The Microbe-Stonefly-Fish Connection: Exploring trophic linkages and fish pathogen transfer through microbial community analysis in the Nyack Flood Plain
Sandra Adams, UM Integrative Microbiology & Biochemistry

The Nyack flood plain is a hyporheic zone in which surface, ground, and subsurface water interact. This pristine and unique subsurface environment supports a diverse array of biota, including abundant plecopterans, which are often found at great distances (> 1 km) from the streambed.

Microbial communities in aquatic ecosystems are important nutrient cyclers and are the base of a complex food web. We hypothesize that microbial communities serve as a storage reservoir of carbon, nitrogen, and phosphorous in the flood plain. Through surveying the hind-gut contents of plecopterans, resident microbial populations in the region were characterized phylogenetically, providing insight to basic mechanisms that are driving the ecosystem. The majority of microorganisms that were identified were most closely related to known denitrifying bacterial species.

Preliminary findings collectively suggest high microbial diversity in the hindguts of plecopterans. However, within insect genera, the diversity in the microbial assemblage was low. For example, individual insects belonging to the genus Paraperla appeared to harbor essentially a monoculture of the bacterial species Aeromonas salmonicida, generally considered to be a fish pathogen. We hypothesize a tritrophic relationship between microbial communities, plecopterans, and fish. The presence of microbes related to denitrifiers and to fish pathogens in insect hindguts intriguingly suggests such relationships may exist. For example, in this system, plecopterans receive a nutritional benefit from microorganisms both as food and functionally, while the microorganisms may receive benefits of environmental control (e.g. an anoxic environment for dentrification) or pathogen transfer through an intermediate host.

Natural Stream Channel Design for Silver Bow Creek, Butte, Montana
Bill Bucher, Maxim

No abstract available.

Accessing Clark Fork Basin ground-water information from the Ground-Water Assessment Program, Montana Bureau of Mines and Geology, Butte
Camela Carstarphen, John LaFave, Thomas Patton, and Larry Smith, Montana Bureau of Mines and Geology

Field data from about 3,000 wells within the Clark Fork River basin are available from the Montana Bureau of Mines and Geology (MBMG) through the work of the Ground-Water Assessment Program. These data have been systematically collected during Ground-Water Characterization studies completed in the Flathead Lake Study Area (Flathead and Lake counties, 1995-1998), Lolo-Bitterroot Study Area (Mineral, Missoula, and Ravalli counties, 1997-2000), and Upper Clark Fork Study Area (Granite, Powell, Deer Lodge, and Silver Bow counties, 2000-2003). Within each study area, information was collected at approximately 1,000 wells and included: on–site measurements of pH, temperature, specific conductivity, water-level, and latitude and longitude. Additionally, about 25% of the visited wells were
sampled for major cations, anions, nitrate, and trace metals (with a small portion of these analyzed for tritium concentration). Ten percent of all wells visited also had monthly water levels collected for 3 years. All information was collected using standardized repeatable methods and has been internally reviewed for consistency and accuracy.

The MBMG has published interpretative maps and a final report for the Flathead Lake Study Area that outlines and evaluates: the geologic framework of aquifers and confining units, depths to and thickness of hydrogeologic units, ground-water flow systems and water quality, and water-level changes. Maps for the Lolo-Bitterroot Study Area are nearing review. Field data, water-quality data, and completed maps are available to download through the Ground-Water Information Center’s website. The field and lab data can be easily downloaded, copied directly into an excel spreadsheet, and used with any geographical information system software. To purchase a hardcopy of maps and reports contact our office (406.496.4174) or log onto MT Bureau of Mines & Geology web site.

Restoring Silver Bow Creek: An Educational CD-ROM

*Kathy Coleman, Montana Natural Resource Damage Program; Todd Trigsted, multimedia producer*

The cleanup of the Silver Bow Creek Superfund site near Butte is the largest stream and floodplain remediation/restoration project ever undertaken in the United States. Since remediation began in 1999, the Montana Department of Environmental Quality has removed over one million cubic yards of tailings in the floodplain, reconstructed the stream channel in the first six miles, and designed work for the next four miles. When complete, over 22 miles of stream channel and floodplain will have been treated to remove some four million cubic yards of tailings and soils laden with heavy metals. Under restoration, a greenway trail system is also being constructed that will enhance aquatic and riparian resources and provide a variety of recreation opportunities. Combined, the 10-12 year joint remediation/restoration work will result in a restored floodplain ecosystem.

The educational CD-ROM, “Restoring Silver Bow Creek” provides the visual context necessary to comprehend the enormous size of the pollution problem, cleanup, reconstruction and restoration effort. Artist Todd Trigsted spent ten years filming the cultural and environmental impacts of Butte’s copper mining industry. Some of this work, and new work under contract with the Montana Natural Resource Damage Program, was consolidated for this educational CD-ROM. The CD-ROM offers photographs, panoramic views, videos, or diagrams that cover topics such as the mining history, environmental injuries, remediation and restoration. Viewers can see snapshots of tailings removal, transport and disposal activities and stream reconstruction activities in progress, as well as reaches of the creek in various phases of cleanup.

Missoula's Riparian Resources—Condition, Risks, Potential

*Kate Colenso, Motoshi Honda, Cheryl Vann, UM Watershed Health Clinic*

In fall 2003, an inventory and assessment of the condition of riparian resources within the Missoula city limits was conducted by the University of Montana Watershed Health Clinic for Save Open Space (a Missoula nonprofit organization dedicated to preserving open space in the greater Missoula urban area). Nineteen sites were surveyed within five areas: Grant Creek Area, Rattlesnake Creek Area, Clark Fork River/Downtown Area, Pattee Creek/South Hills, and Bitterroot River Area. Sites were categorized by quality (high, medium, or low) and by degradation risk (high or low) and restoration potential. Eight
sites were identified as high priority for restoration, and four sites were identified as high priority for preservation. An education program focused on communicating to private landowners the value of maintaining/ restoring natural riparian vegetation was recommended for long-term protection of riparian resources.

**Defining River Recharge and the fate of arsenic in the shallow groundwater system adjacent to a losing river, western Montana**

*R. Cook, A. Tallman and W. Woessner, Department of Geology, University of Montana*

The Missoula aquifer is the source of water for over 57,000 residents of the Missoula valley. This sole-source aquifer is unconfined and coarse grained, and the Clark Fork River is perched above the aquifer in the Missoula valley. The Clark Fork is a losing river, and anywhere from 50% to over 80% of the recharge to the aquifer comes from the river. The source of water input to the Missoula aquifer, and the associated flow regimes are not completely understood. The objective of this study is to identify the source of water for the Missoula valley aquifer, and to quantify the flow regimes of those sources. Of particular interest is whether arsenic is present in the surface and groundwater systems, and how it moves through these systems. Water temperatures measurements, water chemistry (especially arsenic and oxygen isotopes), and hydrological data (such as specific conductance and dissolved solids), will be used to characterize the mixing of surface water with the underlying aquifer, this knowledge will be valuable in assessing the impacts of any possible future contamination of the Clark Fork River on water quality in the Missoula valley aquifer.

**Watershed Restoration Plan for Nine Mile Creek**

*John Dearment, Land & Water Consulting*

No abstract available.

**25-Year Record of Nutrient Loading to a Large, Oligotrophic Lake -- Flathead Lake**

*Bonnie K. Ellis, Jack A. Stanford and James A. Craft*, Flathead Lake Biological Station, University of Montana

Flathead Lake is one of the 300 largest lakes in the world. The Flathead Basin is 22,241 sq. km and is drained by six 5th-order tributaries of the main-stem Flathead River. Almost half (42%) of the Basin is included in National Park and Wilderness protection. Nutrient loading to Flathead Lake from all major tributaries and atmospheric deposition was measured over a period of 25 years. During the last two decades as much as 45% of the annual phosphorus and 24% of the nitrogen load was fallout from the atmosphere, mainly from fugitive dust from local rural roads, smoke particulates from forest fires and agricultural burning inside and often far outside the Flathead Basin. Pelagic primary production (in-lake growth of algae) is limited by availability of nitrogen and phosphorus. Nitrogen loading from human sources upstream of Flathead Lake has steadily increased over the last three decades, and daily nitrogen loading weakly correlates with increasing primary production.

* presenter Scott Relyea of the Biological Station
Montana Water Trust Efforts in the Clark Fork Basin

John Ferguson, Chris Corbin, and Brianna Randall, Montana Water Trust

The Montana Water Trust, located in Missoula, Montana, is a non-profit 501 (c) (3) organization founded in 2001. Our mission is to work cooperatively with farmers, ranchers, and other landowners to develop voluntary agreements that increase stream flows at critical times. Using a grassroots, collaborative approach to restore and protect native fisheries and benefit local communities, the Montana Water Trust seeks to acquire water rights on dewatered tributaries in western Montana, and eventually throughout the state.

In 1995, the Montana legislature amended the state's water code to allow water right holders to donate or lease some or all of their water rights for transfer to instream use. The Montana Water Trust transfers water rights from interested landowners through a variety of innovative methods, including water right purchases, leases, donations, and water saving projects. We work to maintain mutually beneficial relationships, create healthy streams for the enjoyment of local communities, and maximize the benefits of efficient water management by landowners. The Montana Water Trust uses systematic science-based methodology to ensure protection of our instream water rights and to help demonstrate and monitor the ecological benefits of our acquisitions.

Restoring instream flows is an essential part of watershed restoration. Using incentive-based conservation, the Montana Water Trust has restored 13 cubic feet/second -- over 8 million gallons per day! -- to tributaries in western Montana during seasons critical for native fish. We have several projects scheduled for 2005 that should provide ecological and economic benefits to streams & communities in western Montana.

Wetland Surveys for Trumpeter Swan Reintroduction in the Blackfoot River Valley

Brian Ferrasci-O'Malley, University of Montana Watershed Health Clinic

The US Fish and Wildlife Service plans to reintroduce trumpeter swans to the Blackfoot River valley in summer 2005. To identify the best sites for reintroduction, over 70 wetlands across the valley were surveyed in fall 2004 and subsequently analyzed for habitat suitable for adult survival and nesting. Particular emphasis was placed on the abundance of certain submergent plants which are key food species.

Field work was conducted from August to October 2004. Each wetland was surveyed by land and by canoe to develop a current baseline dataset of wetland characteristics. Transects were run across areas dominated by submergent vegetation to provide a semi-quantitative estimate of the abundance of these food species. An overland survey netted information on other wetland characteristics like percent of open water, species diversity of emergent vegetation, and presence/absence of human disturbances. Out of 70 sites surveyed, 22 were determined to have suitable nesting sites, and 9 of these sites were selected as being most suitable for release sites. Hazards near these sites (intruding fence lines and power lines) will be mitigated in preparation for a July 2005 release date.
Restoration Activities in the Upper Clark Fork River Basin funded by the Montana Natural Resource Damage Program

Carol Fox, Kathy Coleman, Greg Mullen, Doug Martin, Montana Natural Resource Damage Program

Decades of mining and mineral processing operations in and around Butte and Anaconda released substantial quantities of hazardous substances into the Upper Clark Fork River Basin between Butte and Milltown. These hazardous substances extensively injured the area’s natural resources. In 1983, the State of Montana filed a natural resource damage lawsuit against the Atlantic Richfield Co. to recover damages for these injuries to the water, soils, fish and wildlife in the Basin and for the public’s lost use and enjoyment of these injured resources. The State settled several portions of the lawsuit in 1999, receiving $215 million. About $130 million is earmarked to restore or replace the injured natural resources in the Upper Clark Fork River Basin between Butte and Milltown Dam near Missoula.

In 2000, the State initiated an annual grant process, administered by the Montana Natural Resource Damage Program, whereby entities can apply for funding for projects that will improve water, fish, and wildlife resources and related public drinking water and recreational services. To date, the State has completed five grant cycles and awarded about $29 million of restoration funds for 42 projects. This poster presentation provides summary information on the projects funded to date.

Little Blackfoot River Streamflow and Water Temperature Study - Identifying Opportunities for Cooperative Problem Solving

Taylor Greenup & Gary Ingman, Land & Water Consulting; Jeff Janke, Little Blackfoot Watershed Group; Susie Johnson, Deer Lodge Valley Conservation District; John Ferguson, Montana Water Trust

This poster presents the findings of a streamflow and thermal assessment project on the Little Blackfoot River initiated in 2003 by the Little Blackfoot Watershed Group. The project goals were 1) to identify and prioritize mainstem reaches of the Little Blackfoot River which suffer from elevated water temperatures and low streamflows, 2) to examine causal as well as mitigating factors, and 3) to identify site- or reach-specific opportunities to solve the documented problems through voluntary measures and landowner participation.

Continuous logging temperature recorders were installed in the mainstem Little Blackfoot River at various locations from the confluence with Dog Creek to the mouth, for the summers of 2003 and 2004. Temperature was measured every half hour from July to October. In 2004, synoptic streamflow measurements were conducted on the mainstem Little Blackfoot River, at the mouths of most of the river’s major tributaries, and at many irrigation diversions. Streamflows were gaged during the pre-irrigation season, during the irrigation season, and during base flow conditions.

The Little Blackfoot River streamflow data were analyzed for influences by natural gaining and losing reaches, tributary inflows, the effects of irrigation withdrawals and "passive storage", and general riparian condition. The results of the temperature monitoring and synoptic flow runs were evaluated with results from a detailed riparian assessment completed by Land & Water in August of 2001. Critical reaches of concern along the mainstem Little Blackfoot River were identified, as well as potential opportunities for instream leasing.
**Grant Creek Flood Control & Stream Naturalization Project**  
*Dan Harmon, HDR Engineering and Project Manager for the Grant Creek project*

Grant Creek flows south into the Missoula Valley from the foothills of the Rattlesnake mountains northwest of the City of Missoula. The creek’s headwaters are in national forest and private ranchlands. However, residential and commercial development has grown rapidly where the creek approaches I90. To protect this development, the creek has been confined by a berm, restricting it from much of its former floodplain. The creek flows under I90 in a culvert and then onto the floor of the valley where much of the creek’s flow is lost to infiltration into its alluvial fan. Below I-90 the creek does not flow much of the year. The creek generally follows its historic path but has been straightened and channelized. From West Broadway to the Clark Fork Floodplain, Grant Creek flows across flat agricultural land that is undergoing rapid development. The creek flows near the Mullan Trail subdivision near Mullan Road, where high groundwater from leaking irrigation ditches is thought to contribute to flooding of the subdivision. The creek passes under Mullan Road in a culvert and flows through ranchland on the Clark Fork floodplain to the Clark Fork. Culverts at W. Broadway, Mullan Trail and to a lesser extent I-90 are fish passage barriers.

Missoula County seeks to develop a project that will reduce flooding, improve fish habitat and passage, and improve recreational & aesthetic opportunities. HDR has designed a project to address these goals.

**Biological Water Quality Status and Trends Monitoring in the Big Blackfoot Watershed**  
*Gary Ingman, PBS&J; Brian McDonald, Blackfoot Challenge; Wease Bollman, Rhithron Associates, Inc.; Erich Weber, PhycoLogic; and Loren Bahls, Hannaea*

This poster presents preliminary findings of a basin-wide biological water quality status and trends monitoring program initiated in the Blackfoot watershed in 2004 by the Blackfoot Challenge. The purpose of the program is to evaluate and describe the status, spatial patterns, and time trends in water quality and biological health in the Blackfoot watershed, as influenced by the cumulative effects of restoration projects as well as land development activities.

The monitoring network consists of six sampling locations in three distinct segments of the mainstem Blackfoot River, and six locations on selected tributaries. Biological monitoring variables include periphyton (attached algae) community structure parameters as well as standing crops (measured as chlorophyll a concentrations), and macroinvertebrate (aquatic insect) community metrics. The biological monitoring is intended to complement water chemistry monitoring being performed at the same stations by the U.S. Geological Survey.

Biological data from summer 2004 are presented which demonstrate spatial patterns in water quality and biological integrity throughout the Blackfoot River main stem and in the selected tributaries. Causal factors and impairment sources are discussed. Following several years of monitoring, the biological data will be statistically analyzed for significant time trends.

Longer term information from this program will help the Blackfoot Challenge and its cooperators to document water quality and habitat improvements resulting from collaborative watershed restoration efforts, and as a feedback mechanism to fine-tune collaborative management approaches in the greater Blackfoot watershed area.
Watershed Assessment of Griffin Creek -- A major source of phosphorus to the Clark Fork River  
Sara Krier, Watershed Health Clinic & Environmental Studies, University of Montana

Gold Creek has been identified as a major source of phosphorus to the nutrient-impaired Clark Fork River of western Montana. This watershed assessment is a follow-up to a study that found that the primary source of the phosphorus in Gold Creek was one of its tributaries, Griffin Creek. Selected aspects of Griffin Creek’s water quality, riparian and physical condition were studied to document current conditions and identify potential sources of impairment and restoration needs. Riparian assessments involved riparian vegetation and streambank stability surveys. The physical assessment documented substrate composition, channel morphology, in-stream temperature fluctuations, and stream discharge. Water quality assessments addressed nutrient and sediment levels and loads at two sites on Griffin Creek and seven other sites throughout the Gold Creek basin. The upper reaches of Griffin Creek were dominated by beaver ponds and showed healthy riparian vegetation and stable channel conditions. The lower three-fourths of Griffin Creek exhibited riparian and channel conditions damaged by grazing, flow manipulation, and beaver dam removal. Griffin Creek continues to be a major source of nutrients to Gold Creek and exhibits nutrient concentrations that exceed water quality standards set for the Upper Clark Fork River. However, Griffin Creek is unlikely to be impaired by nutrients since its fine substrate will not support massive algae growths. Recommendations are made for actions likely to improve the condition of Griffin Creek and reduce its loading to impaired waterbodies downstream.

Proposed Restoration Actions at the Clark Fork River Milltown Sediments Operable Unit  
Doug Martin, Montana Natural Resource Damage Program; Pat Saffel, Montana Department of Fish, Wildlife and Parks; Gary Decker, WestWater Consultants, Inc.

Restoration options for the Clark Fork and Blackfoot River near Milltown Dam are becoming a reality following EPA’s December 2004 Record of Decision to remove the Milltown Dam. The State of Montana’s Natural Resource Damage Program and Department of Fish, Wildlife and Parks, in consultation with US Fish & Wildlife Service and the Confederated Salish Kootenai Tribes, is preparing the floodplain and river channel designs that will be integrated with EPA’s remedial activities. The State’s May 2003 draft conceptual restoration design plan, which is based on natural channel design philosophy, received substantial public support. The State is now using 2004 field data to develop a Phase II draft restoration design plan that will undergo peer review by a panel of national experts and then issued for public comment.

The current Phase II design encompasses the Clark Fork River about 5 miles upstream of the Milltown Dam and downstream of the dam to the Interstate 90 bridge, and the Blackfoot River upstream of the dam to just below the Stimson Dam. Restoration design must be adjusted to account for a number of limiting factors, with the major one being the contaminated sediment that will be left in place. Other limiting factors that affect restoration design include: Interstate 90 bridges on Blackfoot River, Stimson Lumber infrastructure, bridges downstream of dam, and coordination with remedial actions. The Phase II design process will also thoroughly address technical issues raised in public comments on the conceptual design plan.
Watershed Assessment & Conservation Options for Ambrose-Three Mile Creek in the Bitterroot Basin
Will McDowell & Jim Rokosch, under contract to the Tristate Water Quality Council

The State of Montana lists Ambrose-Threemile Creek of the Bitterroot River basin on its bi-annual 303(d) list as impaired by degraded water quality and aquatic habitat. A two-year watershed project assessed stream and riparian conditions and made recommendations for improvements. Work was funded by MDEQ under the 319 Non-point Source Pollution program, and many partners cooperated. The project’s purpose was to improve water quality and habitat for native aquatic life and wildlife while continuing to support agricultural uses of water. Improvements are expected to reduce nutrient and sediment loads to the Lee Metcalf National Wildlife Refuge and Bitterroot River. Project objectives were: 1) assess stream conditions; 2) develop community interest and support; 3) develop a long-term restoration program; and 4) support a stakeholder group capable of a sustained watershed restoration effort. 

Three Mile Creek is a third-order stream with hydrology characterized by mean daily flows of 15-17 cfs and estimated bank-full flows of 10 cfs in Ambrose Creek, 25 cfs in upper Three Mile Creek, and 50 cfs near the outlet. Geology and soils of the watershed are important aspects of water quality problems. Land ownership is 64% private. Land cover is >55% lightly vegetated lands.

Mountain stream reaches were straighter & had lower width/depth ratios than typical. In foothills and valleys, channels were incised with vertical eroding stream banks and unstable channel forms. Stable reaches have <2% eroding banks, while reaches with disturbances have >5% and sometimes >10% eroding banks. Stream substrate in reference reaches is <45% fine material, while disturbed reaches have 55%-90%. Aquatic habitat is diminished by loss of pools, low quantities of woody debris and vegetative cover, and excessive fine sediments. Habitat connectivity between reaches is limited by several irrigation structures and culverts that are fish passage barriers. Riparian habitat with <60% woody vegetation on stream banks corresponds to destabilized channels and banks, high sediment supply, and elevated nutrients. Flow alterations affect the drainage, as operations of the Bitter Root Irrigation District BRID canal can greatly increase peak flows and alter frequency of critical low flows. A sediment budget indicates >2,200 tons/year of sediment production (nearly double the natural rate), primarily from eroding banks, roads, and background erosion from uplands. Gully erosion is an additional source. Nutrient concentrations are higher than other Bitterroot tributaries; key sources are sediments & livestock manure. Summer water temperatures were elevated by discharge of BRID canal water.

Based on key citizen/landowner concerns and assessment results, watershed improvement goals were developed. Priority stream reaches and upland areas were identified. Specific recommendations were developed for improvements, and for monitoring parameters and protocols to verify improvement of creek conditions. The assessment established 8 permanent monitoring reaches. Selection of reasonable indicators of project success will assure that improvement is attainable and measurable. Several pilot stream corridor projects have begun. These areas serve as demonstration sites for other landowners wanting similar work on their properties.
Bringing watershed education into elementary classrooms: Traveling trunks as a teacher resource
*Montana Natural History Center*

This trunk offers a glimpse into our local Clark Fork watershed. Take an imaginary journey using a hand painted floor map and wooden figurines to tell the stories of historical characters whose lives were dependent on water. Curriculum and multimedia materials addressing watershed issues are included. Themes covered are the water cycle, water quality, bull trout, aquatic life and human impacts.
For grade level: 3-6

Reconnecting the lower Clark Fork River/Lake Pend Oreille system: Adult bull trout response to transport above Cabinet Gorge Dam
*Sean Moran & Joseph DosSantos, Avista Corporation*

Electrofishing and a fish ladder/trap were used to capture 129 individual adult bull trout *Salvelinus confluentus* in the Clark Fork River downstream of Cabinet Gorge Dam, Idaho, from 2001 through 2004. A portion of these fish were presumed to have migrated downstream as juveniles from Montana tributaries through or over the dam and reared in Lake Pend Orielle, Idaho (16 kilometers downstream of Cabinet Gorge Dam). Captured adult bull trout were surgically implanted with radio transmitters and were transported upstream by fish tank truck to Cabinet Gorge Reservoir, Montana. Of the 129 individual bull trout successfully released in Montana, 78 were detected in tributaries to Cabinet Gorge Reservoir during the 2001 through 2004 spawning seasons (i.e. September and October). A total of the 26 bull trout transported from Idaho were recaptured in spawning tributaries, transported downstream, and released in the Clark Fork River, Idaho. Another 43 bull trout were documented to have volitionally passed downstream through turbines or over Cabinet Gorge Dam, a minimum of 42 of those likely survived turbine passage. Genetic assignments to tributaries of origin were accomplished for most fish captured over the 4 year study period. Of the 112 viable genetic samples collected below Cabinet Gorge Dam, 90% were assigned to upstream tributaries. Radio receivers at Noxon Rapids Dam (31 kilometers upstream from Cabinet Gorge Dam) detected 40 of the 129 bull trout in the dam tailrace area, 70% of these fish originated upstream of Noxon Rapids Dam, the second dam on the Clark Fork River.

Copper Bioaccumulation in Snails in a Simulation of Silver Bow Creek
*Emily Munday, Butte High School*

Historic mining and smelting contaminated the Silver Bow Creek (SBC) watershed which is now being reclaimed under the Superfund law. Copper and other heavy metals continue to impair water quality, aquatic habitat, and stream life in SBC. To study bioaccumulation of copper in the food chain under conditions similar to SBC, I simulated the creek’s conditions in the laboratory.

The simulated food chain included the biofilm growing on the rocks in SBC and freshwater snails of the Pulmonata Lymnaeoida group -- ideal subjects for this study, because they are fairly tolerant of metals, graze on the biofilm, and occur naturally in SBC.

Snails and water were collected from Blacktail Creek, a relatively unpolluted tributary of SBC. Rocks with biofilm (including attached algae) were collected from SBC. A dilute solution of CuSO4 was used as a source for copper.
To study metals bioaccumulation at different copper levels, I used four aquaria containing Blacktail Creek water with copper added in these amounts.

No additional copper (‘control’);

- enough to reach the LD-50 (lethal dose 50 – that is the concentration at which 50% of the organisms would be killed in a certain amount of time) of the snails;
- enough to simulate SBC conditions during a storm event,
- enough to simulate levels in SBC most of the time (chronic exposure levels).

I monitored each aquaria’s concentration of copper in water daily for 17-35 days with a HACH portable colorimeter. I also digested samples of water, biofilm and snails about 5 times over this period, and analyzed those digests in an Atomic Absorption Spectrophotometer.

In all the aquaria with copper additions, the level of copper in snails fairly quickly tracked the levels of copper in the water. Copper levels in biofilms did not track the water copper levels well, possibly because of analytical problems.

In the Storm simulation aquarium, copper was added in a ‘slug’, and copper levels rose quickly in water & snails and then dropped quickly in both. In the Chronic and LD-50 aquaria, high copper levels were gradually built up by multiple additions of copper. In these situations, copper levels in snails gradually rose, and 50% of the snails had died after 16 days of exposure and after reaching a body burden of 1833 ppm.

**Restoration of German Gulch Creek and a Vision for Fisheries Restoration in the Silver Bow Creek watershed**

_Pat Munday, George Grant, Trout Unlimited_

The German Gulch Watershed Restoration Project will benefit the Silver Bow Creek watershed, complement Superfund remedy and restoration, and enhance recreational opportunities for local residents. Midway between Butte and Anaconda, German Gulch Creek is a major tributary of Silver Bow Creek that was heavily placer mined about 100 years ago. Restoring and protecting natural resources in German Gulch is a key element in maximizing aquatic habitat and recreational opportunities in the Upper Clark Fork River Basin.

This restoration project has four objectives:

1. Insure connectivity between German Gulch Creek and Silver Bow Creek;
2. Restore and protect habitat for native Westslope cutthroat trout;
3. Improve public access to lower German Gulch; and
4. Enhance water quality and quantity to German Gulch Creek and Silver Bow Creek.

German Gulch Creek is the most popular recreational fishery in the Silver Bow Creek watershed, and its restoration will directly benefit Silver Bow Creek through the recruitment of native trout—a seed stock to repopulate the remediated and restored stream. Furthermore, the proximity of German Gulch to Butte, Anaconda, and the Greenway insures that the public will benefit from this restoration effort.
The restoration and protection of Westslope cutthroat trout in German Gulch Creek is an integral part of George Grant Trout Unlimited’s vision for the Silver Bow Creek watershed. Native populations of Westslope cutthroat trout persist in the headwaters of many streams feeding Silver Bow Creek. Because of historical pollution in Silver Bow Creek, it was never colonized by exotic species such as rainbow and brown trout. Thus, the remediation and restoration of Silver Bow Creek by Montana’s Natural Resource Damage Program brings a major opportunity to restore the upper Silver Bow Creek watershed for native trout. Along with this opportunity come serious challenges, including high levels of nutrient pollution from Butte’s sewage treatment plant, metals pollution from mine tailings in the Butte Priority Soils superfund operable unit, agricultural dewatering of tributary streams that severs connectivity with Silver Bow Creek, and the presence of exotic brook trout in most tributary streams. Though these challenges make the restoration of a native fishery in Silver Bow Creek a long term goal, we argue that authentic restoration requires what the philosopher Albert Borgmann calls focal realism and patient vigor.

Water Quality Studies in the Butte Area students of David Murto Environmental Biology, Butte High School
Brad O’Leary, A Comparison of Algae in Silver Bow Creek vs. Beef Strait Creek,
Will Pasco, The Water Quality a Boatman Can Tolerate,
David Murto & students, Water testing at the reclaimed Colorado Tailings on Silver Bow Creek, Warm Springs Ponds, and Silver Bow Creek near Ramsay

No abstracts available.

Issues Contributing to the Decision to Remove the Milltown Dam
Peter Nielsen, Missoula County, & Dennis Gathard, G&G Associates

The Milltown Dam and reservoir are located about 2.5 miles upstream of Missoula, Montana at the confluence of the Blackfoot and Clark Fork Rivers. A 1908 flood filled the reservoir with sediments contaminated with metals from upstream mining and smelting operations. Arsenic contamination in area drinking water was discovered in 1981 by the Missoula City-County Health Department. The United States Environmental Protection Agency (EPA) listed the area on the federal Superfund site list in 1983. In 2003 Montana Governor Judy Martz, the United States Environmental Protection Agency (EPA) and the Montana Department of Environmental Quality (DEQ) called for the removal of contaminated sediments in the Milltown Reservoir and the removal of the Milltown Dam.

Factors leading to the decision to remove the dam included:
- A 1996 ice event scoured contaminated sediments and killed fish. Similar events occurred in the 1980's and 1970's.
- The bull trout was listed under the federal Endangered Species Act.
- The reservoir became populated with an invasive, predatory fish species.
- Electric energy deregulation led to the sale of the dam to a new owner.
- The dam became an unprofitable liability.
- Missoula County proposed ambitious cleanup and restoration goals known as the Two Rivers Restoration Project.
- Strong public support developed for cleanup and dam removal. Dam safety evaluations caused concerns about leaving the dam and contaminated sediments in place.
• EPA and DEQ determined that cleanup and dam removal would restore the polluted aquifer, and prevent surface water and fisheries impacts from ice-scouring, floods or dam failure.

Thompson River Riparian Restoration
Thomas Parker, Geum Environmental Consulting, & Brian Sugden, Plum Creek Timber

Riparian areas along the upper Thompson River have been affected by historic clearing for hay meadows, grazing, and timber harvesting. Historic photographs show that much of the floodplain once supported native riparian shrubs. Currently, the floodplain is dominated by Phalaris arundinacea (reed canarygrass). This conversion has resulted in loss of woody cover, reduced shade, few sources of large wood, and extremely low plant species diversity on the floodplain. During September 2003, Plum Creek Timber Company, working with staff currently at Geum Environmental Consulting, Inc., implemented a riparian restoration project to improve summertime stream temperatures, restore instream habitat, and improve migratory habitat and the quality of connectivity among local populations of bull and cutthroat trout. The project had three major elements: 1) Control competition from exotic reed canarygrass through site preparation, installation of weed barriers (including continuous sheets of linerboard), and application of mulch; 2) Planting of native willow, dogwood, and other shrubs in 1-gallon containers at an 8 foot spacing; and 3) Planting native conifers on adjacent terraces and floodplain areas. Monitoring results from the first growing season show high survival among planted shrubs and effective suppression of reed canarygrass. Unique methods and tools were used during the project to cover 2 acres of floodplain with mulching materials.

Watershed Restoration Coalition’s Approach to Watershed Restoration in the Upper Clark Fork River Basin
Scott M. Payne, Kirk Environmental, LLC

Watershed restoration efforts focus on implementing restoration plans to restore impacted systems with fully functioning systems. The ultimate goal of this process is to meet restoration targets that are demonstrated through long-term monitoring. Many watershed groups hold meetings to define watershed issues, develop environmental policy to protect their watershed, and monitor watershed health to help prioritize where restoration should take place. However, most watershed groups and partner organizations struggle to actually implement large scale restoration plans that make measurable improvements at a watershed scale.

The Watershed Restoration Coalition of the Upper Clark Fork (WRC) began its mission in 1999 to restore impacted watersheds and to protect open space in the Upper Clark Fork River Basin (UCFRB). Twelve strategic components are used by the WRC to implement successful watershed scale restoration efforts. This paper presents the WRC’s implementation strategy, philosophy, values, pitfalls, and current projects that are used to bring about watershed scale improvement in water quality, watershed physical attributes, ecosystems, and preservation of open space.
Restoration Efforts on Lost Creek, Upper Clark Fork Basin
Aaron Penvose, Eric Reiland, and Lindsay Arthur, Montana Fish, Wildlife and Parks; Mike Sanctuary, Confluence Consulting

Lost Creek is a third order stream entering the upper Clark Fork River near Warm Springs, Montana. Lost Creek’s water quality and habitat issues include nutrient loading, excessive sedimentation, habitat and flow alterations, channelization, loss of woody riparian vegetation, and fish passage barriers. Among all tributaries, Lost Creek is the largest contributor of nitrogen to the upper Clark Fork River above Deer Lodge. The Tri-State Council’s Clark Fork River voluntary nutrient reduction program lists Lost Creek as the number one priority among non-point nutrient sources in the upper Clark Fork River basin. Montana Fish, Wildlife and Parks is undertaking a major watershed restoration effort to reduce excessive nutrient and sediment discharge and improve the degraded channel condition of the lower creek. The Lost Creek watershed project involves the coordination of riparian and upland restoration activities across six ranches and 27 stream miles stretching from the community of Lost Creek downstream to the Clark Fork River. Overall, the project includes installation of two fish passage structures, corral relocation, habitat enhancement, riparian revegetation, bank stabilization, historic channel reactivation, bridge replacement, riparian fencing, and grazing management. In addition, this project will evaluate the effectiveness of various in-stream restoration techniques for improving habitat and reducing bank erosion in Lost Creek. These techniques include the use of root wads, coir logs, straw bales, tree revetments, bank reshaping, channel relocation, willow transplanting, and willow sprigging.

How Does Geology Inform Conservation/Restoration Actions in the Clark Fork Basin?
Karen Porter, Director, Geologic Mapping Program of Montana Bureau of Mines & Geology

The geologic framework of the Clark Fork Basin is as diverse as any watershed in the West. The geologic events that are recorded in this region span most of recorded geologic time. The preserved rock units and geologic features help explain what natural processes and events have occurred and are occurring in the basin. The geology of the Clark Fork watershed provides challenges and it suggests solutions; it can be a nemesis or a partner.

The Montana Bureau of Mines and Geology has recently mapped most of the Clark Fork watershed. These geologic maps are available on the Bureau’s website. Maps are at several scales -- some focused primarily on the bedrock of the higher elevations of the watershed, others focused primarily on deposits on the basin floor. In the Deer Lodge area, new houses located on the high benches on the valley’s east side must drill deep wells to obtain ground water. The geologic information shows why. In the Bitterroot Valley south of Missoula, geologic maps identify specific deposits that are prone to land sliding, others that contribute anomalous arsenic to ground water, others that are poor or good aquifers, and others that would not support a road bed. Along the upper Clark Fork, deposits of potential economic value are identified, thus providing opportunity to plan to avoid the clash of conflicting land use values.

Geologic information can minimize unexpected results of land use. It is efficient and cost-effective to add the component of local geology to the planning process for virtually all plans to build, excavate, tunnel, pave, bury, subdivide, extract, irrigate, establish easements, or otherwise engage the land surface.
Jocko River Demonstration Reach Project: Wetland/Riparian Habitat Restoration and Bull Trout Recovery

Amy Sacry, Geum Environmental Consulting, Inc.; 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 seedlings, 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.

Patterns of Ground-water Fluctuations in Aquifers: Natural & human-influenced ground water–surface water interactions in the Clark Fork River basin, Montana

Larry N. Smith & John I. LaFave, Montana Bureau of Mines & Geology

The patterns of water-level fluctuations in wells were analyzed by averaging monthly water-level data for more than 100 wells with multi-year data. Long-term monitoring of water levels in wells shows that two fundamental patterns of seasonal fluctuations are common in the Clark Fork River basin. The most common pattern is a seasonal response to irrigation and canal leakage. Less common is the runoff response—where short-term spring meltwater runoff is mimicked in ground water. An irrigation response has a springtime water-level rise that is maintained through the irrigation season and declines through winter. Runoff responses are common near major and minor streams and in the canyon reaches of the Clark Fork River. In these areas ground water rises during flood stages, and falls quickly as flood seasons pass. The Missoula valley shows a different runoff pattern, in that water levels slowly decline throughout the summer and fall, reflecting a spreading pulse of recharge water from the Clark Fork River.

The ground-water level data shows that the use of the extensive network of irrigation canals through the Clark Fork River basin has profound effects on ground water. Irrigation maintains, and in fact creates, high ground-water levels in aquifers that range from a few feet to a few hundred feet in depth. The ground water, in turn, discharges to surface water, affecting surface-water flows, probably on seasonal time-scales. Future changes in irrigation practices and patterns should be expected to change seasonal ground water levels.
Water-level data and hydrographs for all wells are continually updated and can be obtained from the Ground Water Information Center website: http:\mbmggwic.mtech.edu.

Trophic State of Lakes in the Blackfoot & Swan Basins
Mike Suplee, Montana Department of Environmental Quality; Vicki Watson, 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.

Effects of Road Decommissioning on Stream Habitat Characteristics in Flathead National Forest, Montana
Adam Switalski, Wildlands CPR; Magnus McCaffery & Lisa Eby, University of Montana

The Flathead National Forest in Montana has decommissioned more than 300 miles of roads due to a 1994 lawsuit mandating grizzly bear habitat security. Presumably, this decommissioning also benefits the threatened bull trout (Salvelinus confluentus). Previous research demonstrates negative impacts of roads on stream characteristics important for bull trout; however, it is unknown if road decommissioning reverses these impacts. Our goal was to address two questions: First, is there a relationship between substrate composition (percent of fine sediment) and road density? Second, does road decommissioning have measurable effects on stream habitat? We sampled 12 streams with three different watershed types (1) wilderness, (2) roads in use, (3) decommissioned roads. In 2004, we performed habitat surveys, Wolman pebble counts, visual embeddedness estimates, substrate coring, and macroinvertebrate sampling.

There was high variability across streams regardless of treatment. Within our study area, there was a significant positive correlation between percent of sediment less than 6.3 mm and total road density (all roads – in use, decommissioned, and gated). In comparing our three treatment groups, we found the road-in-use group had the highest percentage of sediment < 6.3 mm while the unroaded and decommissioned groups were similar, but these ranked differences were not statistically significant. There was no difference in our decommissioned stream group from our unroaded stream group, implying that decommissioning is likely improving stream habitat in this area of the Flathead National Forest.
Capture Zone Study of Bank-side Production wells and their interaction with a perched river in an alluvial aquifer, Missoula, Montana

Amelia Tallman, Robyn Cook and William Woessner, Department of Geology, University of Montana

The Clark Fork river has been reported to provide 50 to 80% of the recharge to the Sole Source Aquifer that serves over 60,000 Missoula area residents. The aquifer appears vulnerable if the Clark Fork River becomes polluted. This study is investigating the detailed physical and hydrologic conditions associated with the river and the immediately underlying and adjacent aquifer. Parameters being studied in the river are stream stage, streambed temperature gradients, streambed vertical gradients, and streambed hydrologic conductivity. Parameters being characterized for the aquifer include transient water table position, the distribution of hydraulic conductivity, and both vertical and horizontal gradients. These parameters along with ongoing chemical analysis will be used to produce and calibrate a three-dimensional transient ground water flow model of the area.

Identifying & Protecting Critical Lands in the Flathead Basin

Constanza von der Pahlen, Flathead Lakers

The Critical Lands Project is a collaborative effort to identify, protect and restore lands critical to maintaining and improving water quality in the Flathead Watershed. The Flathead Watershed is located primarily in northwestern Montana. Its headwaters form in the mountains of Glacier National Park, the Bob Marshall Wilderness and other forested lands. Many streams and rivers flow through the Flathead Valley and join together in Flathead Lake, the largest natural freshwater lake west of the Mississippi River. Altogether, the Flathead Watershed drains six million acres of scenic landscapes.

Research by the University of Montana Flathead Lake Biological Station indicates that algae in Flathead Lake has increased over the last 27 years and water quality is deteriorating, primarily due to polluted runoff or nonpoint source pollution. Lake and Flathead counties are among the fastest growing counties in the state. The Flathead Lakers initiated the Critical Lands Project to address threats to water quality from growth and development. The goals of the project are to 1) identify, protect and restore lands and waters critical to the quality of Flathead Lake and its tributaries, 2) build cooperation among various agencies and organizations committed to protecting critical lands, and 3) gain grassroots support by informing the public about the importance of critical lands.

Resource professionals from tribal, state, federal, and county resource management agencies, research scientists, and conservationists have worked together to develop criteria for defining critical lands, to identify priority areas, and plan and implement conservation and restoration projects. The project focused its initial efforts in the Flathead Valley upstream from Flathead Lake, since this area contributes the highest nutrient loads to the lake and is facing acute growth pressures. Priorities for protection include wetlands, vegetated stream and river banks, and floodplains. These areas are among the most important areas for maintaining water quality in Flathead Lake and also provide productive and diverse wildlife habitat and recreation opportunities.

Our presentation provides an overview of past accomplishments and ongoing plans, including land conservation, stream restoration, land use planning, and education and outreach efforts.
Ten Years of Testing Indigenous Plant Materials on Drastically Disturbed Minelands in Western Montana
Susan Winslow, Mark Majerus, Leslie Marty, & Shannon Majerus, USDA-NRCS Bridger Plant Materials Center, Bridger, Montana

The Development of Acid/Heavy-Metal Tolerant Germplasm Project began in 1995 to assemble and evaluate native indigenous plant material from areas heavily impacted by historic mining activities in western Montana. The Deer Lodge Valley Conservation District, in cooperation with the USDA-NRCS Bridger Plant Materials Center, has managed this project with grant monies from state and federal agencies responsible for the remediation and cleanup of the EPAs Upper Clark Fork River Basin Superfund Site. Seven field studies have compared more than 500 local and non-local seed and plant collections in approximately 1,900 plots. Site preparation has consisted of deep plowing to dilute surface contamination or amending soils with lime and deep plowing to raise pH levels. The Woody Comparative Evaluation Planting, established in 2000, contains 19 accessions of seven native shrub and tree species. Top performers of the indigenous ecotypes are common snowberry, ponderosa pine, silver buffaloberry, wax currant, and Woods rose. At the deep-plowed and lime-amended site on Stuckey Ridge near Anaconda, 87 accessions of grasses, forbs, and shrubs, including two mixes each of indigenous and non-indigenous material, were planted in 2003. Superior performing indigenous species include basin wildrye, bluebunch wheatgrass, big bluegrass, slender wheatgrass, western wheatgrass, and silverleaf phacelia. Since the projects inception, three plants were selected for pre-varietal release to the commercial seed industry: Selected class of Washoe Germplasm basin wildrye and Prospectors Germplasm common snowberry, and Source Identified class of Old Works Germplasm fuzzytongue penstemon. Certified seed production fields of Washoe and Old Works have been established in Montana, Idaho, and Washington.

Comparison of historic & proposed channel patterns at the confluence of the Clark Fork & Blackfoot Rivers near Milltown, Montana
Karen Williams, Utah State University

The planform, or pattern, of a river represents how channel form adjusts in a horizontal plane. Channel planform is a continuum ranging from straight to meandering to braided, and is a function of sediment load, sediment size, and channel slope. Meander geometry describes the length, amplitude, and radius of curvature of a meander bend of a river. These characteristics are related to the width and dominant discharge of the river.

Conceptual restoration plans for the Clark Fork and Blackfoot Rivers through the Milltown area have been proposed by the State of Montana. These plans recommend a single thread channel, with a regular pattern, and repeating meander bend geometry for the restored river channels. The HISTORIC planform and meander geometry of the Clark Fork and Blackfoot Rivers through the Milltown area are depicted in late 19th century and early 20th century maps, and are markedly different from the PROPOSED planform and meander geometry. Why do these proposed and historic planforms and meander geometries differ?
A Tale of 2 Creek Projects – Pattee Creek as an example of the challenges of urban stream conservation

John Zelazny, Montana Trout

Pattee Creek flows down from Pattee Canyon into the Missoula urban environment near the corner of Pattee Creek Drive and Higgins. Then it flows west towards the Bitterroot River. For 50 years, development has left little room for the creek to function naturally. What little of the creek remains on Missoula’s valley bottom has been channelized, incorporated into lawns, and is frequently dewatered. Ironically, the creek’s higher reaches still hold genetically pure Westslope cutthroat trout. A few years ago, friends of Pattee Creek were working to improve the condition of the creek when they learned that the city of Missoula was proceeding with an effort begun in the 1980’s to deal with neighborhood flooding by putting long reaches of the creek into an underground storm sewer. Both of these seemingly antithetical efforts have moved forward.

In the fall of 2003, the city of Missoula diverted seasonal high flows of Pattee Creek into a storm sewer at the intersection of Pattee Creek Drive and Higgins, and all of Pattee Creek’s remaining flow downstream of Bancroft Pond into another underground storm sewer. Bancroft Pond was preserved, but several miles of the creek were lost, including a reach through Russell Park West with good restoration potential. On March 14-18, 2005, two small reaches of the remains of Pattee Creek (in Lester & Elms Parks) were enhanced with channel work, revegetation, and installation of fish habitat structures. The enhancement project was proposed and designed by Montana Trout and funded by the National Forest Foundation and Montana Fish, Wildlife & Park’s Future Fisheries program. Missoula Parks and Recreation and Montana Trout provided in-kind resources.