The Institute for Water & Watersheds (IWW)
Annual Technical Report
FY 2010

Introduction

At Oregon State University, over 125 faculty teach and conduct research in areas related to fresh water supply and quality. These faculty members are spread among six colleges and represents many different academic disciplines – including engineering, ecology, geosciences, social sciences, economics and arts. OSU also hosts a vibrant Water Resource Graduate Program where students can earn specialized degrees in water resources engineering, science, and policy and management.

The IWW is the hub for this diverse water research community. It seeks to solve complex water issues by facilitating integrative water research. The IWW's functions are to:

- Assemble diverse research teams and lead interdisciplinary and transdisciplinary water research projects.
- Help policy makers and water managers collaborate with university faculty and students.
- Offer training and access to water quality and stable isotope analysis facilities through a shared laboratory called the IWW Collaboratory.
- Encourage community and collaboration among water faculty, students and water managers by sponsoring events and producing a weekly campus water newsletter.
- Assist water faculty with project development and management.

Research Program Introduction

Why Focus on Water?

Oregon's economic vitality is directly tied to water. Water is “virtually” embedded in all Oregon products, from timber and salmon to solar panels and semiconductors. But water supply and demand in the state is changing. There is now less snowpack in mountain regions and the snow is melting earlier in the spring and summer. These changes have implications for irrigation, human consumption, hydropower generation and ecosystems. Shifting population, land use patterns and environmental policies will also influence the future supply and demand for abundant clean water.

In the academic community there is growing recognition that the solutions to future water challenges lie not within a single discipline or subject but through the connection of concepts between multiple academic fields and through successful collaboration between academics and water managers. For example, anticipating the effect of climate change on Oregon’s water resources requires not just the input of climatologists and hydrologists but also the perspective of many others from biologists and sociologists to water managers and policy experts.

Through an integrative research approach, the IWW seeks answers to questions important for Oregon, the nation and the world, such as:

- Where are climate change and human activity most likely to create conditions of water scarcity?
- Where is water scarcity most likely to exert the greatest impact on ecosystems and communities?
- What strategies would allow communities to prevent, mitigate, or adapt to scarcity most successfully?

The campus also hosts strong graduate degree programs in Water Resources and is located near state-of-the-art experimental watersheds and a suite of federal environmental laboratories. Below are short descriptions of some of the university's strengths in the areas of:

- water science
- water engineering
- water policy and management

Water Science

The OSU community has one of the largest gatherings of hydrologists and ecologists in the USA. They include not only campus faculty but also courtesy faculty from the suite of federal research laboratories located adjacent to campus. This combination makes for a world-class grouping of people, mapped against one of the strongest hydrological gradients (from the super-humid Oregon Coast to arid Eastern Oregon) in the world. The campus is known for its cross-discipline collaborations -- for example faculty from the top-ranked forestry and conservation biology programs collaborating on salmon conservation studies. Many researchers take advantage of nearby field laboratories such as the NSF Long Term Ecological Research (LTER) facilities at the HJ Andrews Experimental Forest and industry timberland instrumented watersheds in the Oregon Coast range (Hinkle Creek, Alsea and Trask).

Water Engineering

Unlike other land-grant institutions, OSU's engineering connection gives it strengths in treatment technologies for surface water, groundwater, and wastewater systems. OSU Engineering now ranks in the top 50 programs in the US. Many OSU engineers specialize in biological treatment methods and OSU hosts a Subsurface Biosphere Initiative that emphasizes interdisciplinary research on soil and groundwater microbial ecology. Many engineering faculty are also connected to the Oregon Built Environment & Sustainable Technologies Center (Oregon BEST) that connects the state's businesses with its shared network of university labs to transform green building and renewable energy research. Partnering with the OSU College of Business places a “business face” on the sustainability of engineered solutions to water problems. Before graduating, many engineering students enroll in coursework leading to a business savvy Entrepreneurship Minor.

Water Policy And Management

Addressing water resource challenges and reducing conflict in the US and abroad requires that water professionals and decision-makers receive specialized resources and skills that go beyond the traditional physical systems approach to water resources management. OSU offers a post-graduate certificate as part of their Program in Water Conflict Management and Transformation. The program leverages personnel from the top-10 nationally-ranked Geosciences Department, the top-five nationally ranked College of Forestry, as well as specialists in water policy, social science, communication, and anthropology. The “softer side” of OSU water has close links with UNESCO, the World Bank, the US Bureau of Reclamation and the US Army Corps of Engineers.

The Influence of Sediment Deposition on the Emergence Success of Juvenile Salmonids

Basic Information

Title:	The Influence of Sediment Deposition on the Emergence Success of Juvenile Salmonids
Project Number:	2008OR103B
Start Date:	3/1/2008
End Date:	2/28/2011
Funding Source:	104B
Congressional District:	5th
Research Category:	Climate and Hydrologic Processes
Focus Category:	Sediments, Ecology, Geomorphological Processes
Descriptors:	
Principal Investigators:	Stephen Lancaster

Publications

There are no publications.

The Influence of Sediment Deposition on the Emergence Success of Juvenile Salmonids

Final Report, May 2011

Submitted by, Christine May and Stephen Lancaster

Research Objectives

The objective of this study was to quantity how the depth and composition of deposited sediment affects the emergence success of juvenile salmonids. Our approach utilized experimental channels at the Oregon Hatchery Research Center (OHRC) to vary the depth and composition of sediment overlying incubating eggs in a series of two experiments. We anticipate that increases in burial depth will result in substantial mortality by entrapping juvenile fish in the subsurface environment. The critical depth at which substantial mortality occurs is important to quantify because the risk of sediment deposition often poses a greater risk than streambed scour (the common assumption) during floods (May et al. 2009). We further anticipate that fine sediment will decrease the depth at which mortality occurs. These results can be used to develop monitoring and risk assessment strategies that can aid in habitat conservation and setting restoration goals for rivers that support gravel-spawning fish.

Research Approach

Experimental stream channels at the Oregon Hatchery Research Center (OHRC) were used to directly test the effect of sediment depth and composition on salmonid egg survival using a series of two experiments. In coordination with the Oregon Department of Fish and Game, fertilized steelhead trout (*Oncorhynchus mykiss*) eggs from the local Alsea fish hatchery were buried in artificial redds in the experimental channels. The gravel composition already in place in the OHRC channels is equivalent to the caliber of gravel used in natural stream channels by the salmonid species (Kondolf and Wolman, 1993); however, it lacks a sand component because a settling pond at the water intake removes this size fraction. This makes the OHRC channels ideal for our experiment because we can precisely control the sand to gravel ratio in our experiments. Unfortunately very fine particles of silt and clay do pass through the settling pond because of low settling velocities, and could have affected survival rates within the channels.

The **first experiment** was conducted during the spring of 2009 and tested the effects of varying fill depths using in-situ gravel. Artificial redds were constructed by pounding a standpipe into the streambed to the desired burial depth, pouring in eyed eggs, removing the standpipe, and ensuring closure of the well hole (**Figure 1**). Juvenile fish emerging from the artificial redds were captured in emergent traps that were built on-site. Each emergent trap was placed directly over an artificial redd, and covered a 0.5 m radius around the egg pocket. Emergent traps were made from fine-mesh aluminum screens, with lids to reduce avian predation. The bottom edge of each emergent trap was buried in the substrate in order to create a tight seal and minimize escapement.

For the experimental control, artificial redds were buried to a 20 cm depth, equivalent to the mean burial depth of salmon and trout observed in previous studies (DeVries, 1997). Five replicates of three treatments that represent a gradient of conditions (2x, 3x, and 4x increases in egg burial depth) were compared to a control (1x), resulting in a total of 20 randomized experimental units within the four experimental channels at OHRC. Channels were randomly assigned to treatments, and each artificial redd contained an equal number of eyed eggs (n =

100). An additional cohort of 100 eyed eggs was also raised in the hatchery to assess the effects handling stress on survival rates.

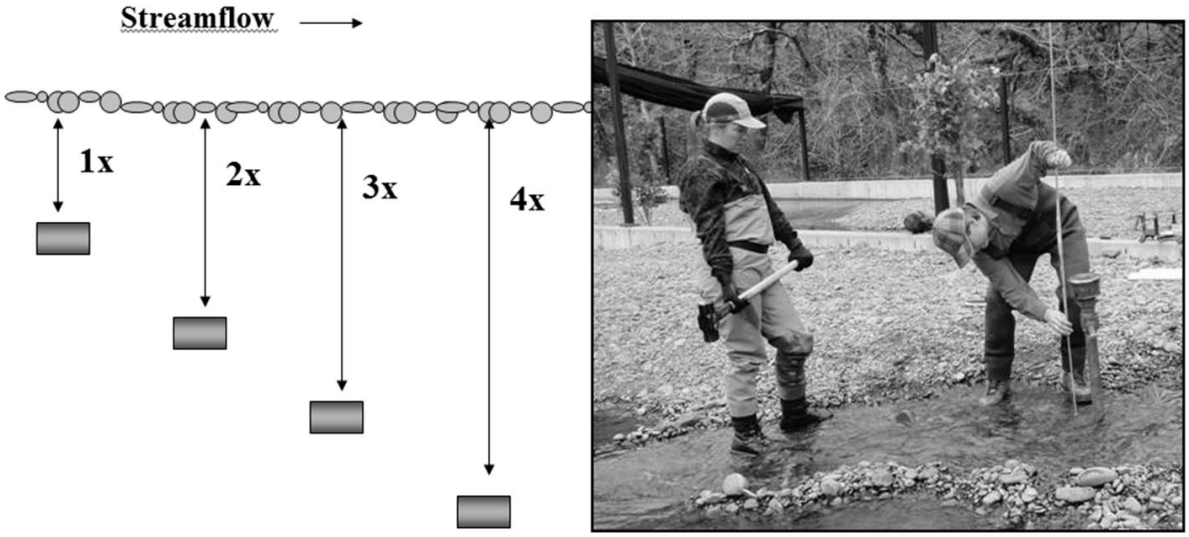

Figure 1. Schematic of experimental design and photograph of standpipe insertion into streambeds for artificial redd placement in OHRC channels.

A **second experiment** was conducted in the spring of 2010 to test how the composition of sediment affects fry emergence through varying depths of fill. Fine sediment was added to the gravel used in the initial experiment, equivalent to 10% by volume of sand. In order to insert the precise sand and gravel mixture into the experimental channels at OHRC, we constructed a large steel core to excavate a 0.5 m diameter hole in the streambed (**Figure 2**). Excavation depth exceeded the egg burial depth by 5 cm in order to completely encapsulate the artificial redds within the sand-gravel fraction used in the experiment. Small diameter (3 mm mesh) flexible plastic screen lined each excavation site, and extended above the surface of the streambed to both contain the sand-gravel fraction and function as an emergent trap. The experimental sand-gravel mixture was then added to the excavated whole, with a standpipe placed in the center to facilitate egg placement. After all excavations were made, eyed eggs were placed in each experimental unit and the standpipes were removed. Four replicates of three treatments that represented a gradient of conditions (1x, 2x, and 3x increases in egg burial depth with 10% sand) was compared to a control (1x, no sand fraction), resulting in a total of 16 experimental units. Channels were randomly assigned to treatments, and each artificial red contained an equal number of eyed eggs (n = 100). An additional cohort of 100 eyed eggs was also raised in the hatchery to assess the effects handling stress on survival rates.

Figure 2. Steel core device that was used to isolate a portion of the streambed in 2010. Experimental mixture of sand and gravel was added into the interior, rebar and flexible plastic mesh extended 5 cm below the egg burial depth (20 cm, 40 cm, 60 cm) to contain the substrate mixture and function as an emergent trap. Experimental channels at OHRC were dewatered during the instrumentation phase and flow was returned to the channels several days prior to placement of the eggs and standpipes were removed.

In both years, juvenile fish emerging from the artificial redds were captured in emergent traps. Fish screens at the end of each channel were also installed to catch any fish that may escape the traps. Traps were checked daily and data on the number, size, timing, and condition of each fish were reordered. All fish were preserved for future laboratory analysis. At the end of emergence a three-pass snorkel survey, followed by elecroshocking was conducted to quantify any escapement from the traps into the channels.

Preliminary Results

The **first experiment** to test the effects of varying fill depths using in-situ gravel was conducted at OHRC from March – May, 2009. Preliminary results indicate a strong linear decrease in survival by burial depth (**Figure 3**). However, it is important to note that overall survival in the experimental channels at OHRC was low despite high survival of the laboratory cohort (>90%), indicating that conditions within the experimental channels were not ideal. Of particular concern was the fraction of very fine sediment in the streambed gravels that could not be removed by the settling pond at the inlet of the facility. Our volumetric estimates of fine sediment in the experimental channels indicate 11% of silt and clay sized material. These very fine and highly cohesive particles can reduce survival by coating the egg membrane and reducing subsurface flow through interstitial spaces in the streambed gravel. Another difficulty that we

experienced during this study was capturing emergent fish. Although the traps we constructed are a standard procedure for estimating survival rates, their trapping efficiency has never been tested. Because escaped fish in our experiments were secondarily trapped within the experimental channels, we could calculate an average trap efficiency for each channel. The overall trap efficiency was modest (64% average capture success) but highly variable (range of 41% to 86%).

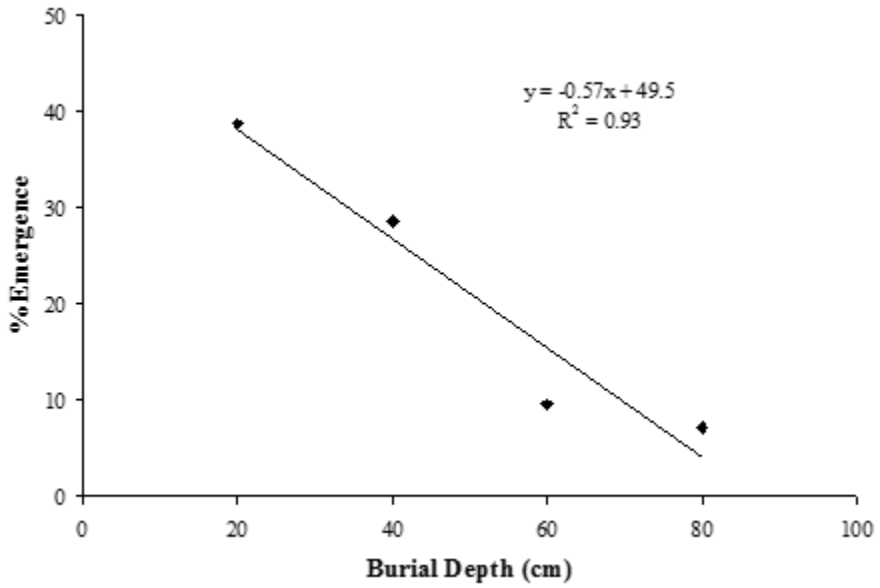

Figure 3. Preliminary results from the first experiment in 2009, indicating a strong linear decrease in survival with burial depth.

The **second experiment** was conducted in March - May of 2010 and tested how the composition of sediment affects fry emergence through varying depths of fill. Channels were randomly assigned to treatments, consisting of a control (1x burial depth) and sand addition of 10% by volume at varying burial depths (1x, 2x and 3x). It was our great misfortune that the control channel for our experiment was comprised, thus making it extremely difficult to interpret the treatment data without a control for comparison. Unbeknownst to us, an experiment that was conducted prior to ours in the OHRC channels used the control channel to study hatchery and wild fish mating. After the completion of the prior experiment, OHRC staff dewatered the channels for several days. However, cool wet winter conditions during the dewatering period allowed the eggs laid during the prior experiment to survive and they hatched into our control channel during the same time (and using the same species) as our study. Therefore, we were unable to distinguish between fish that hatched from our experiment and those that hatched from the previous experiment. Interpreting our results was further confounded by low trap efficiencies from the individual redd caps.

Subsurface burial chambers used in 2010 completely encapsulated the desired sediment mixtures in the experimental channels and were designed to provide a more effective means of

trapping emergent fish. Although the emergent traps extended to 5 cm below the depth of the egg pocket and extended up to the water surface, the trap efficiency was surprisingly low (average = 38%; range 30 – 48%). These results suggest that a great deal of subsurface movement occurs prior to the swim up phase of emergence. Observations made in an incubator housed in the OHRC lab support this idea because hatched fish were observed migrating in the subsurface for distances that exceeded 50 cm (as viewed through the clear side panels of the incubator). These results have important implications for interpreting numerous studies of egg survival that have been based on emergent trap data, and our study provides the first direct test of this standard method.

Current Efforts

Based on the lack of results from the 2010 experiments, due to the contamination of our control channel by a previous experiment at OHRC, we are continuing this research beyond the duration of our grant. To avoid the difficulties we experienced with high levels of silt and clay in the channels, potential for contamination of the channels by other experiments, and low trap efficiencies, our current efforts are utilizing large fiberglass troughs to simulate incubation habitat. A total of four troughs (0.82m wide x 0.56m deep x 4.42m long) were filled to a depth of 30 cm with cleaned gravel from the experimental channels. Each trough was sectioned into four compartments separated by mesh screens to avoid fish migration but not to impede the flow of water. Water flows equally to each trough and is filtered to remove suspended sediment. In each of the four compartments an artificial redd of 100 eyed eggs was inserted to a depth of 20 cm. A control (clean gravel) will be compared to three treatments (20%, 30% and 40% sand by volume). This experiment is currently in progress and will be completed in June, 2011.

Literature Cited

DeVries, P. 1997. Riverine salmonid egg burial depths: review of published data and implications for scour studies. Canadian Journal of Fisheries and Aquatic Sciences 54:1685-1698.

Kondolf, G.M., and Wolman, M.B. 1993. The sizes of salmonid spawning gravels. Water Resources Research 29:2275-2285.

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Vegetation and Soil Processes in Restored Wetlands

Basic Information

Title:	Vegetation and Soil Processes in Restored Wetlands
Project Number:	2009OR112B
Start Date:	3/1/2009
End Date:	2/28/2011
Funding Source:	104B
Congressional District:	5th
Research Category:	Water Quality
Focus Category:	Wetlands, Conservation, Management and Planning
Descriptors:	
Principal Investigators:	Mary Santelmann

Publications

There are no publications.

Vegetation and Soil Processes in Restored Wetlands

Principal Investigator:	Mary Santelmann, Assistant Professor, Senior Research Dept. of Geosciences, 104 Wilkinson Hall, Oregon State University, Corvallis OR 97331
Co-investigator:	David Myrold, Professor Dept. of Crop and Soil Sciences, Oregon State University
Graduate Student:	Sara M. Taylor, M.S. student, Environmental Sciences
Undergraduate Student:	Elizabeth Leondar, BioResources Research

Project period: February 2009-February 2011

EXECUTIVE SUMMARY

Wetlands have been identified as critically important for provision of a number of ecosystem services such as water quality improvement, flood protection, and conservation of native plant and animal diversity (Mitsch and Gosselink 2007, Costanza et al. 1997). Wetland restoration is being considered as a watershed-scale tool for assisting in the meeting of these ecosystem services (Primovich 2008; Willamette Partnership 2008). Several recent reviews have discussed the need to incorporate information concerning provision of ecosystem services into tools that help decision makers evaluate alternative policies for land use and management (Kentula 2007). However, the most commonly used methods used to evaluate wetland functions often rely on site characteristics assumed to be associated with particular functions (such as denitrification, or other forms of nitrogen removal) in the absence of actual data concerning the level to which a particular wetland site actually performs such a function. For example, currently used hydrogeomorphic (HGM) assessments score wetlands for certain observed variables and relate these variables semi-quantitatively (on a scale from 0 to 1 relative to reference sites) to specific functions (Smith et al. 1995; Adamus and Field 2001), producing a site-level score related to estimated site quality or ability to perform functions as compared to reference sites. There is a need for research on how wetland vegetation, soil characteristics, and soil microbial communities interact in wetlands to influence processes such as denitrification, and to understand how these environments compare to agricultural fields, which may also provide some of the same ecosystem services. In addition, we need to better understand how different methods used in restoration may influence these processes.

Results of this project have assisted in advancing our understanding of vegetation and soil responses to various restoration scenarios, and will assist in the development of further research for evaluation of the ability of restored wetlands to provide ecosystem services such as conservation of native plant diversity and nitrogen removal through various soil processes such as N2O evolution and denitrification. An improved understanding of the range of values and natural variability in soil nitrogen processing is an important first step in development of benchmarks for evaluating restoration success.

We investigated relationships among wetland restoration methods, establishment of native vegetation and soil characteristics (such as soil organic matter content, soil water content) in influencing three endpoints for evaluating wetland restoration success: (1) per cent cover of native plants and plant diversity and (2) soil potential for denitrification/ N-processing as measured by denitrifying enzyme activity (DEA) at three restored wetland sites, three natural wetland sites, and three agricultural sites that were being used for crops, but resembled sites that have been restored to wetland vegetation prior to their restoration.

The project addressed issues of long-term water and watershed management with an emphasis on sustainable solutions that balance stewardship of resources with economic viability. We partnered with the USDA NRCS and the Portland Metro wetland mitigation programs to assist them in evaluating the degree to which wetlands are fulfilling their intended role. We promoted education about and implementation of sustainable practices for improved watershed management by presenting our findings at meetings, and plan to publish the project results in peer-reviewed journals such as Restoration Ecology. The results of the project will also provide materials for lectures in courses taught by the PI and co-PI.

PROJECT DESCRIPTION

Project results and benefits

The project described here was intended to result in an improved understanding of wetland vegetation and soil processes in restored wetlands as compared to natural wetlands, or the agricultural fields that are converted to wetlands through programs, and to provide baseline information for preparation of a follow-up research proposal to a funding agency such as the National Science Foundation or EPA. In addition, the project helped to build collaborative relationships as well as identifying hypotheses and research questions for follow-up proposals.

Nature and scope of project

We hypothesized that denitrification enzyme activities (DEAs) would be related to soil properties such as soil organic matter (SOM) and nitrate in soil water, and that recently restored wetlands and adjacent cropped areas would have more homogeneous soils than natural wetlands. We expected that recent restorations and cropped areas would have relatively low and less variable potential for denitrification as measured by DEAs (cf. Bruland et al. 2006). We also anticipated that native plant species might respond differently to variation in soil processes, and that both the legacy of prior use on soils of restored wetlands and feedback between vegetation and soils in these wetlands over time would influence the rate at which these restorations achieve the goals of enhancing native plant diversity and providing habitat for native species.

We addressed two project objectives with the research reported here:

1. To determine rates of DEA in wetland soils and explore the potential relationships among vegetation, soil characteristics, and soil processes such as denitrification.
2. To measure wetland site response to different restoration methods and evaluate these methods for their relative success in establishing native plant cover and native plant diversity

Both objectives have been met and both of the students whose research comprised the project have made presentations to their peers concerning their research results.

Methods, procedures, facilities

Study Region

The NRCS is currently working on several wetland restoration projects in the Tualatin River Basin near Forest Grove and in conjunction with The Nature Conservancy and other partners have established a wet prairie restoration at Gotter Prairie. We selected reference sites from wet prairie remnants in the region with the assistance of Kathy Pendergrass of the USDA NRCS, and agricultural field sites for comparison with the assistance of Portland Metro, the USDA NRCS and the US Fish and Wildlife Service. All but the Green Mountain reference site and the Westbrook agricultural field are within the Tualatin River Basin, the Green Mountain wet prairie remnant is just north of the Tualatin River Basin near Camas, Washington and the Westbrook site is just south of the Tualatin River Basin near Rickreall, Oregon

Vegetation analyses

At each study site, a set of three 10 x 10 m vegetation plots were placed within the wetland at randomly selected coordinates, with nested 1 x 1 m vegetation plots at the northwest and southeast corners of the plot. In each plot, all vascular plant species were identified and visual estimates of the per cent cover of each species as well as the portion of the plot which was bare ground or water were recorded. Verification of field identifications (especially for grass and sedge species) is being conducted in cooperation with the Dr. Richard Halse of the Oregon State University herbarium. The data were analyzed using the NMS ordination program PC-ORD, which separated the study sites into two groups, the remnant and restored sites, separated by several characteristic species with high indictor values.

In addition, at one restoration site where an experiment with different seeding treatments had been established (grass only, forbs only, grass + forbs together), three replicate 1 x 1 m plots were located in each of the three replicate treatment plots, for a total of nine 1 x 1 m plots per treatment and 27 overall, to investigate effects of seeding treatment on plot diversity. The USDA NRCS is fully-funding all aspects of the seeding treatments at the Hutchinson restoration, but has no funding dedicated to monitoring or evaluation of restoration success. Our project provided initial monitoring of the first year results of these seeding treatments with respect to species diversity, as well as data from additional

sites in the region for comparison. A second year of vegetation analysis of the seeding treatment experiment plots at the Hutchinson site was completed in July 2010.

The data analyses and conclusions of these studies are presented in the Masters thesis prepared by Sara Taylor which is scheduled to be defended on June 1, 2011.

Seeding experiment results

From the results of two years of monitoring the Hutchinson wet prairie seeding experiment, we can conclude that the seeding treatment in which grasses and forbs are sown together shows the highest in native plant species abundance and species richness. Drilling grasses in first results in high native cover but lower species richness in comparison to the other treatments. Planting of forbs only results in lower diversity and higher cover of introduced species. Low species richness in the grass only treatment is most likely a result of early, rapid grass emergence that creates shading and therefore retarding forb emergence. It may also be influenced by the use of herbicides to control weeds in the grass only plots (Taylor and Santelmann forthcoming).

The results from this experiment indicate that high native plant species richness can be obtained by seeding in native grasses and forbs at one time instead of sowing in grasses and forbs one year after the other. Substantial decreases in introduced plant species cover from 2009 to 2010 were observed in all seeding treatments, which indicates that native plant species can compete successfully with introduced species for space within the wet prairie community, at least over a two-year time period. Established native perennial grasses limit space available for exotic annual seeds to germinate and limit light available to exotics reducing exotic productivity and shifting competitive interactions in favor of natives (Corbin and D'Andonio, 2004).

Comparison of Wet Prairie Remnants and Restorations

Soil sampling

Soiling sampling

Soil sampling occurred seasonally to capture the major changes in soil water content and temperature. Soils were sampled seasonally, at four dates throughout one year: in September 2009 prior to the rainy season, in November 2009 at the start of the rainy season, in February 2010 in the height of the rainy season, in April 2010 towards the end of the rainy season. Five soil samples from each plot were collected at approximately 10 m intervals, starting at about 1 m from the northwest corner of the plot. All samples were collected within 25 m of the boundary of the plot. Each sample was collected using a metal soil core (2.5 cm diameter), collecting the top 15-20 cm of soil. The five soil cores from each plot were composited into a plastic bag and refrigerated until processed. This provided three composite samples of about 500 g (wet weight) of soil from each study site at each sampling date.

Soil analyses

Each composite soil sample was measured for potential N2O and denitrification enzyme activity. Samples were also processed for extraction of DNA for analysis of the size and composition of the denitrifier community (Rich and Myrold, 2004). Analyses of these DNA extracts will be conducted by the undergraduate student over the summer of 2010. Ancillary measurements of soil water content, nitrate concentrations, and soil organic matter content were also made using standard methods.

.**Denitrification Enzyme Assays (DEAs)**
Soil (~20 g wet weight) from each sample was weighed into a 125-ml Erlenmeyer flask amended with 25 ml of a solution containing final concentration of 240 μg glucose-C ml^{-1} glucose and 40 μg KNO_3-N ml^{-1}. Flasks were sealed with rubber stoppers. The headspace of the flask was flushed with Argon gas for 1 minute. All flasks were placed onto a shaker table for 1 hour on speed 2 to allow the soils to reach room temperature and thoroughly mix with the glucose-nitrate solution. After the hour, 500-μl samples were removed from the flask via gas-tight syringes and injected into a Varian 3700 Gas Chromatograph equipped with a ^{63}Ni electron capture detector. Eight 500-μl samples were injected (once every 30 minutes). After the first three injections, 12 ml of acetylene gas was added to each flask (acetylene was added immediately after injection three so each flask had 30 minutes of exposure to acetylene before injection four).

Nitrate
Soil (~10 g) was weighed into screw top containers and 50 ml of 0.05 M K_2SO_4 was added to the containers. These were shaken for 60 minutes and the contents were poured into filter-lined funnels and filtered (Whatman #2) into small screw cap vials. An Astoria Pacific authoanalyzer was used to measure NO_3^- concentration by the cadmium reduction method.

Water content
Approximately 20 g of soil were weighed into metal tins. These tins were placed into a drying oven at 100 degrees Celsius for 24 hours. The tins were removed and re-weighed to determine the water content of each soil sample.

RESULTS

Soils analyses

Soil moisture content
Average moisture content of the soils varied among sites, with the lowest values in September (15% to 38%) and the highest values in November (25 to 46%). The Knez site was the wettest of our study sites, and samples from that site had the highest soil moisture content, ranging from 38 to 46 % (Table 1). Soils from the wet prairie remnant sites tended to have higher soil moisture content (17 to 46%) than the restorations (15 to 32%), whereas the lowest soil moisture content was found in samples from the agricultural field sites (11 to 27%).

Soil organic matter content

Soil moisture content and organic matter content tended to be highest at the wet prairie remnant sites, although the Gotter Prairie South site is quite similar to the Gotter Prairie North site. Soil organic matter and moisture content were higher in restorations than agricultural sites (Table 2); no pattern was seen in soil acidity, with all site types having an average pH of 5.8.

Rates of denitrification

Rates of N2O evolution from soil samples were available for samples from all sites collected in February and April (Figure 1 and 2 below). Technical difficulties with the analytical equipment resulted in poor quality data for the samples collected in September and November sampling periods, however, these issues were resolved soon after. Highest rates of N2O evolution were found for the Knez remnant site, the Gotter Prairie South remnant, and the Hutchinson restoration in February, and for the Green Mountain, Knez prairie remnant sites, followed closely by the Gotter Prairie Agricultural site and Hutchinson restoration site in April. The Gotter Prairie N and Lovejoy Restoration, Westbrook and Zurcher agricultural sites tended to have lower rates of N2O evolution in both sampling periods. Once data on soil organic matter content and on microbial communities are available from summer 2010 analyses, we will have the information we need to investigate the relationships among soil characteristics and nitrogen processing.

Table 1. Average soil moisture content in samples collected at project study sites

Site	% Moisture (September)	% Moisture (November)	% Moisture (February)	% Moisture (April)
Wet Prairie Remnants				
Knez	0.38	0.46	0.42	0.39
Gotter Prairie S	0.17	0.48	0.39	0.33
Green Mountain	0.26	0.42	0.45	0.36
Wet Prairie Restorations				
Hutchinson	0.20	0.32	0.31	0.25
Lovejoy	0.18	0.32	0.27	0.24
Gotter Prairie N	0.15	0.26	0.30	0.26
Agricultural Fields				
Zurcher	0.19	0.26	0.26	0.22
Westbrook	0.11	0.27	0.28	0.26
Gotter Prairie	0.18	0.25	0.25	0.18

Table 2. Soil characteristics averaged over all sampling dates for remnant, restored and agricultural sites

Site type	Site Names	% organic matter	% moisture	pH	texture class
Remnants	**Gotter Prairie South**	6.8	33.0	5.3	silty clay
	Green Mountain	13.0	36.0	5.4	clay
	Knez	9.1	39.3	6.8	clay
AVERAGE		**9.6**	**36.1**	**5.8**	
Restored	**Hutchinson**	6.9	25.1	6.2	clay
	Lovejoy	6.5	23.6	5.8	clay
	Gotter Prairie North	6.4	26.5	5.5	clay
AVERAGE		**6.6**	**25.0**	**5.8**	
Agriculture	**Zurcher**	6.4	22.3	5.9	clay
	Westbrook	3.7	25.6	6	silty clay loam
	Gotter Prairie Ag	6.0	18.1	5.4	silty clay
AVERAGE		**5.3**	**22.0**	**5.8**	

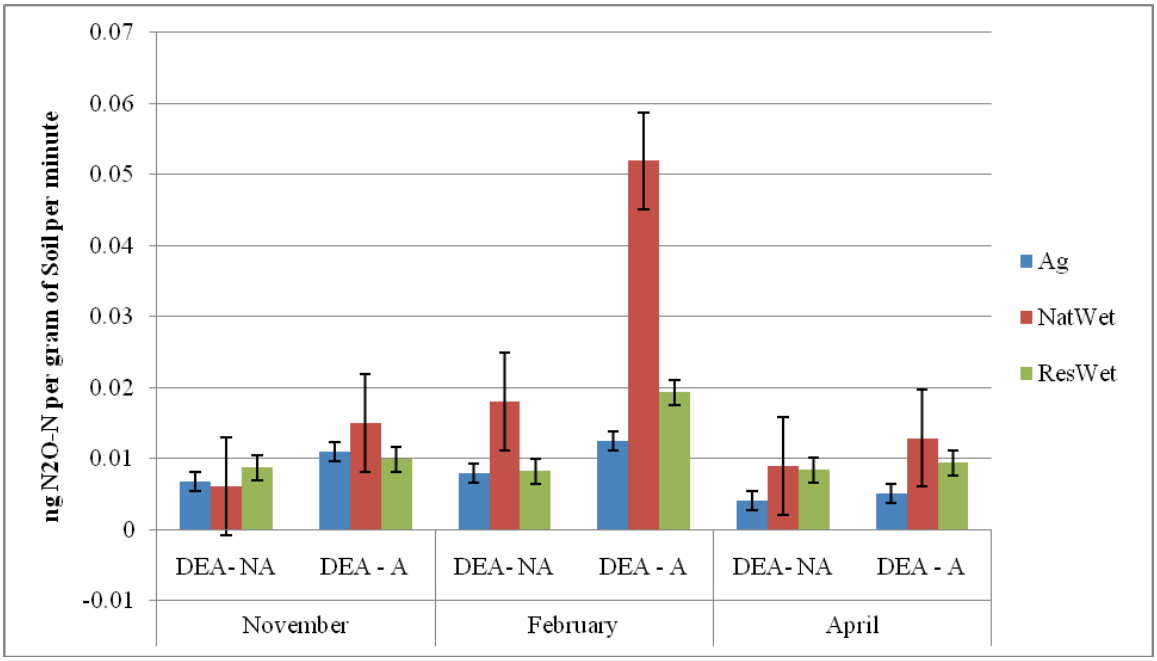
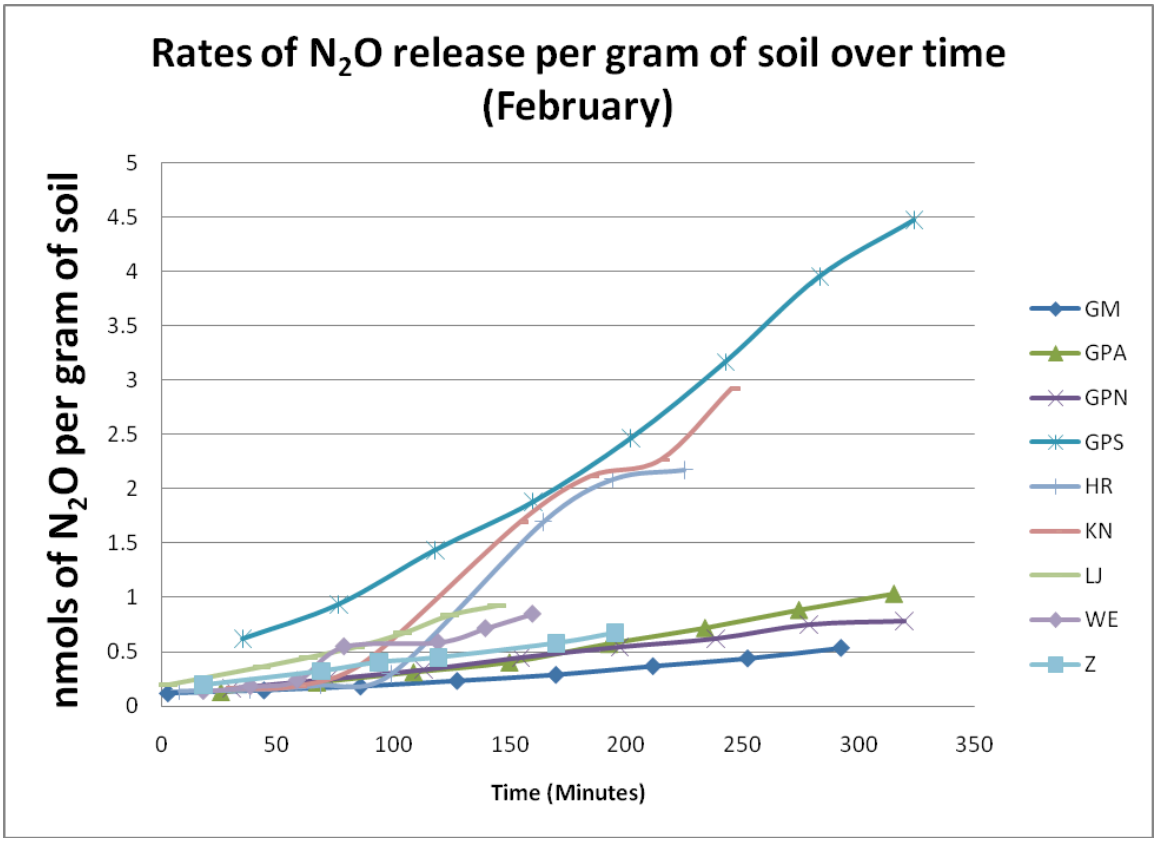
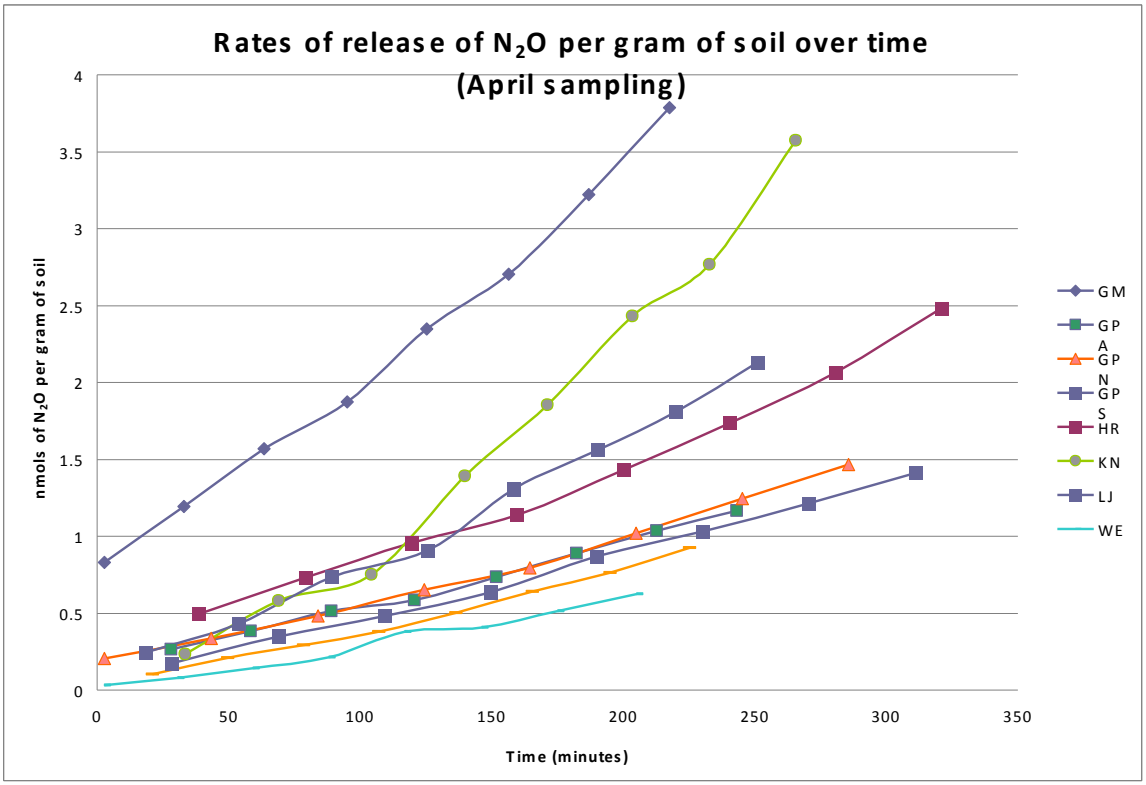


Figure 2. Denitrification rates (with and without acetylene) between agricultural (Ag), natural wetland (NatWet), and restored wetland (ResWet) sites sampled in November 2009, February 2010, and April 2010 (Figure courtesy of Betsy Leondar).

Figure 1. Rates of N2O release (A) from February and (B) April sampling periods





Vegetation analysis

Native plant cover

Comparison of the average plant cover in the remnant and restored sites revealed very little difference among sites, with the exception of the Lovejoy restoration site, which has approximately 30% more cover than the rest of the sites

Plant species richness

A total of 117 species were recorded as present in plots over all study areas; 55 were native and 62 were introduced (Table 3). Of these, 24 species were found in both remnant and restored sites (18 native and 6 introduced). A total of 44 species were unique to the remnants only (22 native 22 introduced). Plots on restored sites had a total of 49 unique species (15 native and 34 introduced). No statistically significant difference was found in native species richness between remnant and restored prairies (p-value 0.9485, N=6). This suggests that land managers have been able to restore vegetation whose native plant species richness resembles the species richness of the best intact remnant prairies within the Northern Willamette Valley Ecoregion in a relatively short period of time (8 years or less). However, a set of more than 20 native species are unique to remnant prairies, whereas species composition of restored prairies generally reflects the diversity of propagules used in establishing native vegetation.

Native species abundance and richness with environmental variables

The NMS ordination separated site types in species space (Figure 3). Remnant prairies positively associated along Axis 1 with a range of separation between negative and positive associations along Axis 2 with species most highly associated with those axes. Restored prairies negatively associated along Axis 1 with Gotter Prairie North being the center point within the ordination. Lovejoy showed slight positive associations along Axis 2 and Hutchinson showed slight negative associations along Axis 2. The NMS ordination also showed that some variables (% soil moisture and February through July flooding) were positively associated with the remnant prairie at Knez. Other positive associations were % organic matter, % sand, native species richness and abundance, years in management and perennials in the Green Mountain remnant. Lovejoy and Hutchinson had negative associations with % soil moisture and positive associations with November flooding and management categories (use of clean crops, yearly mowing and chemical application).

Highest Pearson and Kendall correlation values with species in the main matrix were: *Anthemis cotula,* an introduced, annual forb (-.744 on Axis 1); *Deschampsia cespitosa*, a native, perennial graminoid (-.764 on Axis 2); and *Veronica perigrina*, a native, annual forb (-.770 on Axis 1). A native, perennial forb, *Lomatium bradshawii*, also had a relatively high correlation with Axis 2 (.644). Highest correlations with the second matrix were: % soil moisture (.931 on Axis 1), native species richness (-.803 on Axis 2), use of clean crops (-.900 on Axis 1), February flooding (.901 on Axis 1) and November flooding (-.790 on Axis 1).

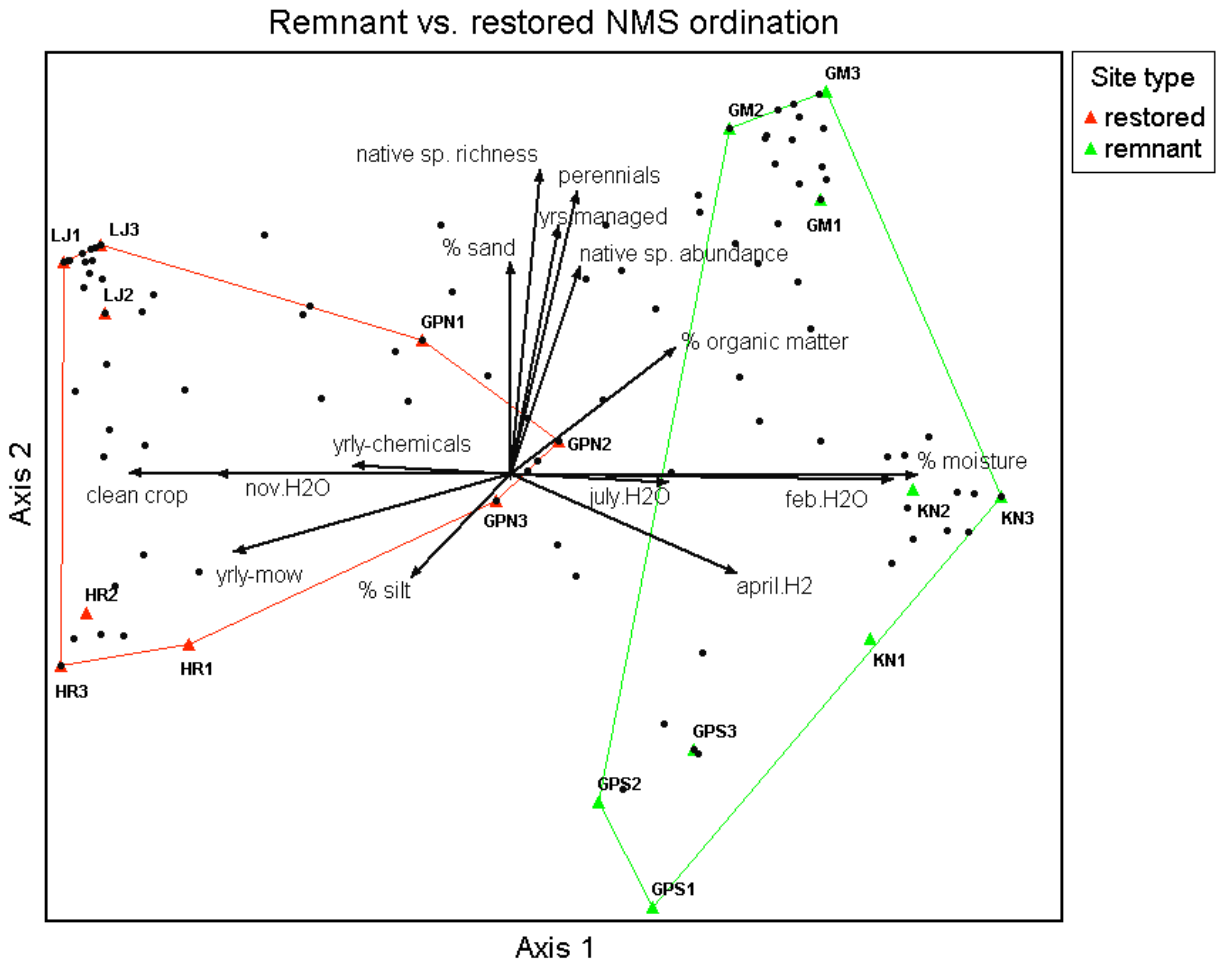


Figure 3. NMS ordination (with Sørensen's measure) of vegetation sampled at remnant (GM, GPS, KN) and restored prairies (GPN,HR,LJ) in species space with an overlaid joint plot showing strongest correlations of species traits (native, perennial, graminoid), soil categories (% moisture, % organic matter, % silt, % sand), management (flooding, use of clean crops, yearly application of chemicals, mowing and years in management) and native species diversity and abundance

Table 3. Average species richness and number of species with various plant traits in remnant and restored prairies

Site type	Project Sites	total # species	# native	# introduced	# perennial	# annual	# graminoid	# forb
remnant	Gotter Prairie S.	13	10	3	12	1	9	5
	Green Mountain	48	30	18	34	14	16	30
	Knez	23	14	9	17	6	13	12
AVERAGE		**28**	**18**	**10**	**21**	**7**	**13**	**16**
restored	Hutchinson	18	9	9	9	9	7	11
	Lovejoy	40	15	25	21	18	11	31
	Gotter Prairie N.	35	25	10	21	14	12	26
AVERAGE		**31**	**16**	**15**	**17**	**14**	**10**	**23**

CONCLUSIONS

The major findings for this study were that in many ways, restoration of wetland prairie has been successful in increasing organic matter in soils, resulting in increased moisture content in soils, and in providing high native species abundance and richness. However, a set of 20 native species were found only in remnant wet prairies. The opportunity to preserve species which are found only in wet prairie remnants is an important reason for the conservation of these rare site types in the Northern Willamette Valley. Sites associated with higher organic matter content and soil moisture and long-term management were Green Mountain (remnant) and Gotter Prairie North (restored). The restoration that has been managed for the longest period of time, Gotter Prairie North, has developed soil qualities and a plant species composition most similar to that of the remnants.

In summary, our results indicate that management practices can have a strong influence on organic matter content soils of remnants and restorations, and those differences influence soil moisture content and species composition of vegetation at the site. Time and effort expended on site management can contribute to high species richness, native abundance and abundance of perennials.

Outreach and Information Dissemination

Training potential

One graduate and one undergraduate student have benefited directly from the work in this project, which is the subject of the MS thesis for an Environmental Sciences graduate student, Sara Taylor, and an honors thesis for Elizabeth Leondar, an undergraduate in BioResource Research degree program.

Taylor presented her initial results at the student competition organized by the Oregon Chapter of the Air and Waste Management Association held on April 8th, 2010 at Portland State University. The presentation won 2nd place and received $150.

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Information Transfer Program Introduction

OSU’s reputation for providing vital environmental information to students and the public is beyond reproach. A few of OSU's water-related outreach programs include:

- **The Master Watershed Steward Program** - An OSU Extension program offering educational sessions and materials to help watershed groups and individuals understand how their watersheds work and apply this knowledge to watershed stewardship on their own land or in their community.
- **The Oregon Well Water Program** - An OSU Extension program designed to help Oregonians protect the groundwater that supplies their drinking water through education.
- **The Hydroville Curriculum Project** - A program proving water-themed educational materials and exercises to K-12 teachers. It is operated by OSU's Environmental Health Sciences Center.
- **The Oregon Explorer Progam** - An online digital library that provides natural resources information to decision makers through a growing series of Web portals.

OSU's overall technology transfer philosophy within the IWW is consistent with the National Research Council's recommendations that highlight the need or increased communication of research in the water area, with specific emphasis water resources planning and other institutional issues. OSU believes that educating the compassionate water engineer requires a multidisciplinary approach incorporating the traditional natural sciences as well as subject in engineering and the humanities. IWW approaches this technology transfer, not only within the academies, but also within our community, and through many different forms of media.

OSU's approach to information transfer includes the following items:

- **H2OSU This Week** a new weekly e-news briefing to build community;
- **IWW web page** (water.oregonstate.edu);
- **Fall and Spring Seminar Series** inviting scholars and graduate students from across the nation and abroad where resident undergraduate, graduate students and non-resident graduate students have been and will continue to be the beneficiaries; and
- A regular series of **shortcourses** focusing on technical writing skills for junior faculty.

IWW Scholars who have shared information and datasets related to water resources research:

February 17, 2011 - IWW Special Seminar: Sustainable co-development as an instrument of international cooperation: the case of sustainable water resources management by Professor Jean Fried who is a Senior Consultant at UNESCO, a Project Scientist at the Department of Planning, Policy and Design of the School of Social Ecology of the University of California, Irvine, and a Visiting Research Scholar at the Center for Sustainability of the California State University, Fullerton

December 9, 2010 - IWW Special Lecture: Identifying multi-decadal catchment travel times and hydrological trends: the value of long-term monitoring data Speaker: Nicholas Howden, Senior Lecturer in Water, WEM Program Director, Department of Civil Engineering, University of Bristol, UK

November 30, 2010 - IWW Special Seminar: Microbial Methane Oxidation in Terrestrial Systems Speaker: IWW Fellow Dr. Martin Schroth, Professor of Environmental Sciences at ETH Zurich

October 29, 2010 - Special IWW Lecture: Long-term monitoring of nitrate - implications for science, policy and management Speaker: IWW Fellow, Dr. Tim Burt, Department of Geography, Durham University

October 26, 2010 - Special IWW Lecture: Rebuilding disturbed landscapes - How computer models can aid environmental rehabilitation Speaker: IWW Fellow, Dr. Greg Hancock, Department of the Discipline of Earth Sciences at the University of Newcastle

October 15, 2010 - IWW Special Seminar: A robust methodology for conducting large-scale assessments of current and future water availability Speaker: David Post Program Director, South Eastern Australian Climate Initiative, CSIRO Land and Water

October 14, 2010 - Special IWW Lecture: Nitrogen Dynamics and Hydrochemical Impacts of Rain-fed Agriculture: Case of the Palouse Speaker: Kent Keller, School of Earth and Environmental Sciences, Washington State University and Co-Director, Center for Environmental Research, Education, and Outreach (CEREO)

May 25, 2010 - Life Cycles: Sustaining the Flow of Water, Fish, and Human Cultures Speaker: Brian Richter, Ph.D., Co-Director, Global Freshwater Program The Nature Conservancy, Charlottesville, Virginia

March 12, 2010 - High-frequency field-deployable isotope analyzer for hydrological applications Speaker: Manish Gupta, Oregon State University

Dams and Development: Ecological, Socioeconomic, and Policy Dimensions

Basic Information

Title:	Dams and Development: Ecological, Socioeconomic, and Policy Dimensions
Project Number:	2009OR123B
Start Date:	3/1/2009
End Date:	5/1/2010
Funding Source:	104B
Congressional District:	Oregon 5
Research Category:	Social Sciences
Focus Category:	Law, Institutions, and Policy, None, None
Descriptors:	Dams, Hydropower
Principal Investigators:	Bryan Tilt, Desiree D. Tullos

Publications

1. Brown, Philip H., Darrin Magee, Bryan Tilt, Desiree Tullos and Aaron T. Wolf. 2009. “Modeling the Costs and Benefits of Dam Construction from a Multidisciplinary Perspective.” Journal of Environmental Management 90 (Supplement 3): S303- 311.
2. Tullos, Desiree, Bryan Tilt and Katherine Reidy-Lierman. 2009. “Introduction to the Special Issue: Understanding and Linking the Biophysical, Socioeconomic and Geopolitical Effects of Dams.” Journal of Environmental Management 90 (Supplement 3): S203-207.
3. Tullos, D., P.H. Brown, K. Kibler, B. Tilt, D. Magee, and A. Wolf. 2010. “Perspectives on Salience and Magnitude of Dam Impacts for Hydrodevelopment Scenarios in China.” Water Alternatives, Special Issue on WCD + 10. (In Press, Accepted for Publication).
4. Brown, Philip H., Darrin Magee, Bryan Tilt, Desiree Tullos and Aaron T. Wolf. 2009. “Modeling the Costs and Benefits of Dam Construction from a Multidisciplinary Perspective.” Journal of Environmental Management 90 (Supplement 3): S303- 311.
5. Tullos, Desiree, Bryan Tilt and Katherine Reidy-Lierman. 2009. “Introduction to the Special Issue: Understanding and Linking the Biophysical, Socioeconomic and Geopolitical Effects of Dams.” Journal of Environmental Management 90 (Supplement 3): S203-207.
6. Tullos, D., P.H. Brown, K. Kibler, B. Tilt, D. Magee, and A. Wolf. 2010. “Perspectives on Salience and Magnitude of Dam Impacts for Hydrodevelopment Scenarios in China.” Water Alternatives, Special Issue on WCD + 10. (In Press, Accepted for Publication).

Dams and Development: Ecological, Socioeconomic, and Policy Dimensions (Research Workshop)

Principal Investigators:
Bryan Tilt, Ph.D.
Oregon State University
Anthropology Department
Bryan.Tilt@oregonstate.edu, 541-737-3896

Desiree Tullos, Ph.D.
Oregon State University
Biological and Ecological Engineering Department
tullosd@engr.orst.edu, 541-737-2038)

Aaron Wolf, Ph.D.
Oregon State University
Geosciences Department
wolfa@geo.oregonstate.edu, 541-737-2722

Philip Brown, Ph.D.
Colby College
Economics Department
phbrown@colby.edu, 207-570-8220

Report Period: 03/01/2009 – 05/07/2010

Workshop Description and Goals

Funding from the USGS Small Grants Program, via the Institute for Water and Watersheds Oregon State University, was used to support an international workshop entitled, "Dams and Development: Ecological, Socioeconomic and Policy Dimensions." This report provides a brief description of the project goals and outcomes. The objectives of this workshop were to (a) provide a forum for scholars to communicate their knowledge and expertise on the impacts of dams on ecology, society and culture in the context of contemporary development policy; (b) solicit critical review of a proposed tool for the interdisciplinary analysis of dams; and (c) develop research collaborations and publications on the topics of sustainable hydrodevelopment. The workshop built on three years of multi-institutional collaboration by an interdisciplinary team of scientists, and an ongoing research grant from the National Science Foundation. This workshop contributed to the improvement of the Integrative Dam Assessment Model (IDAM), a multidisciplinary assessment tool to analyze the costs and benefits of dam construction.

Background

Natural scientists and social scientists have traditionally used their own disciplinary training to study the effects of dam construction, yet dams lie at the nexus of biophysical, socioeconomic and geopolitical relations, and an impact in one area is thus likely to have repercussions for others. For example, the adverse effects of dams on ecosystems, hydrology and water quality (Poff and Hart 2002; Salazar 2000) often disrupt cultural conditions and economic institutions (Cernea 2003), and also impact the relationships between communities, regions or nations (Wolf, et al. 2003).

As a result, the impacts of dams (both positive and negative) are not readily captured through the analytical lens of any single discipline. Dams should rather be analyzed from a comprehensive, interdisciplinary, and systems-based approach built upon both historic and contemporary data. What factors drive conflict over hydropower? How do conflict and cooperation evolve over time? What governing mechanisms are conducive to equitable and sustainable hydropower? Our interdisciplinary research team has spent the last several years developing a decision-support tool called the Integrative Dam Assessment Model (IDAM), which helps policymakers understand the impacts of dams from a holistic perspective.

The objectives of this workshop were to (a) provide a forum for scholars to communicate their knowledge and expertise on the impacts of dams on ecology, society and culture in the context of contemporary development policy; (b) solicit critical review of the IDAM tool for the interdisciplinary analysis of dams; and (c) develop research collaborations and publications on the topics of sustainable hydrodevelopment.

Progress to Date

Our proposal received only a portion of the funds that we had initially sought, which meant that we had to scale-down our plans and objectives. Rather than hold the workshop at Oregon State University, as previously planned, the principal investigators traveled to Coeur d'Alene, Idaho, to participate in an international conference entitled "Transboundary River Governance in the Face of Uncertainty: The Columbia River Treaty, 2014," which was held April 2-4, 2009. Our research team held a special workshop session at the conference on the impacts of dams. The workshop included the following activities:

1. Presentations on the state of current knowledge regarding the ecological, socioeconomic and policy dimensions of dams;

2. A discussion of similarities and differences between international cases in terms of dam development;

3. A discussion on disciplinary and interdisciplinary approaches to evaluating dam impacts; and

4. A presentation of the IDAM tool and solicitation of critical feedback from scientists. This included an evaluation of the structure and operation of the model, selection of appropriate indicators to inform the model, and potential limitations.

Outcomes

This workshop resulted in two significant outcomes, as described briefly below.

1. Peer-Reviewed Publications. Members of the IDAM research team were able to refine their thinking on the best approaches for modeling the effects of dams, including the selection of appropriate indicators. We published a special issue of the *Journal of Environmental Management* in December 2009 on dam assessment, which included a number of papers from IDAM researchers whose papers were improved by this scientific exchange. These papers include the following:

   Brown, Philip H., Darrin Magee, Bryan Tilt, Desiree Tullos and Aaron T. Wolf. 2009. "Modeling the Costs and Benefits of Dam Construction from a Multidisciplinary Perspective." *Journal of Environmental Management* 90 (Supplement 3): S303-311.

   Tullos, Desiree, Bryan Tilt and Katherine Reidy-Lierman. 2009. "Introduction to the

Special Issue: Understanding and Linking the Biophysical, Socioeconomic and Geopolitical Effects of Dams." *Journal of Environmental Management* 90 (Supplement 3): S203-207.

Tullos, D., P.H. Brown, K. Kibler, B. Tilt, D. Magee, and A. Wolf. 2010. "Perspectives on Salience and Magnitude of Dam Impacts for Hydrodevelopment Scenarios in China." *Water Alternatives*, Special Issue on WCD + 10. (In Press, Accepted for Publication).

2. International Conference on Dam Assessment. Building on the lessons learned from the Idaho conference, our research team held an additional conference (using non-USGS funding) on dam assessment in China. The conference was held on July 27-28 in Kunming, China, and included three groups of stakeholders: government officials, hydropower company representatives, and conservation NGO personnel. We used a similar approach to the one developed at the Idaho workshop, which involved presenting the IDAM model and soliciting feedback via survey questionnaires and focus groups from these stakeholders.

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Wolf, A.T., S.B. Yoffe, and M. Giordano, 2003. International Waters: Identifying Basins at Risk. Water Policy 5(1):29-60.

Technology Transfer

Basic Information

Title:	Technology Transfer
Project Number:	2010OR120B
Start Date:	3/1/2010
End Date:	2/28/2011
Funding Source:	104B
Congressional District:	5th
Research Category:	Not Applicable
Focus Category:	Education, Methods, Law, Institutions, and Policy
Descriptors:	
Principal Investigators:	Jeffrey John McDonnell, Todd Jarvis

Publications

There are no publications.

Institute for Water and Watersheds

Breakthroughs in Hydrology Monitoring: from Pore to Watershed Scales

Spring Hydrology Seminar Series

March 31 — **Observational network design and data synthesis: Seeing the forest for the trees**
Brian McGlynn, Associate Professor, Land Resources & Environmental Sciences, Montana State University

April 7 — **Nested watershed studies in arctic Alaska: An overview**
Larry Hinzman, Professor, Civil and Environmental Engineering and Director, International Arctic Research Center, University of Alaska-Fairbanks

April 9 — *Note special day and location: Friday, 4-5 p.m., Room 203, Wilkinson Hall.*
After the global inventory of transboundary aquifers...what we know and what we still need to know
Shammy Puri, Secretary General of the International Association of Hydrogeologists/UNESCO ISARM

April 14 — **Variations in spatial precipitation patterns in the Sierra Nevada, California: Implications for hydrologic modeling and water resource planning**
Jessica Lundquist, Assistant Professor, Civil and Environmental Engineering, University of Washington

April 21 — **New approaches to evaporation measurement**
Jim Shuttleworth, Regent's Professor, Hydrology and Water Resources, The University of Arizona

April 28 — **Satellite-based estimates of groundwater depletion in India**
James S. Famiglietti, Professor, Earth System Science, University of California-Irvine

May 5 — **Weathering and erosion and the critical zone**
Suzanne Prestrud Anderson, Researcher, Institute of Arctic and Alpine Research and Assistant Professor, Geography, University of Colorado at Boulder

May 12 — **Climate and vegetation water use efficiency at catchment scales**
Peter Troch, Professor, Hydrology and Water Resources, The University of Arizona

May 19 — *Special joint event with the COAS Frontier Seminar Series in Gilfillan Auditorium.*
So what's new about transpiration?
Inez Fung, Professor, Earth and Planetary Science and Environmental Science, Policy and Management
Co-Director, Berkeley Institute of the Environment, University of California-Berkeley

Water geochemistry of the Angelo Coast Mountain Reserve in the high frequency time domain
James Bishop, Faculty Senior Scientist, Lawrence Berkeley National Laboratory
Professor, Earth and Planetary Science, University of California-Berkeley

May 26 — **The California Critical Zone Observatory**
Jan Hopmans, Professor and Associate Dean, College of Agricultural and Environmental Sciences, University of California-Davis

June 2 — **Quantifying flow and reactive transport in the heterogeneous subsurface environment: From pores to porous media and facies to aquifers**
Tim Scheibe, National Ground Water Association Darcy Lecturer and Hydrology Technical Group, Pacific Northwest National Laboratory

Students can enroll for credit:
Seminar — WRS 507 (CRN 58077)
Journal Club — WRS 505 (CRN 58075; Tuesdays, 12-12:50 p.m., Strand 348)

Seminar Sponsors: Institute for Water and Watersheds, U.S. Geological Survey, National Ground Water Association, College of Oceanic and Atmospheric Sciences, Water Resources Graduate Program, Geosciences, OSU Biological and Ecological Engineering, International Association of Hydrogeologists

WEDNESDAYS
March 31–June 2
4–5:20 p.m.
water.oregonstate.edu

ALS 4000
(except April 9 and May 19)
FREE
541-737-9918

Oregon State University

Accommodations for disabilities may be made by calling 541-737-9918

INSTITUTE FOR WATER AND WATERSHEDS

2010 WINTER WATER FILM SERIES

STAG 111 Thursdays 5:00-6:30 pm

FREE Film screenings!
PUBLIC WELCOME!

January 14 - ***A Journey in the History of Water*** **Part 1** – 45 minutes – Join Professor Dr. Terje Tvedt of the Univ. of Bergen, Norway on a tour of irrigation canals carved into cliff walls the Karakoram Valley, deep hand-drawn wells in Ethiopia, one of the world's oldest river gauging stations in Egypt, sinking buildings in Mexico City and more to see how ancient water management strategies continue to impact modern peoples. http://watervideo.com/

January 21 – ***A Journey in the History of Water*** **Part 2** – 45 minutes – Water has shaped the geopolitical landscape. Learn how hydropower fostered the Industrial Revolution and visit towns erased by the construction of China's Three Gorges Dam. http://watervideo.com/

January 28 - ***A Journey in the History of Water*** **Part 4** – 45 minutes – Is whiskey for drinking and water for fighting over? Transboundary rivers and aquifers demand cooperation among nations in the Nile and Jordan River Basins. http://watervideo.com/

February 4 – ***Connecting Delta Cities*** – 42 minutes - How will climate change and rising sea levels change coastal cities such as Jakarta, Rotterdam, New York and Alexandria? See how people around the world are adapting to their changing environment. http://connectingdeltacities.com/

February 11 - ***Downwind Downstream*** – 60 minutes – This 1988 film about water pollution from mine drainage and acid rain remains relevant today. Check out the NY Times series "Toxic Waters: A series about the worsening pollution in American waters and regulators' response" for updates on some of the issues presented in the film. http://projects.nytimes.com/toxic-waters

February 18 – ***Bull Run*** - 29 minutes - Individuals and local government have ensured that Portland's water source, the 100 sq. mile Bull Run Watershed, has been protected since the 1880's. Learn about this unique resource. http://opb.org/

February 25 – ***River of Renewal*** - 55 minutes - In 2009, an agreement to remove the four hydroelectric dams on the Klamath River was reached between the California and Oregon governors and Warren Buffett's PacifiCorp. Jack Kohler, a Yurok/Karuk Indian visits his ancestral home to learn about threats to natural resources and traditional livelihoods, as well as a building consensus about future river management. Based on the book River of Renewal, Myth and History in the Klamath Basin by Stephen Most. http://riverofrenewal.org/

Water Law & Policy in a Changing Environment

Fall Water Policy Seminar

Wednesdays 4 – 5:20 pm Owen Hall 106

Sept 29: International Waters and Climate Change
Aaron Wolf, Professor and Chair, Department of Geosciences, Oregon State University

Oct 6: Water Reallocation: Challenges and Opportunities
Gail Achterman, Director, Institute for Natural Resources, Oregon State University

Oct 13: Municipal Water Permitting in an era of Change: Legal structures and policy trajectories
Laura Schroeder, Schroeder Law Offices

Oct 20: My Brief Career as a Foreign-Policy Pawn in the New Great Game: Conflict, Gas, Oil, and Water in the South Caucasus
Michael Campana, Professor, Department of Geosciences, Oregon Sate University

Oct 27: Stable Water Policy: Building a Three-Legged Stool
Janet Neumann, Professor, Lewis & Clark Law School

Nov 3: Science, Values, and Water Resource Management
Denise Lach, Director, School of Public Policy; Professor, Department of Sociology, Oregon State University

Nov 10: Transboundary River Governance in the Face of Uncertainty: Resilience Theory and the Columbia River
Barbara Cosens, Professor, University of Idaho Law School

Nov 17: Topic: Iran's Shared Water
Mehdi Mirzaee, Visiting Scholar in Department of Geosciences, Oregon State University

Dec 1: Policy Reform for Market-Based Reallocation of Water Rights
Bruce Aylward, Ecosystem Economics LLC

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	6	0	0	0	6
Masters	4	0	0	0	4
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	11	0	0	0	11

Notable Awards and Achievements

IWW Director Jeff McDonnell named the 2011 Birdsall Dreiss Distinguished Lecturer for the Geological Society of America. As a recipient of this lectureship, Dr. Jeff McDonnell, Richardson Chair in Watershed Science, will travel to different university campuses and give lectures on two topics: "Where does water go when it rains? Conceptualizing runoff processes in headwater catchments." and "Isotope tracers in catchment hydrology: How far can we go?".

Willamette 2100 Project Awarded by the National Science Foundation. Three Oregon universities are working together on a five-year study of climate change, population growth and water availability, a project supported by a $4.3 million National Science Foundation grant. Faculty from Oregon State University, the University of Oregon and Portland State University will work together on "Willamette Water 2100," a study that will use Oregon's Willamette River basin as a test case for managing regional water supply. The five year project began in October 2010, and is a collaborative effort of faculty from Oregon State University, the University of Oregon and Portland State University. It is funded by the National Science Foundation.

Oregon State University's student chapter of **Engineers Without Borders** was awarded a $2000 "Outstanding Chapter Award" at the West Coast Regional Workshop this October, for their ingenuity and contribution to local water catchment systems in rural communities in El Salvador and Kenya.

Jennifer Holderman is **OSU s first graduate of the concurrent JD-MS in Water Resources,** a program possible through a partnership with University of Oregon s law school.

Dr. Roy Haggerty Named Hollis M. Dole Professor in Environmental Geology at Oregon State University! An installation ceremony was held on Friday, May 21 with more than 60 colleagues, current and past students, friends and family members attending.

Jay Zarnetske Receives AGU Outstanding Student Paper Award. Jay's paper was titled: Labile Dissolved Organic Carbon Availability Controls Hyporheic Denitrification: a 15N Tracer Study and he presented at the 2009 Fall AGU Meeting. Jay is a Ph.D. student in the Dept. of Geosciences & the Water Resources Graduate Program. This is the second year in a row that he has received this award.

Christoph Thomas Receives NSF CAREER Award from National Science Foundation to work on "A new direction into atmospheric near-surface transport for weak-wind conditions in plant canopies". The project will study how air moves in plant canopies such as crops and forests where winds are usually relatively weak, and how it affects the transport of heat, water and momentum. The level of scientific understanding of weak-wind transport is very limited, and commonly used forecast tools and mathematical formulations don't apply.

Oregon State University conducted an "International Undergraduate Field Hydrology" course in the environs of Chillán, Chile. The course was led by OSU's Dr. John Selker, with additional instruction by OSU research scientists Dr. Majdi Abou Najm, Dr. David Rupp, and Mr. Ryan Stewart. Local expertise was also be provided by Dr. Hamil Uribe, a hydrologist at the Instituto de Investigaciones Agropecuarias (INIA), and Dr. José Luís Arumí, a professor at the Universidad de Concepción, Chillán. This course was funded by a CUAHSI HydroGeoPhysics Travel Grant and the Hydrologic Sciences Program (NSF) to advance both undergraduate education and the scientific mission of OSU's Chilean project.

The IWW welcomed Dr. Martin Schroth, Professor of Environmental Sciences at ETH Zurich, to the OSU campus as an IWW visiting fellow. Dr. Schroth specializes in the development and application of novel methods for the assessment of microbial processes at the field scale. His current research activities

focus on the quantification of microbial processes involved in greenhouse-gas turnover in soils, with particular emphasis on microbially mediated methane oxidation. Dr. Schroth is working with Professor John Selker and team on distributed temperature sensing using fiber-optic cables to obtain high resolution wind-speed and soil-moisture data for various environmental applications.

IWW welcomed Dr. Tim Burt as a distinguished fellow. Dr. Tim Burt is Master of Hatfield College and Professor of Geography at Durham University, UK. He has been researching aspects of hydrology, geomorphology and climate change since the mid-1970s. While at OSU he will be working with Professor Jeff McDonnell on a range of topics including the analysis of long-term hydrological data from the H J Andrews watersheds and a textbook on hillslope hydrology. He also hopes to complete analysis of some long (many decades) records of nitrate concentrations in English rivers and his compilation of daily rainfall data from the 1820s for the Radcliffe Observatory at Oxford University, possibly the longest such record in existence.

IWW welcomed Dr. Greg Hancock as a distinguished fellow. Dr. Greg Hancock is an Associate Professor and Head of Department of Earth Sciences at the University of Newcastle, Australia. His research interests are in the long-term dynamics of geomorphic systems and the interactions between landscape geomorphology, hydrology and erosion. He has extensively tested and used soil erosion and landform evolution models for both theoretical and applied situations such as mine sites. Greg is working with Professor Jeff McDonnell and team examining the sediment transport and landscape stability of mine sites in the USA. He is also examining the role of catastrophic events such as hurricanes and consequences such as tree-throw in altering hydrology and geomorphology and triggering landscape change.

2011 Publications by IWW Principal Investigators

Argerich, A, Martí E, Sabater F, Haggerty R, Ribot M. 2011. Influence of transient storage on stream nutrient uptake based on substrata manipulation. Aquatic Sciences.

Brantley, SL, Megonigal JP, Scatena FN, Balogh-Brunstad Z, Barnes RT, Bruns MA, Van Cappellen P, Dontsova K, Hartnett HE, Hartshorn AS et al.. 2011. Twelve testable hypotheses on the geobiology of weathering. Geobiology.

Burt, T., N, Howden, F. Worrall and J.J. McDonnell, 2011. On the value of long-term, low-frequency water quality sampling: avoiding throwing the baby out with the bathwater. Hydrological Processes, in press

Graham, C., H. Barnard, W. van Verseveld and J.J. McDonnell, 2011. Closure of the hillslope water balance within a measurement uncertainty framework. Hydrological Processes, in press.

Hancock, G., K G Evans, J.J. McDonnell and L Hopp, 2011, Ecohydrological controls on soil erosion a landscape evolution. Ecohydrology, in review.

Hopp, L, McDonnell JJ, Condon P. 2011. Lateral Subsurface Flow in a Soil Cover over Waste Rock in a Humid Temperate Environment. Vadose Zone Journal. 10(1):332.

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Zarnetske, JP, Haggerty R, Wondzell SM, Baker MA. 2011. Dynamics of nitrate production and removal as a function of residence time in the hyporheic zone. Journal of Geophysical Research. 116(G1)

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Bumbaco, KA, Mote PW. 2010. Three Recent Flavors of Drought in the Pacific Northwest. Journal of Applied Meteorology and Climatology. 49(9):2058-2068.

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Carey, S.K., D. Tetzlaff, J. Seibert, C. Soulsby, J. Buttle, H. Laudon, J.J. McDonnell, K. McGuire, D. Caissie, J. Shanley, M. Kennedy, K. Devito and J. Pomeroy, 2010. Inter-comparison of hydro-climaticregimes across northern catchments: synchronicity, resistance and resilience. Hydrological Processes,DOI: 10.1002/hyp.7880.

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Publications from Prior Years