PROGRAM

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FLOODPLAINS AND RIVERS: CONNECTIONS AND RECONNECTIONS

Science in a Workshop Format

September 22 and 23, 2005

On the Campus of The University of Montana
Missoula, Montana

Emmanuel J. Gabet, Conference Chair
William W. Woessner, Acting Center Director

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Thursday September 22

07:30 Fieldtrip

Field Trip registration is closed.

07:00 Registration University Center South end

Leaves at 7:30 A.M. between the University Center and Library

Parking: Parking permits ($2/day) are available at the Registration Table

We will travel to the Arlee Valley approximately 50 km north of Missoula.

Lunch is included.

Stop 1: Jocko River Valley Overview

Stop 2: Jocko River Above Restoration

Stop 3: Jocko River Restoration

Stop 4: Jocko River Fish Hatchery-Plans for Future Restoration

Stop 5: Soft Restoration Planning, Schaff Site, Jocko River

<u>Friday September 23</u>

08:00-Keynote Speakers, Posters and Discussion

07:30-09:00 On-site Registration, University Center Theater, Third Floor

Parking is tight on campus. If you are staying near campus it may be easiest to walk. You need to arrive before 7:40 A.M. to find a parking place. Parking passes can be purchased at registration for $2.00 (cash please)

07:30-08:00 Posters hung in the South Ball Room, University Center

08:00-08:15 Welcome- Bill Woessner Center Director, Dean Gerald Fetz-College of Arts and Sciences, Opening Remarks by Manny Gabet, Conference Chair

08:20-09:35 ***Stan Trimble, UCLA***
Historical Legacy Sediment in Streams: Examples and Some Management Implications in the Eastern U. S.

09:35 -09:55 Coffee Break-South Ballroom

10:00-11:15 ***F. Richard Hauer, Chair of Limnology, The University of Montana, Flathead Lake Biological Station***
The Ecological Connections Between Channels and Floodplains

11:15-12:30 ***William Dietrich, UC Berkeley***
Channel-to-Floodplain Sediment Transfer: Lessons from the Fly River

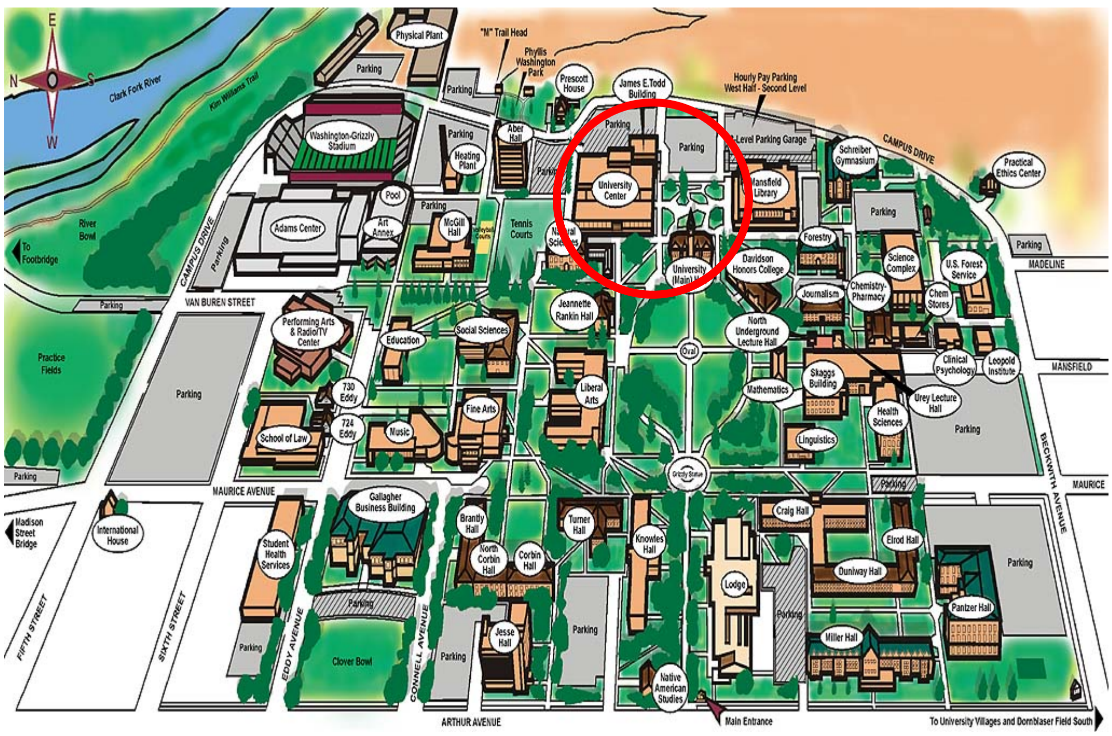
Poster Presentations and Lunch

12:30-14:00 Lunch provided in the South Ballroom, Poster Session. List of posters attached.

14:05-15:20 ***Geoffrey Poole, Eco-Metrics, Inc.***
Quantitative River and Floodplain Assessment to Support River Restorations: Applications of Remote Sensing and Simulations Modeling

15:20-16:35 ***Jeff Mount, UC Davis***
Ecologic and Geomorphic Response to Passive-Aggressive Floodplain Restoration

16:40-16:50 - Wrap up, Manny Gabet, Conference Chair. Meeting adjourns.



Poster Abstracts

1. The annual cycle of pCO2 in the Clark Fork River

Janet Lynch, Laura Jungst, Cory Beatty and Michael DeGrandpre
Department of Chemistry, University of Montana, Missoula, MT 59812

Instruments used to measure the partial pressure of CO2 (pCO2) were deployed in the Clark Fork River beginning September of 2004 to gain a better understanding of riverine carbon cycling. The SAMI-CO2 instruments are calibrated in the lab prior to deployment using an infrared gas analyzer and CO2 gas standards. To confirm the quality of the SAMI-CO2 data, grab samples are taken at the deployment site two times per week and analyzed for pH and total alkalinity. These data are then employed in a model (CO2SYS) to calculate pCO2 and compared to the values from the SAMI-CO2. Photosynthesis and respiration drive the diel cycle of pCO2, which is observed by taking between 48 and 96 measurements per day. These autonomous sensors have been deployed and collecting data for nearly a full year, making it possible to also monitor the annual carbon cycling of the Clark Fork River.

2. A Geomorphic Assessment of the Grays River Watershed, Washington: Diagnosis of Degradation and Prescriptions for Restoration

Chase Barton, Chris Brummer, Tim Abbe, Galen Ward, Tracy Phelps and Jennifer Schmidt
Herrera Environmental Consultants, Seattle, Washington

The Grays River watershed in southwestern Washington has undergone a significant change in its sediment budget and river response due to widespread changes in land use. Over 98 percent of the 230-square-kilometer upper watershed has been logged since the early 1900s. Diking to control channel migration and flooding of the lower river began in the 1960s, after much of the valley had been cleared for agriculture. The steep watershed is dissected by many confined channels that drain into the broad alluvial valley of the lower Grays River. Increased sediment delivery to the lower river has triggered channel migration and vertical fluctuations in the riverbed. Aggradation and several flood events in 1999 initiated two avulsions, one of which breached a levee and destroyed a chum salmon spawning channel. This channel loss and chronic habitat degradation prompted an assessment of the Grays River watershed to determine the impacts of historical and current land use practices on geomorphic processes and identify measures for mitigating these impacts and restoring habitat. Results indicate that current sediment production in the watershed is 9 to 20 times greater than the background erosion rate. Sediment production was found to lag 10 to 30 years behind the forest clearing, and the response of the lower river to the increased sediment was estimated to lag behind the clearing by approximately 25 to 45 years. Instability of the lower river channel will continue to result in habitat loss and a threat to infrastructure for decades and longer if current timber harvest rates are sustained. Restoration of floodplain forests, levee setbacks, and construction of stable logjams could improve habitat within alluvial reaches; however the long-term productivity of the watershed will depend on reducing timber harvest rates.

3. Evaluating Channel Change at Tamarisk Removal and Control Reaches Following a Prescribed Flood on the Upper Green River, Lodore Canyon, Dinosaur National Monument

Jason S. Alexander, John C. Schmidt
Department of Aquatic, Watershed, & Earth Resources, Utah State University, Logan, UT 84321
Michael L. Scott
U.S. Geological Survey, Biological Resources Discipline, FORT Science Center, Fort Collins, CO 80526

Stream channels of the upper Colorado River Basin narrowed and simplified in planform during the 20th century. These changes were the result of natural and human induced shifts in the hydrologic and sediment regimes caused by climate change, land use changes, the completion of the Upper Colorado River Storage Project (CRSP) and the establishment and spread of the non-native riparian shrub tamarisk (Tamarix ramossissima). Channel narrowing and simplification resulted in the loss of important aquatic and flood plain habitat features, including in-channel backwaters, which serve as nursery habitat for some endangered endemic fish species and seasonal pools, which provide breeding habitat for some amphibians. Several options for mitigating undesirable environmental conditions associated with channel simplification and widespread establishment of tamarisk in the upper Colorado River basin have been considered. In the Upper Green River of Dinosaur National Monument, paired experimental reaches have been established in the fan-eddy complexes of Lodore Canyon. Each pair includes a reach where tamarisk have been completely removed by teams of volunteers (weed warriors) and a reach where no riparian treatment has been applied. In the summer of 2005, an experimental flow of 192 m3/sec was released through the Canyon of Lodore from Flaming Gorge Dam. The flood was one of a few post CRSP floods on the Upper Green River that have significantly exceeded Flaming Gorge Dam powerplant capacity of 130 m3/sec. We evaluated channel geometry changes and scour and fill resulting from the rare flood at 17 cross-sections within the tamarisk control and treatment reaches. Pre and post-flood channel geometry surveys were performed on cross sections containing the most significant sand storage units. Scour chains were installed and recovered on beaches above and below channel constrictions to evaluate flood scour and fill in backwater and expansion hydraulic environments. Results from this study will assist managers of regulated rivers in assessing the ability of physical removal of tamarisk in combination with controlled floods to reverse undesirable channel simplification and subsequent loss of riparian and aquatic habitats.

4. Jocko River Demonstration Reach Project: Wetland/Riparian Habitat Restoration and Bull Trout Recovery

Amy Sacry, Geum Environmental Consulting, Inc., 307 State Street, Hamilton, MT 59840
Rusty Sydnor, Confederated Salish and Kootenai Tribes

The Confederated Salish and Kootenai Tribes are restoring bull trout habitat in the Jocko River watershed, located on the Flathead Indian Reservation in western Montana. In the spring and summer of 2005, the first phase of a large restoration project along 3, 200 feet

of the Jocko River was implemented to reverse the trend of channel incision, reestablish the connection between the active channel and the historic floodplain, and restore native plant community types to the riparian and floodplain areas. To restore these native plant communities, the tribes used numerous revegetation strategies. The main obstacles to restoring a native forest cover type to the floodplain included competition from high densities of weeds and grasses, loss of woody vegetation cover, low levels of natural regeneration, and soil compaction. Nearly 20,000 native plants were installed in the floodplain. Weed mats and rigid browse protectors were used to control competition from weeds and grasses and prevent herbivory of seedlings. In addition, experimental weed treatment plots, including the use of mulch, continuous weed mat, and cardboard were established in areas with high densities of weeds to determine weed control effectiveness for use in future planning efforts. Revegetation strategies along the newly constructed channel focused on planting native tree, shrub and forb seelings, seeding with native and quick establishing annual grasses and forbs in disturbed areas, salvaging and transplanting native shrubs and trees, and installing soil bioengineering structures adjacent to rigid habitat structures to encourage establishment of shrubs along high energy banks.

5. Relationships between flood frequency, microhabitat variability, and riparian vegetation distribution in montane streams of Western Montana, USA

Motoshi Honda, Dept of Ecosystem and Conservation Sciences, University of Montana, Missoula, MT 59812

Along lower elevation streams a strong functional relationship exists between the frequency and magnitude of flooding and the structure and distribution of riparian plant communities. Definition of an appropriate flood frequency and management of streamflows to achieve this flood frequency should result in the long-term maintenance of riparian vegetation.We are investigating the relationship between flood flows and the distribution of riparian vegetation along steep, gravel- and cobble-bedded, headwater streams in western Montana, USA. In summer 2005, hydrologic and vegetation data were collected from three streams in 6th level Hydrologic Unit Code (HUC) watersheds in the Bitterroot National Forest and Flathead Indian Reservation. Stream and riparian area topography were surveyed in each 100-300 meter stream reach. Two to three belt transects (at least eight 16m2 plots wide in longitudinal direction), extending across the stream-floodplain-upland continuum, were placed randomly along each stream reach. Vegetation data were collected from three different plot sizes (0.25m2, 4m2, and 16m2 for herbaceous, shrub, and tree species respectively) along these transects. Periodic flow measurements encompassing the range of natural flows are being used to quantify the stage-discharge relationship for each study reach. Co-occurrences of rapid changes in vegetation and environmental variables (topography, flood frequency, canopy cover, and soil properties) are analyzed using the boundary analysis (Fortin 1994, Fortin et al. 1996). The hydrologic and vegetation data are being used to calibrate a linked flood hydrology – vegetation model that: 1) identifies the flood frequencies required to inundate the riparian area, and 2) relates floods of varying frequencies and magnitudes to riparian vegetation composition and structure.

6. Ice Jams, Contaminated Sediment, Dam Removal and Bridge Scour on the Clark Fork River, Montana

Andrew M. Tuthill, Kathleen D. White and Lynn A. Daniels

The Milltown Dam, at the confluence of the Clark Fork and Blackfoot Rivers in Montana lies at the downstream end of nation's largest Superfund Project. Since its construction in 1907 several hundred thousand tons of metal-contaminated sediment from upstream copper mining and smelting activities have accumulated in the dam impoundment. Large amounts of this sediment were transported downstream during a 1996 ice jam event on Clark Fork and Blackfoot Rivers. The EPA remediation plan calls for phased removal and off-site disposal of much of the contaminated sediment, followed by removal the Milltown Dam and a smaller mill dam upstream on the Blackfoot River. As much as possible, the river channels will be restored to their pre-project morphology. This study examined ice impacts associated with the restoration plan, specifically where ice jams and related ice jam scour are expected to occur with and without the dams in place. Also addressed was the effect of dam removal on potential ice-related scour around the piers of five bridges that cross the Blackfoot River just upstream of the Milltown Dam.

7. Comparison of Transient Storage Characteristics in Restored and Unrestored Reaches of the Provo River, Heber Valley, Utah

Randy R.Goetz[1], Michael N. Gooseff[2], and John C. Schmidt[1]
[1] Department of Aquatic, Watershed, and Earth Resources, Utah State University, Logan, Utah, USA
[2] Department of Geology and Geologic Engineering, Colorado School of Mines, Golden, Colorado, USA

We performed Rhodamine-WT (RWT) stream tracer tests in order to compare transient storage characteristics between restored and unrestored reaches of the Provo River, Heber Valley, Utah. The 13-mile long section of the Provo River located in the Heber Valley (Middle Provo) has undergone extensive geomorphic and hydrologic alteration during the 20th century due to federal reclamation projects. The Provo River Restoration Project (PRRP) is intended to mitigate the negative environmental impacts of reclamation activities by completely renaturalizing the channel and floodplain. Restored reaches are designed with alternating pool-riffle sequences, mid-channel gravel bars, point bars, secondary channels, and relatively high sinuosities. Unrestored reaches are constrained by dikes, making them relatively straight, topographically homogenous, and providing a narrow distribution of water velocities within the channel. Test reaches in our study were chosen in order to provide a statistically sound basis for determining the general effects of the PRRP in terms of transient storage. In each 500 to 800 meter long reach, a single pulse of RWT was injected at a discharge close to base flow (125 cfs). Breakthrough curves were developed using RWT concentrations automatically logged in the field at 5-second intervals. We simulated field data using STAMMT-L software, which solves a one-dimensional, dual-porosity, advective-dispersive transport equation. Model parameters yielded estimates of the average cross-sectional area of transient storage, and average transient storage residence time in each reach. Results suggest that restoration efforts have produced a relative increase in these aspects of transient storage. We hypothesize that greater geomorphic complexity introduced by channel restoration will increase hyporheic exchange as well.

8. Generalized Descriptions of Natural Stream Channel Geometry

Matthew Klara
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Joel Cahoon, M. ASCE, Otto Stein, M. ASCE
Associate Professor, Civil Engineering Department, Montana State University, Bozeman, MT 59717

Channel cross-sections from streams in Montana and Wyoming were analyzed to develop generalized ratios of the flow area centroid depth, the hydraulic depth, and the hydraulic radius relative to the flow depth. The relationships were developed for the pooled data, then tested for significant differences when grouped using the Rosgen Level 1 classification system. Analyses of variance indicated that the ratio of centroid depth to flow depth was not significantly different across Rosgen classes. The same held for the ratio of hydraulic depth to flow depth. Significant differences across Rosgen classes were found for the ratio of hydraulic radius to flow depth. Rosgen class E channels had a significantly lower ratio of hydraulic radius to flow depth than class B channels. Based on these results, the centroid depth and hydraulic depth are linearly related to flow depth with ratios of 0.63 and 0.62, respectively, across the stream classifications tested for varied depths from the thalweg to bankfull. The ratio of hydraulic radius to flow depth varied by Rosgen classification between 0.49 and 0.60.

9. Revelations from A Milan Project: Monitoring Results Quantify Channel Wood Production Rates in Small, Steep Stream Channels, Columbia River Basin

Charles Chesney
WDNR Forest Practices Branch, PO Box 2454, Yakima, WA 98907

Long term ecological monitoring was conducted to describe the functional roles of wood in small, steep stream channels, and to document the relationship between riparian vegetation, tree fall, channel wood, and sediment storage. Results from monitoring over 5800 trees are presented for three ecological processes: rates of tree fall, and production rates of fallen trees making fluvial (channel) wood or terrestrial (down) wood. Over a period of four years of monitoring (2000-2004) at eighteen sites, 28% of fallen trees became fluvial (channel) wood, and 72% of fallen trees became terrestrial (down) wood. However, most channel wood was above and near the channel, and not hydraulically active channel wood. Three of fifteen sites with tree fall had no new channel wood production. In ten of twelve sites with new channel wood production, over two-thirds of new channel wood was zone 3 and 4 wood (located above and near the channel, not within the wetted perimeter of the channel). Implications for creating channel wood budgets are discussed, including requirements for future measurements of fluvial import, terrestrial input, and fluvial export for this Milan Project (300-year duration).

10. How poor practices misrepresent channel wood performance

Charles Chesney
WDNR Forest Practices Branch, PO Box 2454, Yakima, WA 98907

Lessons learned from monitoring 2079 pieces of SWD, 395 pieces of LWD, and 300 sediment wedges, are shared from long term (300-year) measurements from eighteen sites in small, steep stream channels of Eastern Washington. Comparisons of several channel wood accounting practices derived from the Channel Reference Site Network (CRSN) and Wood In Small Streams Project (WISSP) dataset show how the choice of channel wood monitoring indicators affects information and knowledge yield. Explorations of the regulatory requirements for channel wood on State and private forest lands in Washington, as codified in the Washington Forest Practice Rules (WAC 222; July 2001), using an indicator of wood piece count per unit channel length, will be conducted with the CRSN/WISSP dataset. Practical implications for scientists, monitors, channel designers, river thinkers, and restoration specialists will be discussed in the context of an ongoing stream of results from A Milan Project (300-year duration).

11. A simple model for the interaction of contaminated sediment with river floodplains

J. Wesley Lauer
Ph.D. Student, University of Minnesota, Department of Civil Engineering

A numerical model for the long-term evolution of the concentration of a conservative contaminant in a river's floodplain-size sediment is presented. The model is based on the simple idea that floodplains of single thread meandering rivers represent repositories for sediment and that channel migration through these floodplains results in a simple, measurable exchange of relatively old floodplain sediment with material that has recently been transported by the river. One of the primary challenges in modeling a floodplain's influence on river contaminant concentration is characterizing the mass of contaminant entering the river at eroding streambanks. The model presented here assumes that the contaminant concentration in the eroding banks is a function of the history of contaminant concentration in the actively transported river sediment and the age distribution of sediment entering the river from bank erosion. The model is applied to the case of the Fly/Strickland River System, Papua New Guinea, which has received potentially contaminated mine tailings at its upper end for some 20 years.

12. Reclamation of Hazardous Mining Wastewater and Tailings

Ed Rosenberg
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Dan Nielsen
Ph.D. Student, Department of Chemistry, University of Montana, Missoula, MT 59812
Joel Clancey, Jeff McKenzie
Undergraduate Research Assistant, University of Montana, Missoula, MT 59812

Toxic and polluting metals contaminate waters worldwide. Presently, metal laden wastes and waste-streams are either discharged into riverian systems, contained in perpetuity, or relocated. Silica polyamine composites were utilized to recover Cu(II), Zn(II) and Mn(II) from Berkeley Pit Lake water (Butte, MT), and Philipsburg District tailings. The reported materials exhibit exceptional metal selectivity and capacity at high flow rates. Environmentally benign and economically feasible syntheses allow these materials to be used at an industrial scale.

13. Environmental and Societal Obstacles to Stream Renaturalization

Jessica Hawn
Department of Geography and Sociology, University of Montana

In a small town, any type of proposed change tends to arouse emotions from the locals. Renaturalizing a streambed not only involves compromises from the land, but it requires compromises within the community as well. This is a study of a small Montana town, Lewistown, with a population of approximately 6,000 people.The small agricultural-based community tunneled its local water resource called Big Spring Creek under the city streets in the early 1900s. Now, as the town is experiencing a tremendous loss in population and economic activity, the townspeople are faced with the decision of how to revitalize the failing downtown businesses. One of these options is to "daylight" Big Spring Creek and build a downtown gathering place to attract outside tourists which would be in conjunction with a similar project in the area known as Brewery Flats. This watershed on the outskirts of town underwent a transformation in the late 1990s when the straightened channel was r eturned to its original meandering form. There have been both positive and negative results from this environmental change. This particular case forces researchers and the people of Lewistown to ask questions such as if it is always beneficial to return a body of water to its natural state, if the advantages will always outweigh the disadvantages, and when (if ever) is it too late to interfere with such a valuable resource? This study will examine the viability of Spring Creek's downtown revitalization project and apply the findings to the possibilities of Lewistown's environmental, economic, and social recoveries.

14. Stable isotopes of precipitation, evaporated mine waters, and rivers in Montana

Chris Gammons
Dept. of Geological Engineering, Montana Tech, Butte, MT
Simon Poulson
Dept. of Geology, Univ. Nevada-Reno, Reno, NV

The isotopic composition of a full year of rain and snow samples was used to construct a local meteoric water line (LMWL) for Butte, Montana. The derived equation (dD = 7.312d18O - 7.48, r2 = 0.987), represents the first LMWL for any location in the northern Rocky Mountains. Samples of underground and surface mine waters in Butte, including the Berkeley pit-lake and the Yankee Doodle tailings pond, fell on a different linear trend (dD = 5.00d18O - 49.54, r2 = 0.991) with a much lower slope than the LMWL. The mine water trend is explained by evaporation at an average relative humidity of roughly 65%. Detailed calculations indicate that the shallow Berkeley pit-

lake was approximately 25% evaporated in October, 2003, whereas the surface of the tailings pond was at least 50% evaporated. The intersection of the LMWL and mine water evaporation trend was used to calculate the isotopic composition of recharge water to the flooded mine complex. The result is consistent with the main period of groundwater recharge occurring from snowmelt and Spring rains. The results were also compared with stable isotope data that have been collected by the USGS for rivers in Montana. Several of the smaller rivers (e.g., the Musselshell, Milk, and Tongue) as well as the Missouri River below Fort Peck Reservoir clearly show the effects of evaporation, especially for samples collected during mid-summer, low-flow conditions. These evaporated river waters fall on the same isotopic trend as the Butte mine waters, implying that a single evaporation line may be applicable to all surface waters in Montana.

15. Trophic State of Lakes in the Blackfoot & Swan Basins

Vicki Watson
UM Watershed Health Clinic
Mike Suplee
Mt. Department of Environmental Quality
Jolanta Glabek
UM Watershed Health Clinic

In 2003 & 2004, the Montana Department of Environmental Quality & the University of Montana collaborated on a survey of Montana's lakes to develop a lake classification system based on key physical, chemical & biological characteristics. Study lakes in the Clark Fork basin were concentrated in the Blackfoot & Swan River drainages and included a group of lakes intensively studied in the 1970's & early 1980's by UM researchers Richard Juday & Ed Kellor. Key indicators of lake trophic state were computed from recent & historic data and compared. Historic data showed more productive lake trophic states than the 2003-04 data. It is likely that the lakes have experienced some recovery since the heavy logging of the 1960's and 70's. Despite the increase in residential development around the lakes in recent years, the lakes seem to have improved since the 1970's & 80's. However, continued growth in residential development may cause the lakes to degrade in the future. The 2003-04 data provide a baseline against which development impacts can be judged in future.

16. Comparison of two flow routing algorithms to detect ephemeral streams in a mountainous watershed using remotely sensed imagery

Bret Magdasy
Department of Geography, The University of Montana

Correct estimation of ephemeral channel networks is important for accurate runoff prediction, making the identification of these networks vital in landscape-scale geomorphic and hydrologic analyses. For this reason, models that predict the extent and characterization of channel networks contribute to our understanding of surface erosion, landform evolution, and the sensitivity of landscapes to environmental change. The focus of this study is to identify which algorithm is the best at identifying ephemeral stream channels from remotely sensed data in the Tenderfoot Experimental Forest, located in the Little Belt Mountains of central Montana. Two different routing algorithms (multiple flow and non-nearest neighbor) are used to delineate the channel network in the study area at two different scales, 30 meters and two meters. This study compares the different algorithms at different scales, and identifies the algorithms at both scales that best detect the presence of ephemeral stream channels observed on the ground.

17. Plecopteran Nymphs: A Potential Vector for Transmission of the Fish Pathogen Aeromonas salmonicida in Freshwater Ecosystems

Sandra M. Adams, Nathan S. Gordon, Alejandra Valenzuela, James E. Gannon and William E. Holben.
Microbial Ecology Program, Division of Biological Sciences, The University of Montana, Missoula MT 59812, USA

Trophic interactions between microbes and insects in aquatic systems are not completely understood. However, it is generally accepted that early instars of many plecopteran species graze on microbial biofilms and that fish are predators of stoneflies. Investigations of bacterial communities of plecopteran hindguts and of sediment samples from the hyporheic zone of the Nyack flood plain (near West Glacier, Montana) have indicated the presence of Aeromonas salmonicida, a known fish pathogen. In the current study, we investigated the possibility that plecopteran nymphs act as a reservoir and/or mode of transmission for A. salmonicida. Feeding assays were conducted in which plecopteran nymphs were presented with a suite of different bacterial species, A. salmonicida being one. In these assays, plecopteran nymphs (Capniidae: Isocapnia spp. and Chloroperlidae: Paraperla spp.) showed a preference for A. salmonicida. In subsequent experiments, plecopteran nymphs of the Family Pteronarcyidae (genus Pteronarcella Banks) were sustained solely on a diet of A. salmonicida since survival times of nymphs feeding on A. salmonicida were significantly greater than nymphs presented with no bacteria. Viable bacteria were isolated from both the hindgut and frass obtained from these nymphs, indicating that plecopteran insects may serve as a vector for transmission of Aeromonas salmonicida to its fish hosts.

18.Long-term hydrogeomorphic effects of dam failure/removal – a pilot study

Denine Schmitz
Land Resources and Environmental Sciences, Montana State University
Selita Ammondt
Earth Sciences, Montana State University
Matt Blank
Civil Engineering, Montana State University
Duncan Patten
Land Resources and Environmental Sciences, Montana State University

Restorative potential of dam removal on ecosystem function depends on the reversibility of the ecological effects of the dam. We tested this hypothesis in a pilot project at two sites where reservoir sediments were naturally evacuated. The Pattengail site included a dam which failed during a high water event in 1927, while the Mystic Lake site had a dam removed prior to spring run-off in 1985. We used paleoflood hydrology, hydrologic

modeling (HEC-RAS), historic aerial photo analysis, and field surveys to measure long-term hydrogeomorphic responses to dam failure and removal. Our data showed greater geomorphic response at the Pattengail site compared to Mystic Lake. Hydrogeomorphic responses were difficult to detect at Mystic Lake due to low resolution aerial photos and smaller fluvial events. The size of the flood following the Pattengail dam breach set in motion a series of channel adjustments and reworked over 0.2 km2 of floodplain along the 1.5 km study reach immediately downstream of the dam. These preliminary results support the commonly held assumption that the restorative potential of dam removal lies in reestablishing a natural flow regime. More importantly, recovery time depends on the sizes and timing of high flow events post-removal and their effects on channel evolution and floodplain development. These results will be used to generate testable hypotheses for a multi-year, interdisciplinary project to study the long-term ecological effects of dam removal. Such a study will advance the knowledge of dam removal methods and their effects, leading to healthier ecosystems and associated human communities.

19. Studying the effects of small dam removal on riparian woody species in Montana using aerial photo interpretation and field surveys

Selita Ammondt
Earth Sciences, Montana State University
Denine Schmitz, Duncan T. Patten
Land Resources and Environmental Sciences, Montana State University

Dams, while providing social benefits, have negatively impacted riparian systems for decades. The removal of dams presents the possibility of reversing their effects on riverine ecosystems. A rejuvenated natural flow regime amplifies floodplain development and provides opportunities for seedling establishment and colonization. We analyzed two sites in southwestern Montana through historical airphoto analysis and field surveys. The Pattengail dam naturally failed in 1927, and the Mystic Lake dam was removed in 1985 due to safety issues. Because of the small magnitude flows after the Mystic Lake dam breach and relatively poor resolution aerial photographs, detecting historic changes in vegetation cover was difficult. However, a time series of aerial photographs from the Pattengail site shows dramatic changes in distribution and aerial extent of the following landcover types: coniferous, deciduous, herbaceous, bare ground, and water. Along our study reach of 1.5 km downstream of the breached dam, coniferous and herbaceous cover types increased, and the amount of bare ground decreased, as our hypothesis predicted. An observed decrease in deciduous vegetation, however, was not anticipated. Channel planform appears to changing is some locations of Pattengail Creek. As riparian vegetation is a good indicator of change in riverine ecosystems, a study of its changes through space and time allows inferences into the effects of dam removal on riparian ecology. Our results will be used to further the scientific knowledge base for dam removals, providing useful evidence for any dam owner considering the option.

20. Effects of Sediment Pulses on Channel Morphology, Sediment Transport and Flow Resistance in Gravel Bed Rivers

Daniel F Hoffman, Manny Gabet
Department of Geology, The University of Montana

Sediment delivery to stream channels in mountainous basins is strongly episodic with

large inputs of sediment typically delivered by infrequent mass wasting events. Identifying the role of mass wasting in the evolution of channel morphologies and fluvial sediment transport is crucial to an understanding of the erosional development of mountain basins. In July of 2001, an intense precipitation event triggered numerous debris flows in the severely burnt Sleeping Child watershed, Sapphire Mountains, Montana. Nine large debris flow fans were deposited on the valley floor, completely filling the stream channel with 2-3 meters of sediment. Investigations focused on the channel response to the large influx of sediment. The channel has aggraded immediately upstream of the pulses and incised through the pulses, resulting in the formation of coarse-grained terraces, and braided reaches immediately downstream. The deposition upstream of the pulses consists almost exclusively of fine material resulting in a bed material D50 one to two orders of magnitude lower than the ambient channel material. The volume of sand being transported is so great that these aggrading reaches extend hundreds of meters upstream of the pulses with one to two meters of sand deposited across the entire valley floor. Spatial distribution of critical shear stress values from analysis of bed material size and channel geometry were calculated along with the distribution of potential bedload transport rates and provide insight on the processes of sediment wave dispersal.

21. Floodplain Disconnection and Persistent Active Channel Complexity Reduction on Lower Deer Creek, California: Quantifying Channel Complexity Changes to Guide Restoration Planning

Mark R. Tompkins
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Deer Creek drains 540 km2, joining the Sacramento River near Vina, about 160 km north of the city of Sacramento. The U.S. Army Corps of Engineers constructed a levee and partly straightened the lower five miles of Deer Creek in 1949, disconnecting the active channel of Deer Creek from its floodplain except during levee failures associated with extreme peak flows. Repeated levee failures and the presence of the federally threatened spring-run Chinook salmon (Oncorhynchus tshawytscha) in Deer Creek have prompted investigations of floodplain reconnection on Deer Creek to restore habitat and provide more reliable flood protection. The Deer Creek Watershed Conservancy identified a significant reduction in channel complexity between 1938 (pre-levee) and 1997, but did not attempt to quantify this reduction. In this study, we analyzed high quality aerial photographs from 1938, 1952, 1966, 1979, 1985, and 1998, and quantified changes in river corridor complexity by digitizing distinct bedforms, cumulative channel length, flood corridor width, average active channel width, shaded riverine aquatic (SRA) habitat, and total riparian vegetation area on each set of photos using ArcGIS. Each of these metrics showed persistent reduced active channel complexity after the completion of the flood control project in 1949, with reductions in complexity significantly greater in the leveed reach of lower Deer Creek. In the leveed reach, cumulative channel length has decreased by 10-15%, flood corridor width has decreased by 40%, average active channel width has increased by 9-63%, shaded riverine aquatic (SRA) habitat has decreased by 55-70%, and riparian vegetation area has decreased by 14-30% between 1938 and 1998. Outside the leveed reach, cumulative channel length has decreased by 0-7%, flood corridor width has decreased by 42%, average active channel width has increased by 0-36%, shaded riverine aquatic (SRA) habitat has decreased by 0-26%, and riparian vegetation area has decreased by 14-30% between 1938 and 1998. The number

of distinct bedforms in the lower river has also decreased significantly over the same period. These results provide a basis for prioritizing, locating, and developing designs for floodplain reconnection approaches that would contribute to the enhancement and restoration of aquatic and riparian habitat along lower Deer Creek.

22. Reconfigured-Channel Monitoring and Assessment Program

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Channel reconfiguration to mitigate a variety of riverine conditions has become an important issue in the western United States. Reasons cited for channel reconfiguration include restoration to more natural or historical conditions, improved water conveyance in flood-prone areas, mitigation of unstable streambed and streambanks, more efficient sediment transport, and enhancement of fish and riparian habitat. Numerous projects have been undertaken to reconfigure stream and river channels. However, the effectiveness of these modifications over a period of time, in terms of channel response and achievement of project objectives, has not been assessed in a consistent manner. Channel reconfiguration projects have been or are being undertaken for several river and stream reaches in Montana. In Colorado, the U.S. Geological Survey is engaged in the Reconfigured-Channel Monitoring and Assessment Program (RCMAP) to monitor and assess selected river reaches that have undergone reconfiguration. Long-term monitoring of physical changes and hydraulic performance of reconfigured channels will allow determination of why a particular reconfiguration design may have remained stable or failed. The RCMAP could be expanded to include reconfigured channels in Montana and other western states.

23. Analysis of Groundwater Flow and Connections with the Beaverhead River After Drought and Impacts from New Production Wells

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Southwestern Montana has been experiencing drought for approximately seven years. The Dillon area is experiencing a decrease in average annual precipitation from a 30-year-average of 11.6”/year to 8.7”/year since 1999. Additionally, some of the major canal

systems have not been running water. In 2004 the East Bench Irrigation District received none of its allotment from the Clark Canyon Reservoir. In response to the ongoing drought, ranchers and farmers have been installing high capacity wells to compensate for the water shortage. This is occurring on both sides of the Beaverhead River. The greatest number of new irrigation wells is on the east side. Many of the permits for these wells have not yet been granted.

A groundwater study was conducted by the DNRC in the early 1990's to evaluate the impacts from irrigation production (Uthman and Beck, 1998). The study area was conducted between Barretts, approximately eight miles to the south, and the town of Dillon Montana. To account for the changes in stresses in the groundwater/surface water system a new thesis study was began in 2005 (with some data from 2004). This was initiated to compare changes in the flow system and extend the study to the north, where new baseline data are desperately needed. The new study area encompasses the region from Dillon to Beaverhead Rock, about 26 miles to the northeast and all tributaries in between. Comparative data from wells from the Uthmand and Beck (1998) study are also being collected to evaluate longer term changes.

The cumulative effects on the aquifer and ultimately the baseflow of the Beaverhead River from drought, well drawdown, and lack of normal recharge from the East Bench Canal are largely unknown. Preliminary results will be presented using existing and new observation wells, documenting the occurrence and flow of groundwater, determine aquifer properties by analyzing drawdown impacts through aquifer testing, measuring streamflow, evaluating SW-GW interactions, and the development of a groundwater flow model.

24. Investigation of hydrologic properties at a microbial scale, Nyack Floodplain, Montana

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An NSF-funded Microbial Observatory project was begun in 2004 to examine the microbial diversity in the floodplain of the Middle Fork of the Flathead River in Western Montana. The need to trace flowpaths and determine flux rates at the cm- to m-scale in this highly heterogeneous sand, gravel and cobble dominated-site presents a number of hydrologic challenges. A number of traditional and innovative techniques are being applied to characterize field conditions. A network of small diameter piezometers and wells were used to develop a potentiometric surface and determine general flow directions. Local, small-scale horizontal water velocities through the bar sediments were determined by using pit dilution experiments and tracer breakthrough trials. The local vertical distribution of hydraulic conductivity is being investigated by using borehole pneumatic slug tests and borehole dilution tests. Attempts to characterize geologic bar structure included surface geological mapping, LIDAR image interpretation, pit excavation and the installation of several "glass wells" (clear PVC), which are being logged using a down-hole camera and digital recorder. Preliminary results suggest that rapid flow occurs in discrete flow paths in coarse sediments rather than diffusively. The pathways seem to be unrelated to sediment composition or grain size, and may be determined by “connectedness” (according to the chaos of the sedimentation process). As of yet, these discrete paths are not predictable, making the location or prediction of “well-to-well” flow paths difficult. Flow rates near the water table are seen to vary as much as from 3.9 to 232 m/d. Future work will include detailed well-to-well tracer studies, application of borehole and surface GPR and other surface geophysical techniques, and modeling the sedimentary processes forming the floodplain microbial environments..

25. A heat budget for a shallow alluvial floodplain aquifer with implications for stream temperature and salmonid habitat, Northeastern Oregon

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Efforts to restore salmonid fisheries in the Umatilla River in northeast Oregon are challenged by summer stream temperatures that are higher than historically recorded and detrimental to the fish. Earlier analyses suggest that river temperatures are cooled and buffered by river/floodplain groundwater exchange. This work attempts to develop a heat budget for the floodplain/riparian zone groundwater system including the influence of surface conduction, a factor altered by floodplain shading. Two reaches of the river and associated floodplain aquifer were instrumented with over 70 ground water monitoring wells and hundreds of temperature loggers. This work showed that the temperature of the infiltrating river water and heat conduction from the land surface drive ground water temperature. The importance of either component was assessed with numerical simulations (VS2DHI) of heat and water flux and is dependant upon the thicknesses of the vadose zone and aquifer, and the residence time of the ground water. In cases where surface conduction dominates, land cover can affect the average ground water temperature, which in turn influences stream temperatures.

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