highest priority" category for snowmelt runoff modeling by IDWR.

The impact of climate change on southern Idaho water supplies was investigated by coupling a snowmelt runoff model (SRM) with a basin wide model of reservoir operations and prior-appropriation water allocation (MODSIM) to assess the potential changes to supply and distribution of irrigation water. In addition, changes to crop evapotranspiration associated with scenarios of climate change were also evaluated. Six climate change scenarios corresponding to wet, average and dry climate scenarios for two different time periods, one approximately 25 years (2030) and the other approximately 75 years (2080) into the future, were used to cover a range of possible future conditions. The climate scenarios were taken from model output included in the IPCC Fourth Assessment Report (AR4) for the mid-range (A1B) carbon emissions scenario. The climate scenarios impacted the supply through changes to accumulation of winter precipitation and the timing of spring runoff, impacted the allocation because the timing of runoff affected the ability to store and transport water throughout the system, and impacted the net irrigation demand by means of changes to evapotranspiration and precipitation across irrigated cropland. Collectively, these have the potential to impact crop production and revenues.

Results. Results from this study of the impact of climate change on irrigated agriculture can be separated into four different categories: changes to supply, allocation, net irrigation demand, and the economic value of crop production, with respect to historical values of these quantities. Supply corresponds to changes associated with the quantity of snowmelt runoff; Allocation corresponds to changes in the amount of water delivered by the managed system for irrigation purposes; net irrigation demand corresponds to the difference in evapotranspiration minus precipitation over cropland for each climate scenario; and economic value corresponds to changes in crop revenue for various irrigation adaptation strategies. I reported on the first three results last year. This year I report on the analysis of economic impact on crop revenues.

The economic effects of a worst-case climate scenario (2080-Dry) on crop revenue have been modeled and compared with average historical revenues from the Snake River Plain of Southern Idaho. The modeling was based on methods from Contor et al (2008) and Martin et al (1989). The impacts of the climate change scenario manifest themselves through reduced snowmelt runoff, the source of irrigation water supply, and increased demand associated with increased crop evapotranspiration and reduced annual precipitation on agricultural land. On the supply side, the climate scenario yields a 2.73% reduction compared to the historical irrigation water supply after the water has been routed through the existing infrastructure and been subject to water rights priorities.

Three water allocation strategies have been evaluated for the distribution of the 2.73% supply reduction corresponding to the 2080-Dry climate scenario. The first one, the Uniform Percent Deficit strategy, allocated a 2.73% reduction in water uniformly to each crop category across the Snake River Plain. This can be carried out either by reducing the irrigated area, or by implementing deficit irrigation in which the full planted area is irrigated with less water than is required for full yield. Compared to the historical average revenue of $1,967 million from the agricultural production from the region, this strategy resulted in a $62 million reduction aggregated over all crop categories if the UPD strategy was implemented through reducing the irrigated area, but resulted in a $43.8 million revenue increase if the UPD strategy was implemented through deficit irrigation (Fig. 1).

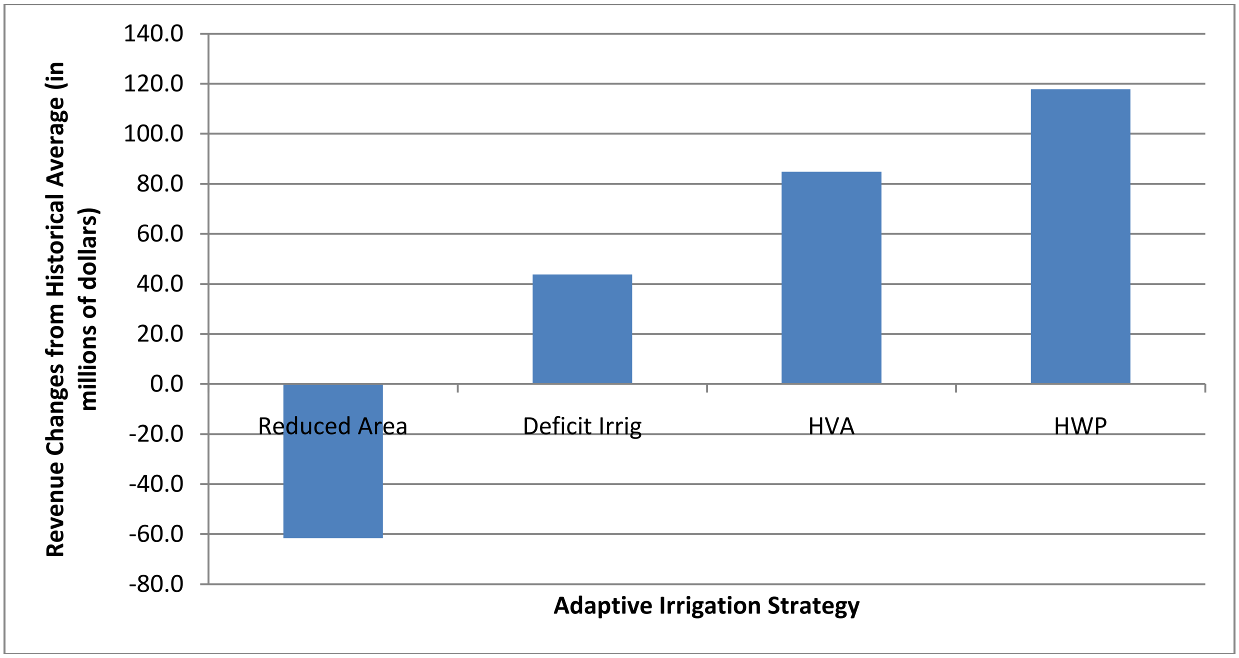


Figure 1. Snake River Plain crop revenue changes relative to historical average of $1,967 million for several irrigation strategies proposed for adaptation to the 2080-Dry climate change scenario which imposes a 2.73% reduction in available water together with increased irrigation demand . The Uniform Percent Deficit (UPD) strategy applies a 2.73% irrigation reduction uniformly to each crop category either by means of reduced irrigated area, and with deficit irrigation (first two columns in fig. 1). The High Value Allocation (HVA) strategy fully irrigates all high value crops and applies the entire water deficit to the crop category (spring grain) with the lowest value per unit of irrigation water. The High Water Price (HWP) strategy distributes water among crop categories in such a way as to equillobrate the crop revenue per unit of irrigation water applied among all crops.

The second strategy, the Highest Value Allocation (HVA), provided full irrigation to the crops with the highest revenue value per unit of irrigation water applied, and relegated the entire water reduction by means of deficit irrigation to the lowest revenue value crop category, which was spring grain in this case. This management strategy produced an estimated $84.8 million excess revenue above the historical average (Fig. 1). The increase in revenue may be attributed to increased yields and a shift toward production of higher valued crops, although no land was shifted from one crop to another; water was simply shifted to meet the full evaporative demand of the higher value crops and low valued crops were shorted water.

Finally, we analyzed a High Water Price strategy (HWP), which generated the crop water allocation that would maximimize gross profit given a water price much higher than historical or current prices, but which would result in equilibrium between climate-driven water supply, which is prescribed for a particular climate scenario, and profit-maximizing demand for irrigation water under the altered climate state. All reductions were applied by means of deficit irrigation. This strategy resulted in reductions in a couple of crops with lower value per unit of irrigation water (spring grain, and winter grain), but increases in the other crop categories, producing an overall increase in revenue of $117.9 million compared to the historical revenue (Fig. 1).

This work demonstrates some of the potential negative financial consequences of climate change if undergone without any change to historical farm management practices. It further illustrates two examples of adaptive strategies that can be employed to overcome and even benefit from potential climate change in terms of crop revenue production. The strategies presented require minimal changes to practice or infrastructure. No land is switched from one crop to another and no new crops are introduced, but water is simply reallocated in a more profitable manner. More aggressive adaptive strategies, such as incorporation of new crops that are better suited to the modified climate which eventually emerges, may provide even better results.

References Cited:

Contor, B.A., G. L. Moore, and G. Taylor, Spreadsheet tool for estimating economic demand for irrigation water using commodity prices and evapotranspiration production functions (Draft 1), Report to Idaho Water Resources Research Institute, June 2008.

Martin, D. L., J. R. Gilley, R. J. Supalla, Evaluation of irrigation planning decisions, J. Irrigation and Drainage Engineering, 115 (1): 58-77, 1989.

Publications . Several drafts of manuscripts for refereed journal articles are in preparation.

Graduate Student Researcher Supported: Ayodeji Arogundade, currently working on the Ph.D.

Notable Achievements of Awards. Delivered invited presentations of portions of this work to the Idaho Senate and House of Representatives' Agricultural Affairs Committees.

Modeling Energy Implications of Water Management Decisions in the Upper Snake River Basin

Basic Information

Title:	Modeling Energy Implications of Water Management Decisions in the Upper Snake River Basin
Project Number:	2009ID138B
Start Date:	3/1/2009
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	1
Research Category:	Climate and Hydrologic Processes
Focus Category:	Management and Planning, Models, Hydrology
Descriptors:	None
Principal Investigators:	Gary Steven Johnson

Publications

There are no publications.

Project Summary

Irrigation is by far the largest consumptive use of water in the western US and in southern Idaho. Irrigation water use in the high elevation eastern Snake River Plain in southern Idaho can have a dramatic impact on hydropower generation throughout the Snake River and lower Columbia River system. Changes in irrigation water management likewise can have beneficial or adverse effects on power generation, however, the two considerations are seldom linked to maximize benefits to both sectors.

The Idaho Legislature directed the Idaho Water Resource Board to develop a Comprehensive Aquifer Management Plan (CAMP) for the eastern Snake River Plain aquifer. The CAMP has recently been approved by the Legislature and lays out plans to modify the aquifer water budget by about 600,000 acre-feet per year. There are several approaches described in the CAMP to collectively accomplish that goal. Although Idaho Power Co. has been involved in the planning of the CAMP, there is no comprehensive recognition of whether the proposed changes will favor or diminish power production, nor recognition of the potential magnitude of the impacts. This situation serves as an opportunity to develop and test a systems dynamics model of the irrigation and hydropower systems of the Snake River.

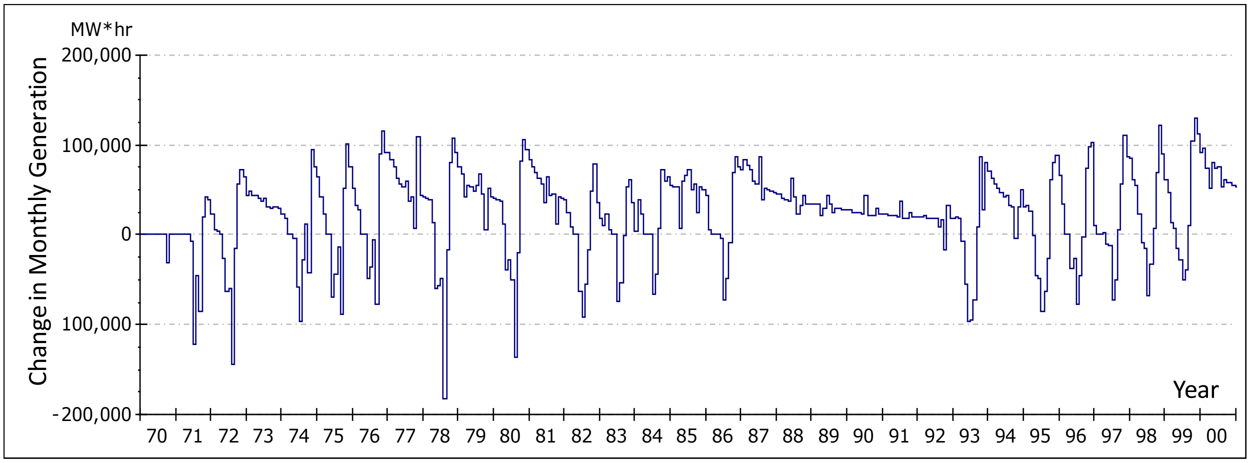
A Powersim systems dynamics model has been developed that represents monthly hydropower production at 22 facilities along the Snake River above the confluence with the Clearwater River. The model simulates *changes* in power production resulting from *changes* in irrigation water use and practices in the eastern Snake River Plain. Any changes in water management impact water storage, irrigation use, and aquifer conditions and these have subsequent effects on hydropower production. The model provides for potential secondary changes in irrigation diversions, aquifer base flow contributions to the river, evapotranspiration, and reservoir storage. For example, in a hypothetical case where more water is available in the river in a given month, the model would need to determine (with user's input) whether the water is available to flow through turbines, bypass turbines because of limited hydraulic capacity, be consumptively used by irrigation, contribute to aquifer recharge and return to the river at a later time, or be stored in a surface water reservoir and later released and possibly diverted.

In pilot applications, the model was applied to evaluate power production effects of two CAMP approaches: 1) the conversion of ground water irrigated acreage to Snake River water, and 2) managed or artificial recharge of the aquifer using Snake River water. The conversion of ground water to surface water temporarily diminishes flow in the river, but the reduced ground water pumping results in increased baseflow which in the long term balances the increased diversions from the river. The net change is only in the timing of flows in the Snake River. This example is described in greater detail below. Managed recharge effects also primarily alter the timing of flow in the river.

The proposed limited conversion of ground water irrigated lands to surface water (Snake River water) irrigated lands is estimated to potentially effect 200,000 acres and 1,100,000 acre-feet of water per year. This water would be diverted from the Snake River in existing canal systems during the irrigation season of April through October. This activity will decrease aquifer pumping of the area by an estimated 400,000 acre-feet per year and likely provide additional incidental recharge associated with canal seepage and field percolation. Together these impacts will increase baseflow to the river in an amount equivalent to the new river diversions (assuming ground-water pumping was meeting consumptive use). Baseflow contributions however, may be downstream of the diversion point, and will be more uniformly distributed than the seasonal character of the new diversions.

A simulation period representing hydrologic and power production conditions of 1970 through 2000 was developed as a potential representation of the future under status quo conditions. A change in flow was simulated in the model at three diversion points reflecting the proposed additional diversions of water. This reduction in river flow was assumed to occur only in years that were wetter than normal. The increased rate of diversions in these years reduced flow in the river in spring and early summer and consequently reduced simulated hydropower production. The increased diversions however reduced levels of ground water pumping and provided additional incidental aquifer recharge. The reduced pumping and increased recharge resulted in longer term baseflow increases to the Snake River that over time increased power production. The model does not include consideration of changes in the value of power during the year, but overall power production was estimated to increase by 8,500,000 megawatt-hours over the 31 year period. A graph of changes in power production resulting from this scenario is presented in the following figure. Periods of negative effects on power generation result from increased Snake River diversions and periods of positive generation reflect a stronger effect of increased baseflow.

The M.S. Water Resources thesis describing the model and findings is expected to be completed in June 2010.



Publications Resulting from the Project
A University of Idaho MS Water Resources thesis is in preparation.
An abstract has been accepted for the Universities Council on Water Resources annual conference in July 2010.

Undergraduate and Graduate Student Researchers supported on the project
University of Idaho MS Water Resources student Kristyn Scott has been and is (as of February) funded under this project and producing a thesis on the described topic.

Development of a Hydrologic Frame Work and Estimation of the Water Balance in the Mountainous Watersheds of Idaho

Basic Information

Title:	Development of a Hydrologic Frame Work and Estimation of the Water Balance in the Mountainous Watersheds of Idaho
Project Number:	2009ID139B
Start Date:	3/1/2009
End Date:	8/31/2010
Funding Source:	104B
Congressional District:	2
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Water Quantity, Surface Water
Descriptors:	
Principal Investigators:	Venkataramana Sridhar

Publication

1. Sridhar, V., Sinnathamby, S., Muche, M., Assessment of Water Availability in the Mountainous Watersheds of Idaho, American Water Resources Association 2010 Summer Specialty Conference, GIS& Water Resources VI, Orlando, Florida, March 29-31, 2010.

BSU Progress Summary : Development of a Hydrologic Frame work and Estimation of the water balance in the mountainous watersheds of Idaho

SWAT model Calibration for the Boise River Basin:

- The Soil Water Assessment Tool (SWAT) model has been implemented.
- The basic drivers for this model are DEM, soils, vegetation and weather data.
- We provide the gridded precipitation and temperature data at the 1/8th degree resolution, derived from Variable Infiltration Capacity input files that are generated by the University of Washington for the historic period.
- Based on the sensitivity analysis, we identified 11 parameters of interest for this basin.
- The parameters are SCS curve number, deep aquifer percolation fraction, maximum canopy storage, soil depth, threshold water depth in the shallow aquifer, available soil water capacity, saturated hydraulic conductivity, channel effective hydraulic conductivity, soil evaporation compensation factor.
- Model Parameters were calibrated using the Autocalibration function in the model.
- Historic period was divided into calibration (1958-1981) and validation (1982-2005) windows for this analysis.
- Flows at Twin Springs and Parma were verified. Simulations results showed a good correlation between observed and simulated flows for the historic periods. Both high and low flows were captured well by the well which is considered as a prerequisite for our implementation of the model with the calibrated parameters under the climate change scenarios.

SWAT model Calibration for the Rathdrum Prairie Basin:

- Model has been configured to run for the whole of Spokane River watershed in order to establish the hydrologic connectivity and watershed characterization including the aquifer.
- Identified 15 sensitive parameters for this basin and they include surface flow, groundwater, soil and snow parameters
- Have completed the initial calibration by dividing the basin into 32 sub-basins, but additional delineation to represent the spatial heterogeneity of the basin is being conducted.
- Initial autocalibration for the Post Falls streamflow station shows good correlation for the historic period.

Next Steps:

- Identify and delineate climate model-downscaled precipitation and temperature products for both Boise and Spokane River basins.
- Run simulations using the calibrated parameters for both basins
- Estimate streamflow and the hydrologic budget in the basins under future climate conditions and report the trends for every decade.

Conference Presentation:

Sridhar, V., Sinnathamby, S., Muche, M., Assessment of Water Availability in the Mountainous Watersheds of Idaho, American Water Resources Association 2010 Summer Specialty Conference, GIS& Water Resources VI, Orlando, Florida, March 29-31, 2010.

Graduate Student:

Muluken Muche was partially supported by this grant between March 2009 and Dec 2009.

Information Transfer Program Introduction

During the 2009 Program Year, 104B program and state funds were used to support the Idaho Water Resources Research Institute Information and Technology Transfer Program. This program includes efforts to reach all water resource stakeholders in the state, from K to Grave. These efforts included; Water Education Workshops for Teachers (300 teachers were trained in 12 workshops across Idaho); groundwater protection workshops for local governments that were held in several locations across Idaho; Youth events across the state which include Water Awareness week (over 10,000 attendees), Youth Water Festival in Moscow and Salmon and Steelhead Days held in Boise; and a state wide water resources seminar series delivered via a compressed video system to Boise, Moscow, Pocatello, Idaho Falls and Coeur d'Alene (20 seminars during the year with an average attendance in all locations of 35 people per seminar).

In addition, during the 2009 Program Year, training opportunities for water professionals were continued through interactions with the Boise Watershed Center. The IWRRI also developed or sponsored three water resources workshops, conferences and symposia focusing on specific water resources issues of interest across the state, region and nation. These meetings were: the University of Idaho's Presidents Sustainability Symposia focused on Sustainable Energy Production and Use, held in Idaho Falls, ID in October of 2009; The Palouse Water Summit, held in Moscow, ID, in October 2009; Idaho Water Users Conference, held in Boise, ID in January 2010; and the Water and Land Use in the Pacific Northwest Conference held at Skamania Lodge, WA on November 4th - 6th, 2009. Finally, the IWRRI continued its support of the new Idaho State Chapter of the American Water Resources Association by recruiting members and providing sponsorship and publicity for several of its events.

In addition to these activities, one Information Transfer project was ongoing during the 2009 Program Year assess the economic impacts of water transfers within the Magic Valley (Twin Falls area) of Idaho, which is part of the Snake Plane aquifer which is currently undergoing the largest water rights adjudication effort in the United States.

Community Economic Impacts of Water Transfer in the Magic Valley

Basic Information

Title:	Community Economic Impacts of Water Transfer in the Magic Valley
Project Number:	2009ID136B
Start Date:	3/1/2009
End Date:	2/28/2011
Funding Source:	104B
Congressional District:	2
Research Category:	Social Sciences
Focus Category:	Economics, Surface Water, Irrigation
Descriptors:	
Principal Investigators:	Phillip S. Watson, Stephen C. Cooke

Publications

There are no publications.

Community Economic Impacts of Water Transfers in the Magic Valley

Project Summary – completed up through 2/28/2010

A customized social accounting matrix (SAM) has been developed for the magic valley which specifies all the transactions that take place in the economy. The SAM is originally based on secondary data and was obtained through the IMPLAN economic modeling software. This original SAM was then modified with primary data and information to better and more accurately reflect true economic relationships in the Magic Valley. Because a SAM must accurately represent every sector of a regional economy, much work goes into developing a customized SAM for a specific region that incorporates all the best available information that is available on that region.

A large component of the SAM generated for the Magic Valley is the water usage by sector for both ground and surface water. The data for the Magic Valley SAM is compiled primarily from the IMPLAN input-output regional modeling system (MIG 2007); however, water and land use and values, and cattle and feedlot data were collected from other data sources. The IMPLAN Data Guide describes their data collection for the county level social accounts, used in this study, in detail (Olson and Lindall 1999). IMPLAN amasses the social accounts data from various data sources including the U.S. Census Bureau, U.S. Bureau of Economic Analysis (BEA), and ES-202 employment data.

Water use data is obtained from the United States Geological Survey (USGS, 2005). The data is divided into ground and surface water withdrawals for seven sectors: irrigation, livestock, aquaculture, mining, public supply, domestic supply, and industrial. These seven USGS sectors are divided into the various SAM sectors using 2007 Agricultural Census, and Idaho Department of Water Resources (IDWR), and County Business Patterns data (USDA, 2007; IDWR, 2009; and USCB, 2006). The agricultural sectors in the SAM (Field Crops, Potatoes and Onions, Alfalfa, Horticultural Crops, and Sugar beets) use different amounts of water; therefore, the USGS irrigation water withdrawals are proportionately allocated to the agricultural sectors. To calculate the proportions, 2007 Agricultural Census data is used to sum the total number of irrigated acres in the Magic Valley and the number of irrigated acres for each for each agricultural SAM category (USDA, 2007). Then the ratio of the total number of irrigated acres for each SAM category to the total number of irrigated acres in the Magic Valley is calculated. The livestock water withdrawals are broken out proportionately, because differences in water consumption, into the SAM livestock sectors (i.e., dairy, feedlot, and range cattle sectors). The inventory numbers for dairy, feedlot, and range cattle is obtained from the 2007 Agricultural Census and the Idaho Department of Water Resources (IDWR) provides the total water consumption for dairy and non-dairy cattle (USDA, 2007 and IDWR, 2009). To calculate the proportions, the dairy, feedlot, and range cattle total water consumptions are divided by the total water consumption for all three categories. The aquaculture, mining, public water, and domestic water withdrawals values are *not* disaggregated into different SAM categories, they go directly into the other livestock, mining, water utilities, and owner-occupied dwelling SAM sectors, respectively. The industrial water withdrawal values are proportionately disaggregated into the construction and manufacturing (crops, animal, other, wood, and technology) SAM sectors. The consumptive water use for these sectors is directly proportionate to the size of the industry. Therefore, we use the County Business Patterns data to obtain percentage of employees in each industry as a proxy to the size of these sectors (USCB, 2006).

According to the USGS Idaho water use data 2,256 million gallons of water are supplied to the Magic Valley each year. Of this, 1,731 and 505 million gallons go to agriculture and livestock, respectively. As a result, agriculture and livestock account for 99 percent of water use in the Magic valley.

As of 2007, Idaho has not established a water market; therefore no price of water is available. Idaho created the Idaho Water Bank, which allows unconsumed irrigated water to be sold at a *sets* rental rate (IDWR, 2006). However, this rental is not established by a market and does not reflect the true market price of water. The difference in value between land and water and just dry land is the value water (Contor, 2009). The data on the assessed value of land is collected from the Idaho State Tax Commissions through personal contact with Rick Anderson (ISTC, 2009). The value of dry land is calculated by taking the difference between irrigated land and non-irrigated land. To calculate the opportunity cost of water, the value of dry land is subtracted from the value of land and water, and then it is divided by the quantity of water (i.e., P=V/Q), and is $46 per million gallons. The municipal water price is not needed because these sectors are very small compared to agriculture. For example, agricultural and livestock land account for 97 percent of the land use and 99 percent of water use. The total value of water in the Magic Valley is $106 million. Of this, agriculture accounts for $79.5 million or 77 percent, while livestock account for $22.24 million or 22 percent. Together, these two industries account for 99 percent of the water value.

Based on the SAM developed here a nested computable general equilibrium (CGE) model is currently being built and is near completion. This model incorporates water in a novel and unique fashion compared to previous CGE models. Water is incorporated as a primary factor of production for agricultural operations and for a municipal water providing sector only. This municipal water sector then uses primary water to produce “city water,” which is consumed by other businesses as an intermediate input, and by households through their demand functions. Additionally, this model incorporates differing consumptive water use rates for the respective sectors; thus, the total available water in the basin is increased when water is transferred from a sector with a high consumptive water use rate to one with a lower rate. Land is also incorporated into the model as a primary factor of production for all sectors and water is not modeled as being appurtenant to land, as per Colorado water law. Compared to previous studies, this model also uses a more disaggregated sectoring scheme which was shown to have important implications for the results.

Publications Resulting from the Research

There has not, as of yet, been any publication from this research. Publications are planned upon completion.

Notable Achievements

Although his thesis was not directly related to this research, the graduate student who worked on this project won the outstanding thesis award by the Western Agricultural Economics Association.

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USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	2	0	0	0	2
Masters	5	0	0	0	5
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	8	0	0	0	8

Notable Awards and Achievements

The PI for project 2008 ID99B (Russ Qualls) Delivered invited presentations of portions of this work to the Idaho Senate and House of Representatives' Agricultural Affairs Committees.

The graduate student who was partially supported on project 2008 ID136B won the outstanding thesis award from the Western Agricultural Economics Association.

Publications from Prior Years

1. 2003ID11B ("Validating Metal(loid) Flux Predictions from Lake Coeur d'Alene Sediments Using Contaminated Ponds as Mesocosms") - Articles in Refereed Scientific Journals - L. L. Oram, D. G. Strawn, M. J. Morra and G. Moller, 2010, Selenium Biogeochemical Cycling and Fluxes in the Hyporheic Zone of a Mining-Impacted Stream, Environ. Sci. Tech., 44(11), pp 4176-4183.