The 37th ANNUAL MEETING
OF THE
MONTANA CHAPTER
OF THE
AMERICAN FISHERIES SOCIETY

February 2-6, 2004
Grouse Mountain Lodge
Whitefish, Montana

Theoretical and Practical Approaches for Watershed Restoration and Stream Habitat Improvement

Continuing Education Workshop

River Assessment and Stability Analysis for Enhancement and Restoration, facilitated by Dave Rosgen (Wildland Hydrology), Ron Pierce (Montana Fish, Wildlife & Parks), and John Muhlfeld (River Design Group, Inc.)

Agency Program Direction and Policy Constraints

Montana's Future Fisheries Improvement Program. Mark Lere (Montana Fish, Wildlife & Parks)

Stream Restoration from the Perspective of the Natural Resources Conservation Service. D. James Suit (Natural Resources Conservation Service)

Stream Restoration from the Perspective of a Water Resource Specialist within the U.S. Forest Service. Traci Sylte (Lolo National Forest).

Stream Restoration from the Perspective of a Regulatory Agency. Doug McDonald (Army Corps of Engineers).

Theoretical and Practical Approaches to Watershed Restoration and Stream Habitat Improvement

Context, Context, Context: Diagnostic Approach to Channel Assessment. David R. Montgomery (University of Washington)

Geomorphic Approach for Natural Channel Design. Dave Rosgen (Wildland Hydrology)

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Watershed Restoration and Stream Habitat Enhancement: Examples, Approaches, and Lessons Learned

Restoration of Grave Creek: Applications, Results and Lessons Learned. John M. Muhlfeld (River Design Group, Inc.).

Practitioners At Risk: Managing Risk and Uncertainty in Stream Restoration. Dale E. Miller (Mainstream Restoration, Inc.)

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Rock Creek Feasibility Study. Bruce Anderson (Land & Water Consulting)

Fish Responses to Habitat Restoration and Passage Improvements

Fish Community Response to Habitat Improvements in Western Washington Rivers. George Pess, Phil Roni, Sarah Morely (National Marine Fisheries Service), and Roger Peters (U.S. Fish and Wildlife Service).

Implementation and Assessment of Upstream Passage for Fluvial Bull Trout and Westslope Cutthroat Trout in a Large Clark Fork River Tributary. Ladd Knotek, Raven Rashap (Montana Fish, Wildlife & Parks), Bruce Farling (Montana Trout Unlimited), and Jeff McLaughlin (Bureau of Reclamation)

Assessment of Culverts as Fish Passage Barriers in a Montana Drainage Using a Multi-tiered Approach. D. Drake Burford and Thomas E. McMahon (Montana State University)

Committee Caucuses

Detection of (Batrachochytrium dendrobatidis), the Chytrid Fungus Associated with Global Amphibian Declines, in Montana Amphibians. Bryce A. Maxell (University of Montana), Grant Hokit (Carroll College), and Kirwin Werner (Salish Kootenai College)

Further Investigations in Watershed Restoration and Assessment

Streamlining Data Collection and Analysis for Support of TMDL and Water Quality Restoration Plan Development in Montana. Amy M. Beussink (Rollins) (U.S. Forest Service)

The Catron and Nash Story: Urban Development as a Stream Restoration Tool. Patrick Byorth (Montana Fish, Wildlife & Parks)

Geomorphic Comparison of Holocene Terraces Between the Sun River, Montana and Sopachnaya River, Kamchatka: Implications to the fisheries resource resulting from floodplain function and land use. Steve Buckley and Mike Koopal (Watershed Consulting)

Wetland Sod for Bio-Engineered Streambank Stabilization and Wetland Revegetation. Katie M. Salsbury (Intermountain Aquatics, Inc.), Paul B. Hook* (Consultant), and Jeffrey M. Klausmann (Intermountain Aquatics, Inc.)

Aquatic Conservation Efforts of a Private Organization – Can We Make a Difference or Are We Just Turn(er)ing Circles. Carter Kruse (Turner Enterprises, Inc.)

Outcomes of the Yellowstone River Taskforce

Upper Yellowstone River Task Force: The Process of Working to Completion. Robert H. Wiltshire (Federation of Flyfishers)

Paradise stabilized: Juvenile Salmonid Abundances in the Yellowstone River. Alexander V. Zale (Montana State University)

Channel Modification and Fish Habitat in the Upper Yellowstone River. Zachary H. Bowen, Ken D. Bovee, and Terry J. Waddle (U.S. Geological Survey)

An Assessment of Reproductive Isolation between Yellowstone Cutthroat Trout and Rainbow Trout in the Yellowstone River, Montana. James N. De Rito, Alexander V. Zale (Montana State University), and Bradley B. Shepard (Montana Fish, Wildlife, & Parks and Montana State University)

Temporal Patterns of Channel Migration, Fluvial Events, and Associated Vegetation along the Upper Yellowstone River, Montana. Michael F. Merigliano and Mary Louise Polzin (University of Montana)

Historical Channel Changes and Geomorphology of the Upper Yellowstone River. Chuck Dalby and Jim Robinson (Montana Department of Natural Resources and Conservation)

Contributed Papers

Continued Invasion of Nonnative Trout and Associated Changes in Fish Communities in Shields River Tributaries from 1974 to 2003. Bradley B. Shepard (Montana Fish, Wildlife & Parks and Montana State University)

They're (Almost) Gone: Removal of Northern Pike from Milltown Reservoir, Montana- It's Just Like Pulling Knapweed, Only Less Controversial. David A. Schmetterling (Montana Fish, Wildlife & Parks)

Population Characteristics of Lake Trout in Lake McDonald, Glacier National Park: Implications for Removal. Andrew M. Dux, Christopher S. Guy (Montana State University), Leo Marnell (National Park Service), and Wade A. Fredenberg (U.S. Fish & Wildlife Service)

Interactions Among Three Top-Level Predators in Harlan County Reservoir, Nebraska. Nathan W. Olson, Christopher S. Guy (Montana State University), and Keith D. Koupal (Nebraska Game and Parks Commission)

Life-history Characteristics of an Adfluvial Population of Bull Trout in a Northern Idaho Stream. Christopher C. Downs (Idaho Department of Fish and Game) and Robert Jakubowski (Avista Corporation)

Assessment of Tributary Potential for Wild Rainbow Trout Recruitment in Hebgen Reservoir, Montana. Darin A. Watschke and Thomas E. McMahon (Montana State University)

Application of a Two-Dimensional Habitat Model for Instream Flow Investigations on the Flathead River, Upstream of Flathead Lake, Montana. William J. Miller (Miller Ecological Consultants, Inc.) and Doran J. Geise (Spatial Sciences and Imaging)

Bacterial Coldwater Disease: Hatchery Epidemiology and Control. Eileen K. N. Ryce, Alexander V. Zale (Montana State University), Mark Sweeney, and Jay Pravecek (Montana Fish, Wildlife & Parks)

Effects of Wildfire on Fish and Aquatic Ecosystems

Does Wildfire Favor Invasion of Nonnative Fishes? Clint M. Sestrich, Thomas E. McMahon (Montana State University), and Michael K. Young (Rocky Mountain Research Station)

Predicting Post-Fire Sediment Risks to Streams. Kevin Hyde (University of Montana and Rocky Mountain Research Station)

Effects of Wildfire on Aquatic Habitat of the Wigwam River 70 Years Later - Insights into Temporal Dynamics in Watershed Processes, Channel Condition and Riparian Function. Kim C. Green (Apex Geoscience Consultants Ltd.)

Contributed Papers

They're (almost) Everywhere: Movement Patterns and Habitat Use in Boreal Toads in Western Montana Basins. Michael K. Young (Rocky Mountain Research Station) and David A. Schmetterling (Montana Fish, Wildlife & Parks).

Age Structure, Growth Rate, and Condition of Margaritifera falcate (Gould, 1850), a Native Freshwater Mussel in West-Central Idaho. Kristi Overberg (GEI Consultants, Inc.)

Using Fish Assemblages as Indicators of Aquatic Ecosystem Integrity in Montana Prairie Streams. Robert G. Bramblett, Alexander V. Zale (Montana State University), Thomas R. Johnson (U. S. Environmental Protection Agency), and Daniel Heggem (U. S. Environmental Protection Agency). 42

Fish Entrainment Investigations from the Yellowstone, Sun and St. Mary Rivers in 2003, with Preliminary Evaluations of an Experimental Electric Barrier at the St. Mary Diversion. Steve Hiebert, Juddson Sechrist, Eric Best, Sue Camp (U.S. Bureau of Reclamation), and Jim Mogen (U.S. Fish and Wildlife Service)

Configuring Libby Dam Operation for Recovering the Endangered Kootenai White Sturgeon - What Will Society Bear to Save This Ancient Species? Brian Marotz (Montana Fish, Wildlife & Parks)

Sheppard Creek: A Case Study of a Brook Trout Electrofishing Removal Effort and Lessons Learned. Beth Gardner (U.S. Forest Service).

The Un-Streaming of Mitchell Slough; How Landowners along a Spring Creek will Not be Required to Obtain 310 Permits. Chris Clancy (Montana Fish, Wildlife & Parks)

Overview of Rainbow Trout Broodstock Management and Egg Production Techniques at Ennis National Fish Hatchery. Sean H. Henderson (U.S. Fish and Wildlife Service

Poster Presentations

Trammel Net Efficiency for Juvenile Pallid and Shovelnose Sturgeon. Eric W. Oldenburg, Paul C. Gerrity, Christopher S. Guy (Montana State University), and William M. Gardner (Montana Fish, Wildlife & Parks).

Food Habits of Hatchery-Reared Juvenile Pallid Sturgeon and Juvenile Shovelnose Sturgeon in the Missouri River above Fort Peck Reservoir, Montana. Paul C. Gerrity, Christopher S. Guy (Montana State University), and William M. Gardner (Montana Fish, Wildlife & Parks)

The Kootenai River Network (KRN). Rox Rogers (U.S. Fish and Wildlife Service and Kootenai River Network)

A Stream Table will be displayed that is used for educational and outreach purposes, demonstrating the function of watersheds, floodplains, riparian areas, and stream channel systems. Rox Rogers (U.S. Fish and Wildlife Service and Kootenai River Network).

Wild Fish Habitat Initiative: Technical Resources on Habitat Restoration for Resource Professionals and Project Managers. M. Boucher, W.C. Fraser, and M.D. White (Montana Water Center)

Fridley Creek Reconnection Project. Daniel E. March (Land & Water Consulting, Inc.)

Distribution, Species Richness, and Predictive Modeling of Montana Prairie Fishes. Melissa R. Jones-Wuellner, Robert G. Bramblett, Christopher S. Guy, and Alexander V. Zale (Montana State University).

Influence of Water Temperature and Competition on Growth and Survival of Westslope Cutthroat Trout, Oncorhynchus clarki lewisi. Beth A. Bear, Thomas E. McMahon, and Alexander V. Zale (Montana State University).

New Tools to Mosaic and Georeference Imagery: DIME "the New Tool" Showcasing the Flathead National Forest Post Fire Management. Dale R. Johnson (Positive Systems, Inc.).

Preliminary Evaluation of Entrainment Losses and the Efficiency of Fish Screens at Skalkaho Creek. Steve Gale and Alexander V. Zale (Montana State University).

Clark Fork River Response to Reduction in Nutrient Loading from Watershed. Vicki Watson (University of Montana), Gary Ingman, John Babcock, and Bruce Anderson (Land & Water Consulting).

Can Passive Solar Heating Be Used To Control The Spread Of New Zealand Mud Snails? Robert H. Wiltshire (Federation of Fly Fishers)

River Morphology/Stability Analysis and Fish Habitat/Population Significance

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Stability of rivers is key to understanding their physical and biological function and their "potential" state. Corresponding relations of habitat quality and fish population dynamics are directly related not only to stream type, but to stability as well. River stability (equilibrium) is defined as the ability of a stream, over time, in the present climate, to transport the flows and sediment produced by its watershed in such a manner to maintain its dimension, pattern and profile without either aggrading nor degrading. To predict and verify river stability involves a quantitative effort of assessment involving numerous measurements and prediction methods. The prediction level (III) and validation level (IV) are presented that allows the assessor to determine the nature, magnitude, cause and consequence of instability. The methodology involves prediction and validation to document the nature and rates of; bank erosion, aggradation, degradation, enlargement, lateral accretion, successional scenarios and associated stages, down-valley meander migration, changes in sediment competence and capacity, changes in river hydraulics, and riparian vegetation/channel interactions. Fish habitat assessments and population data will be presented demonstrating the importance of understanding river types and their state or condition. As biologists are often expected to improve the fisheries resource, it is imperative to integrate river morphology and stability with the biological assessments in order to make management recommendations and/or conduct restoration/enhancement. Detailed procedures for measurement and analysis are presented involving existing characteristics of channel properties including their dimension, pattern, profile, materials, sediment and hydraulic relations. This is done on both impacted and reference reaches. Reference reach data is assessed to document stability indices of the stable form in order to complete a departure analysis of disturbed river systems. Reference reach data is also used to establish a range of morphological variables amongst stable rivers of a particular type and to establish dimensionless ratios for application in natural channel design. Example departure and potential condition analyses completed on disturbed stream reaches in the Prospect and Grave Creek drainages in western Montana are presented. Both study reaches have deviated significantly from their potential state, resulting in accelerated lateral erosion, channel widening, down valley meander migration, and subsequent meander abandonment. The predicted channel succession sequence has resulted in impaired channel form and function in both systems, reducing the availability of complex fish habitat for resident and migratory fish species. Example design plans and stream restoration applications are presented for the Grave Creek study reach. Pre and post construction effectiveness monitoring data are presented demonstrating the benefit of stream restoration applications to migratory adult bull trout habitat.

Montana's Future Fisheries Improvement Program

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The Future Fisheries Improvement Act, passed by the 1995 legislature, established a funding program for voluntary habitat projects that protect and enhance Montana's wild and native fishes. The legislature expanded this program by passing the Bull Trout and Cutthroat Trout Enhancement Act in 1999, directing a portion of the program funding towards projects that enhance native bull trout and cutthroat trout. Funding for the Future Fisheries Improvement Program (Program) comes from the re-direction of River Restoration program funds, sale of Montana fishing licenses and expenditures from Montana's resource indemnity trust fund. Anyone or any entity proposing a good habitat project designed to enhance wild and native fishes will be considered for funding. To date, the Program has committed approximately $6.8 million to 353 habitat projects. Cost sharing with other funding partners has extended these committed funds by an additional $15 million. In general, projects funded to date fall into one of the following categories: channel re-naturalization (21%); riparian enhancement (21%); fish passage (19%); bank stabilization (15%); in-stream flow enhancement (9%); lake and reservoir enhancement (9%); and miscellaneous (6%). About 55% of the habitat projects completed under the Program have been monitored for their effectiveness in enhancing wild fish populations. Fish populations have responded positively in 42% of the monitored projects, while populations displayed no response in 8% of the projects. It remains premature to draw conclusions for the remaining 50% of the projects primarily due to the short time frames for populations to respond following project completion.

Stream Restoration from the Perspective of the Natural Resource Conservation Service

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A quality planner, designer and those that construct stream restoration projects need to balance the hands on, the art, the necessary experience and the sciences to provide a quality stream restoration project that meets the humanistic, social, environmental and economics required for the particular stream project. First the planner needs to ask what if anything should be done to the stream. Should it be left alone, should a change in management be given priority, or should the designer install many of the currently popular green engineering options? An experienced planner and or designer should be able to answer these questions as they provide advice to their clients. Not one discipline has all the answers. To do a quality stream restoration project requires training, experience, and several interdisciplinary professionals. The restoration requires quality planning, adequate designs, drawings, specifications and necessary permits that follow all federal and state laws. The planner/designer needs to determine if the particular stream restoration is considered engineering and covered by the Montana Professional Engineers & Land Surveyors Laws and Rules or not. Mr. Suit's presentation will attempt to define the sciences required, the permits, the laws, and the need for interdisciplinary knowledge and abilities to provide a quality and non-detrimental stream restoration project.

Stream Restoration from the Perspective of a Water Resource Specialist within the U.S. Forest Service

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The Forest Service is engaged in many types of stream restoration and rehabilitation projects. With healthy watersheds as the ultimate objective, stream activities primarily focus on individual stream reaches, aquatic species passage at road crossings, road decommissioning, mining and grazing, and habitat enhancement. People educated in stream restoration are in short supply. Academia must begin providing specialized degrees in application-based fluvial geomorphology and environmental river mechanics. Agencies need to develop programs to assure employees are trained and remain current. Despite a huge work backlog and an increase in stream health awareness and past policy initiatives, restoration budgets have dwindled. Most restoration occurs as a byproduct of timber management or partnerships. Although congressional funding to the agency has increased, most money is allocated to currently popular initiatives or to fire or timber related programs. Moreover, a traditional timber and fire focused philosophy combined with only verbal restoration support have many publics suspicious of National Forest work. Many restoration projects are tied up by timber related law suits. Sound restoration relies on our ability to work with the public, and together as agencies, to be as credible, knowledgeable, and efficient as possible. The future of restoration, and arguably the Forest Service, depends on a turn in philosophy with restoration as the primary emphasis, with timber as the by-product, and with an urban strategic, ecologically based fire suppression program. Leadership must look beyond short-sighted, politically driven objectives and manage the agency for which it was created – "…assuring favorable conditions of flow."

Stream Restoration from the Perspective of a Regulatory Agency

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Stream restoration projects require authorization under Section 404 of the Federal Clean Water Act. It is recognized that the purpose and intent of such projects is to restore and enhance aquatic resources. Most stream restoration projects are authorized under Nationwide Permit #27. Providing specific information in the Joint Application Form can result in expedited reviews and authorization. Applications should include information on monitoring, Endangered Species Act coordination/consultation, mitigation, maintenance, and reference site data. Initial observations regarding the use and success of a specific feature such as root wads and rock/log structures shows mixed results. Compliance with required monitoring and other project specific conditions are not always met. Requiring mitigation of adverse impacts to wetlands has become routine. Now, mitigation for adverse impacts to the physical, biological and chemical components of a stream will also be required. Enhancing the stream and/or the riparian areas can mitigate impacts. The Corps has developed a Stream Mitigation Process and Document that outlines the program, and will likely be implemented in 2004. It will require applicants to mitigate for adverse impacts to a stream in addition to mitigating for unavoidable impacts to wetlands.

Context, Context, Context: Diagnostic Approach to Channel Assessment

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Channel assessment procedures are often based on quantitative or qualitative ranking criteria that are scored to evaluate the "stability" or "condition" of a channel. Because of the often overwhelming importance of context in interpreting and evaluating - and therefore assessing – channel conditions, I argue that a diagnostic procedure, not unlike that followed in medical practice, provides a more logical basis for stream channel assessment and monitoring. In general, a particular indicator or measurement of stream channel condition can mean different things depending upon the local geomorphic context and history of the channel in question. A diagnostic framework assesses reach-level channel conditions as a function of location in the channel network, regional and local biogeomorphic context, controlling influences such as sediment supply and transport capacity, riparian vegetation, the supply of in-channel flow obstructions, and disturbance history. A similar approach and level of understanding is needed to design effective monitoring programs, as stream type and channel state greatly affect the type and magnitude of channel response to changes in discharge and sediment loads. However, the formulation of specific diagnostic criteria and monitoring protocols must be tailored to specific geographic areas because of the variability in the controls on channel condition within river basins and between regions. The diagnostic approach to channel assessment and monitoring requires a relatively high level of training and experience, but proper application should result in useful interpretation of channel conditions and response potential.

A Geomorphic Approach to Natural Channel Design

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The application of geomorphic principles and fundamental assessments are presented for the purposes of stream restoration using natural channel design procedures. Contrary to uniformed interpretations of the method…it is not a "cookbook" approach in river restoration. The analysis conducted involves analog, empirical and analytical methods. The methods involve: 1) a watershed and river stability assessment to determine the source, nature, extent and consequence of channel change, 2) alternatives for recovery based on natural recovery potential, changes in management related to the cause of the disequilibrium, and direct restoration approaches, 3) selection of the potential stable valley and stream type, 4) development of reference reach and regional curve data, 5) design of stable dimension, pattern and profile, 6) hydraulic relations of proposed design channel, 7) sediment competence and capacity calculations, 8) stabilization methods, and 9) a monitoring plan. An example is presented demonstrating the application of the methodology. This methodology has been successfully implemented since 1968 on large and small rivers throughout a range of hydro-physiographic provinces.

Prioritizing Stream and Watershed Restoration: A Review of Approaches and a Recommended Interim Method

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Hundreds of millions are spent annually on watershed restoration and habitat improvements in the western United States. It is generally accepted that watershed restoration should focus on restoring natural processes that create and maintain habitat rather than manipulating habitats. However, most process-based restoration is site-specific, i.e., conducted on a short stream reach. In an effort to synthesize site-specific techniques into a process-based watershed restoration strategy, we reviewed the effectiveness of common stream restoration techniques at improving fish habitat, synthesize various methods for sequencing restoration actions, and developed a hierarchical strategy for prioritizing them. The hierarchical strategy we present is based on three key elements: 1) principles of watershed processes, 2) protecting high-quality habitats, and 3) knowledge of effectiveness of techniques. Initially, efforts should focus on protecting areas with intact processes and high-quality habitat. Following a watershed assessment, we recommend that restoration focus on reconnecting isolated high-quality habitats. Once the connectivity of habitats has been addressed, efforts should focus on restoring hydrology, geologic, and riparian processes through improvement and restoration of roads and riparian areas. Instream habitat enhancement should be employed only after restoring natural processes or in cases where short-term improvements in habitat are needed. Other approaches to prioritizing restoration are not completely incompatible with the above strategy. Information on species of interest, project cost, cost-effectiveness, access, ownership and other factors can be used to modify the prioritization method we describe above. Finally, our review of both restoration effectiveness and methods for prioritizing restoration emphasize the need for watershed assessments to understand watershed function and restoration opportunities as well as the need for rigorous monitoring to determine effectiveness of restoration techniques.

Conceptualizing Watershed to Channel Scale Groundwater-Stream Exchange under Natural and Re-naturalized Conditions

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Attempts to improve or re-establish stream health are hampered by physical and sociological constraints. The role of groundwater in stream systems is usually poorly understood or ignored even through it underpins the ecology of stream and floodplain systems. Groundwater exchanges with the stream channel creating gaining, losing, flow-through and parallel-flow reaches. Such transfers of water, nutrients and temperature are critical components of stream-riparian-floodplain function. Groundwater and surface water interaction also creates hyporheic zones, areas in which groundwater and stream water mix at the channel bed scale. These zones also provide critical spawning and rearing areas for several salmonid species. Restoration, re-naturalization and remediation of stream systems should incorporate groundwater-stream exchange as one of its goals.

Restoration of Grave Creek: Applications, Results and Lessons Learned

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The Grave Creek watershed in northwest Montana has been identified as a core bull trout (*Salvelinus confluentus*) recovery watershed. Subject to a century of land use activities including agriculture, grazing, logging, road construction, and rural development, Grave Creek is currently functioning below its probable geomorphic and biological potentials. In conjunction with the Montana Department of Fish, Wildlife & Parks, the U.S. Fish & Wildlife Service, and the Kootenai River Network, we restored approximately one mile of channel corridor with primary emphasis on re-establishing migratory habitat for threatened bull trout in fall 2002. The pre-construction channel was over-widened and shallow with bankfull widths ranging from 45-240 feet, and a mean width to depth ratio of 93.5. Restoration techniques included reactivating abandoned meanders and installing bank stabilization and fish habitat structures that incorporate large diameter woody debris. The designed channel reduced the mean bankfull width and width to depth ratio to 52 feet and 22, respectively. Post-construction project monitoring indicated an almost nine fold increase in the total number of pools present in the restored section of Grave Creek, increasing critical pool habitat for adult migratory bull trout by 230% relative to baseline conditions. Maximum pool depths were increased by 152% from pre-restoration conditions. Eighty-two percent (82%) of the structures performed as designed following spring runoff 2003. We measured less than optimal performance on 18% of the structures. Factors affecting structure performance included the location of the individual structures along the meander arc and detachment of the Mirafai fabric from the vane logs.

Practitioners at Risk: Managing Risk and Uncertainty in Stream Restoration

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Stream restoration projects, especially those that involve natural channel design, have an inherent element of risk and uncertainty. Risk involves identifying the possible outcomes associated with different alternatives. Uncertainty involves a situation where probabilities cannot be assigned to outcomes. Since most stream restoration failures are related to the effects of flooding, the probability of risk can often be quantified using hydrologic analysis—if the threshold of failure is also quantified. With increased attention to geomorphic process, and the availability of readily applied hydraulic and sediment modeling tools, the mechanisms of failure can be quantified. Designers can use various techniques or measures to satisfy component-specific design criteria. Hydrologic probability, either unbounded by time or within a given time-window, can then be assigned to quantify the risks of project failure. Additionally, it is also appropriate to recognize the inherent uncertainty in restoration design. Examples of uncertainty are the lack of sufficient, accurate or representative data, or where an equation or model is used at its boundary of applicability. Restoration practitioners should be encouraged to openly discuss and record the risk and uncertainty in their work, but should be careful of speaking in terms that denote certainty when such certainty does not exist. Using good science, practitioners should strive to describe and manage risk at a level acceptable to project stakeholders. Discussion of risk and uncertainty, use of design criteria, and adequate documentation of design will all contribute to further maturation of the profession.

Nevada Spring Creek Restoration
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Through the efforts of numerous individuals and agencies, 4 miles of Nevada Spring Creek have been restored from the source to the mouth. Nevada Spring Creek suffered from a number of interrelated impairments resulting from an over-widening of the channel and severe nutrient enrichment. High summer water temperatures exceeding 78º F within a ¼ mile of the artesian water source occurred annually. Water, livestock and land management in the drainage all contributed to the impaired status. Corrective management actions enforceable through conservation easements along Nevada Spring Creek provide long-term protections necessary to maintain the restoration actions.
Stream channel pattern, profile and dimension were mechanically changed to conform to an E4 and E6 channel type. Channel filling and new channel construction were the two primary methods used for reconstruction of the channel. We utilized evolving techniques in stream restoration including: 1) Sod mat stacking on “high” bank reconstruction, 2) Alteration of bottom substrates to reduce weed growth and promote macroinvertebrate production and, 3) Conveyor belt gravel delivery system. Maximum water temperatures have been reduced 17ºF to 62ºF and mean water temperature reduced 13ºF to 52ºF downstream 2 miles, where fall 2003 restoration began. Fall and winter thermal conditions have also been changed significantly with “warmer” groundwater influenced flows reaching downstream over the 4 miles of restored stream channel. All fish species were in low abundance in 2003 prior to completion of restoration work, except perhaps redside shiners (Richardsonius balteatus) in the lower Nevada Spring Creek system.

Rock Creek Feasibility Study

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Rock Creek is a "Blue Ribbon" stream supporting a high value coldwater fishery. A feasibility study was conducted to evaluate restoration strategies for the reach extending 14.5 miles downstream from Skalkaho Road. This study endeavored to undertake a "systems approach" to evaluate channel process on Rock Creek. This approach sought to identify underlying causes of channel instability, and present recommendations to improve equilibrium condition. At first glance, the braided, unconfined reach of Rock Creek appears to be undergoing large scale changes in channel stability, channel form, bedload transport and deposition, and riparian habitat. Channel morphology has probably adjusted to some degree to land use, although data to support this assumption were lacking. Despite substantial agency and landowner experience, channel dynamics are not completely understood and no consensus exists in interpretation of cause/effect and natural versus altered channel conditions. Channel cross-section data were collected with survey grade GPS, and included geo-referenced field data (pebble counts, Rosgen classification, substrate scoring, riparian condition, etc). Hydraulic analysis was performed using HEC-RAS. Braided conditions were related in part to land use, with inherent geological factors being the predominant driving influence. Imposed sediment load from upstream reaches did not appear to account for braided conditions. Further, rather than being a net depositional or aggrading zone, the braided reach appeared to be a net producer of sediment. Restoration activities aimed at conversion of the braided reach to a single-thread morphology is not necessarily consistent with the geological setting, and requires tradeoffs in terms of fish habitat and recreational use.

Fish Community Response to Habitat Improvements in Western Washington Rivers

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Habitat enhancement and restoration techniques are used in streams throughout the world in an effort to increase and conserve fish stocks. However, few of these techniques have been thoroughly evaluated. Since 1996, we have been systematically evaluating various habitat restoration techniques in the Pacific Northwest United States. Here we summarize the results of almost a decade of our research evaluating anadromous fish response to habitat improvement techniques including: large woody debris (LWD) and boulder weir placement, reconnection of off-channel habitats, and constructed side-channels. In 30 small streams, higher levels of coho salmon (Oncorhynchus kisutch), steelhead (O. mykiss), cutthroat trout (O. clarki), and larval lamprey (Lampetra spp.) were found in reaches treated with LWD though the level of response varied by season and species. Higher levels of coho salmon were also found in streams treated with boulder weirs in 12 southwest Oregon streams. An increase in juvenile and adult salmon abundance and species richness was found in habitats associated with constructed logjams in two large western Washington rivers. We analyzed existing smolt-trapping data from over 30 off-channel habitat enhancement projects and found that constructed groundwater channels were particularly productive for juvenile coho salmon. We then examined groundwater channels intensively and found that constructed channels supported higher densities of coho salmon during the winter, but fish diversity was higher in naturally-occurring channels. Our results suggest that common habitat improvement techniques increase the abundance of salmonids as well as species richness, but results vary by species habitat preferences, season, and magnitude of habitat improvement.

Implementation and Assessment of Upstream Passage for Fluvial Bull Trout and Westslope Cutthroat Trout in a Large Clark Fork River Tributary

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Rattlesnake Creek is a large (bankfull discharge ~ 1000 cfs), relatively pristine fourth order tributary of the Clark Fork River near Missoula, Montana that supports a mixed (native and non-native) salmonid community. The stream has been the focus of a series of fishery enhancement efforts in 1999-2003 that culminated in an upstream fish passage project at Mountain Water Company Dam located four miles from the mouth. The goal of the project was to enhance migratory bull trout Salvelinus confluentus and westslope cutthroat trout Oncorhynchus clarki lewisi populations by affording adults access to ~ 15 miles of upstream natal spawning areas that have been completely inaccessible to fluvial trout for nearly a century. Project implementation was preceded by a series of disease, genetics and species composition surveys, as well as testing of aspects associated with final fish ladder design, operation and efficiency. In 2001-2003, we also evaluated the efficacy of the project using radio telemetry, floy and PIT tagging, redd counts and a fish trap operated just upstream of the fish ladder. Monitoring indicated that the permanent fish ladder is an effective means of passing adult migratory trout past the dam. The timing of adult trout migrations was closely tied to stream temperature and discharge. Fish ladder operational schedules were developed that encourage species-selective fish passage. Project monitoring also provided insight on adult fluvial trout growth rates, movements, mortality rates and habitat use.

Assessment of Culverts as Fish Passage Barriers in a Montana Drainage Using a Multi-tiered Approach

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Culverts may be a major factor contributing to the fragmentation and isolation of fish populations by potentially restricting movement through important migratory corridors. Culverts can impede movement of fish due to high water velocities, inadequate water depths, and excessive outfall heights among other factors, depending on the swimming and jumping capabilities of the fishes. The objective of our study was to assess the extent to which culverts restrict movement of fishes across a large drainage basin. We used 3 different approaches to investigate fish passage through culverts throughout the upper Clearwater River drainage, Montana. First, we measured physical conditions at 48 culverts sites to determine fish passage status using the FishXing software package. Second, we electrofished above and below a subset of 23 culverts to assess what culvert characteristics may be influencing fish distribution, abundance, and size structure. At a further subset of 12 sites, we measured passage directly by monitoring the movement of marked fish through culverts with varying physical characteristics. The large scale assessment of culverts using FishXing indicated that over 90% impaired fish movement at some discharge. However, electrofishing results showed little difference in fish population characteristics above and below culverts. Results from the mark-recapture studies indicate that fish passage is occurring at 11 of 12 of the culverts studied, but over half showed a degree of restricted movement relative to control reaches. Our findings suggest that using a combination of methods is advantageous for thoroughly assessing fish passage through culverts.

Detection of (*Batrachochytrium dendrobatidis*), the Chytrid Fungus Associated with Global Amphibian Declines, in Montana Amphibians

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In order to identify potential causes of declines in the northern leopard frog (*Rana pipiens*) and western toad (*Bufo boreas*) which have been noted since the 1980s and assess the risk posed to other amphibian species whose status is uncertain, we submitted 98 tissue samples gathered from 8 amphibian species across Montana for PCR based identification of the chytrid fungus (*Batrachochytrium dendrobatidis*). This chytrid fungus has been associated with declines, extirpations, and losses of numerous amphibian populations and entire species around the globe over the last 2 decades. Tissue samples from 30 museum voucher specimens of 3 species collected in the Flathead Valley in the 1970s, prior to amphibian declines in the area, were all negative for *B. dendrobatidis*. However, 4 species and 26 of 68 tissue samples gathered during inventory work across the state since 1998 tested positive for *B. dendrobatidis*. In light of its association with other amphibian declines, *B. dendrobatidis*, acting alone or synergistically with other stressors, is a potential cause of the declines observed and should be regarded as an ongoing threat to Montana amphibians. In order to prevent additional spread of this fungal pathogen personnel working in either lentic or lotic systems should thoroughly rinse and decontaminate all equipment with 10% bleach between (1) any sites where dead, dying, or ill amphibians are encountered, (2) sites located in different local watersheds or definitive clusters of sites, (3) all breeding sites of sensitive species separated by more than 1 kilometer.

Streamlining Data Collection and Analysis for Support of TMDL and Water Quality Restoration Plan Development in Montana

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In recent years, the Lolo National Forest has participated in Total Maximum Daily Load (TMDL) and Water Quality Restoration Plan (WQRP) development for five watersheds in western Montana: Upper Lolo Creek (1999 – 2003), St. Regis River (2001 – 2004), Prospect Creek (2003 – 2004), Middle Blackfoot River (2003 – 2005) and Ninemile Creek (2003 – 2004). The TMDL development process for each of these 303 (d) listed water bodies has varied depending upon stakeholder participation, previous watershed assessment efforts, and the impaired beneficial uses and probable causes involved. "Aquatic life support" and "Cold-water fishery – trout" are impaired beneficial uses common to all of these water bodies with some of the probable causes including

habitat alteration, siltation, flow alteration, and thermal modification (1996 and 2002 303(d) lists). After several years of providing collaborative support for TMDL development in these watersheds, specific data and certain analysis methods and models demonstrate greater potential for establishing targets and allocations in the resulting Water Quality Restoration Plans. An overview of field data, analysis methods and models used will be provided. These include Rosgen Surveys Level 1, 2 & 3, riffle stability index (RSI), R1/R4 fish habitat inventories, fish population surveys, water yield modeling (ECA), sediment modeling (WATSED/LoloSED, XDRAIN, Washington Method), culvert-fish passage assessments, queries of Forest Service databases including TSMRS and INFRA, and GIS analysis. Data, analysis methods and models with greatest potential will be highlighted, and their application to Water Quality Restoration Plans described in detail. The purpose of this presentation is to share insight into providing focused, efficient support of TMDL development so to expedite development and implementation of restoration plans.

The Catron and Nash Story: Urban Development as a Stream Restoration Tool

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In Western Montana, population growth and urban development are accelerating and affecting aquatic systems. For many aquatic biologists, active participation in community planning is critical to stream protection and restoration. Engaging in community planning and regulatory processes is an alternative means of restoring streams and aquatic habitats. Nash Spring Creek and East Catron Creek are suburban streams that were historically channelized for agriculture and more recently threatened by suburban development. Through the Natural Streambed and Land Preservation Act (310) permitting process, specifications and terms for realignment and restoration were directly negotiated with developers. In each case, the primary goal was to reconstruct each stream in a more naturally functioning state with improved habitat conditions. To document the affects of the reconstruction on fish, we conducted electrofishing surveys in several reaches of both streams. In Catron Creek, fish densities severely declined within a year of realignment. However, in some reaches fish densities and diversity increased over time. In Nash Spring Creek, total fish numbers recovered rapidly to levels similar to an unimpacted reach. However, channel realignment resulted in a shift of fish community structure. Pressures on aquatic resources created by suburban development are inevitable. However, biologists can instigate stream restoration and mitigate impacts by actively engaging in community planning and permitting processes.

Geomorphic Comparison of Holocene Terraces Between the Sun River, Montana and Sopachnaya River, Kamchatka: Implications to the Fisheries Resource Resulting from Floodplain Function and Land Use

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The impacts of land-use activities on a salmonid fishery are well documented. However, the geomorphic evaluation of floodplain function and departure is often overlooked. Throughout many of the rivers in the northern Rocky Mountains, three major Holocene fluvial terraces have formed as rivers abandoned their floodplain in response to global climate change after the end of the Pleistocene. On the Sun River, the highest Holocene terrace stands 15' above bankfull, and is rarely preserved and never inundated. The middle terrace is found 6'-8' above bankfull and is rarely inundated (>100 year flood). This feature has well-developed loamy soil and has been deforested and farmed. The lowest terrace is 3' above bankfull and is inundated frequently (10 year flood). The Sopachnaya River in Kamchatka, Russia has a similar geomorphic setting to the Sun River but flows through a pristine wilderness. There are also two well-developed Holocene terraces, one at 15' and the other at 8' above bankfull stage. In marked contrast to the Sun River, there is no lower Holocene terrace. Instead, the low landforms associated with the Sopachnaya are active floodplains with organically rich deposition and young vegetation (<20 years old). Although similar in many respects, the contrast in land-use and flow regulation between the two rivers points to the impacts of floodplain function. The Sun River has lost access to a wide floodplain, the floodplain vegetation has become decadent and the floodplain soils have desiccated. In contrast, the Sopachnaya displays frequent inundation, greater stability, and increased fish habitat diversity.

Wetland Sod for Bio-engineered Streambank Stabilization and Wetland Revegetation

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Wetland sod is a pre-vegetated coconut fiber mat containing well-established native plants that have been grown hydroponically to achieve high initial root density. It provides immediate soil stabilization and accelerated revegetation for stream and wetland restoration projects. In 2002-2003 we used wetland sod and other materials to stabilize 1340 m of eroding streambanks at 6 sites on the Teton River, SE Idaho, a predominantly groundwater-fed, free-flowing system. Before construction, banks averaged 1-1.5 m high and 1:1 or steeper slope, with silty clay loam texture and vegetation dominated by introduced pasture grasses. Using stable, natural reference sites as a guide, banks were excavated, reconstructed at an average slope of 4:1, and stabilized using long-term erosion control fabric, wetland sod planted with native sedges and rushes, and containerized willows and rooted and dormant cuttings. Within 1 month, wetland sod was fully rooted and could not be displaced by human or animal disturbance. Bank treatments successfully established native plant communities and withstood cattle trampling, grazing and peak flow events over 1 year. Total cost was $246 per linear meter including design, permitting, construction, revegetation, irrigation and weed control. In a replicated field experiment in Teton County, Wyoming, we compared wetland sod and six other wetland revegetation methods in an off-stream, floodplain setting. Wetland sod and other methods using vegetative plant materials provided superior establishment of target species compared to broadcast seeding, passive revegetation, or salvaged marsh surface. Wetland sod was uniquely effective in reducing establishment of invasive, exotic, and other undesirable species.

Aquatic Conservation Efforts of a Private Organization – Can We Make a Difference or Are We Just Turn(er)ing Circles?

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The Turner organization is uniquely positioned to conduct large-scale conservation projects because of our large land base and geographical extent. Our operational objectives are guided by the philosophy of managing landscapes in an ecologically sensitive manner to conserve native biological diversity while maintaining economic viability. As such, the objectives of our biological programs are to: conserve and restore native, imperiled, and endangered species and their habitats; develop long-term working relationships with federal and state agencies and other non-governmental organizations to further conservation; conduct scientifically credible research regarding conservation and management of imperiled species; and work with and educate other private landowners. Since 1998 biologists within the Turner organization have worked diligently to build networks with state and federal agencies and implement on the ground projects. Aquatic native species conservation has focused primarily on native cutthroat trout (*Oncorhynchus clarki*) restoration projects with efforts ongoing to restore two subspecies on three properties in two states, including the infamous Cherry Creek project. Two of these projects, to our knowledge, are the largest (in contiguous stream km) ever attempted. We are involved in significant efforts to monitor and recover Chiricahua leopard frogs (*Rana chiricahuensis*) and Rio Grande suckers (*Catostomus plebius*) in the desert southwest, and restore the native bosque community along the Rio Grande River. The Turner “model”, while fraught with inconsistencies, has been very successful initiating on-the-ground projects as agencies and organizations recognize the scientific credibility, logistical organization, and financial resources that we can bring to the table. Ultimately, collaboration is the key to success on many of these projects and we remain committed to their successful conclusion.

Upper Yellowstone River Task Force: The process of working to completion

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As the Upper Yellowstone River Task Force worked to complete their mission decisions about how the Task Force would conduct their business had a great bearing on the final outcome. In this presentation the process the Task Force adopted will be examined and the key decisions that impacted the most will be discussed. The Presenter will offer comments as to the impacts of various process decisions and will discuss possible alternatives that could be examined by others in similar situations.

Paradise Stabilized: Juvenile Salmonid Abundances in the Yellowstone River

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Juvenile salmonid abundances along bank habitats of the Yellowstone River near Livingston, Montana, were assessed to evaluate the effects of bank stabilization on recruitment to the fishery. Use of stabilized main-channel banks (riprap, barbs, jetties) was similar or higher than that of natural, unaltered main-channel banks. Artificially-placed boulders and shoreline irregularities associated with stabilized banks likely attracted juvenile salmonids. Some natural bank reaches included little cover and were used by few fish. Juvenile abundances at all banktypes were low relative to other rivers and were likely insufficient to maintain the fishery; immigration may therefore be an important component of recruitment here. Abundances of juvenile salmonids in ephemeral lateral side channels during spring runoff were higher than among main-channel banks. Bank stabilization that reduces the frequency and duration of inundation of side channels, or reduces side-channel formation rates, or directly precludes inundation or accessibility of side channels likely decreases juvenile fish habitat and possibly recruitment. A comprehensive understanding of recruitment dynamics in the Yellowstone River is necessary to competently evaluate the effects of anthropogenic alterations. Management of development along the Yellowstone River will continue to be contentious until consensus is reached on how much lateral migration the river will be allowed.

Channel Modification and Fish Habitat in the Upper Yellowstone River

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A two-dimensional hydrodynamic simulation model was coupled with a geographic information system (GIS) to produce a variety of habitat classification maps for three study reaches in the upper Yellowstone River basin in Montana. Data from these maps were used to examine potential effects of channel modification on shallow, slow current velocity (SSCV) habitats that are important refugia and nursery areas for young salmonids. At low flows, channel modifications were found to contribute additional SSCV habitat, but this contribution was negligible at higher discharges. During runoff, when young salmonids are most vulnerable to downstream displacement, the largest areas of SSCV habitat occurred in side channels, point bars, and overbank areas. Based on simulations in modified and unmodified sub-reaches, channel simplification results in decreased availability of SSCV habitat, particularly during runoff. The combined results of the fish population and fish habitat studies present strong evidence that during runoff, SSCV habitat is most abundant in side channel and overbank areas and that juvenile salmonids use these habitats as refugia. Channel modifications that result in reduced availability of side channel and overbank habitats, particularly during runoff, will probably cause local reductions in juvenile abundances during the runoff period. Effects of reduced juvenile abundances during runoff on adult numbers later in the year will depend on (1) the extent of channel modification, (2) patterns of fish displacement and movement, (3) longitudinal connectivity between reaches that contain refugia and those that do not, and (4) the relative importance of other limiting factors.

An Assessment of Reproductive Isolation Between Yellowstone Cutthroat Trout and Rainbow Trout in the Yellowstone River, Montana

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The genomic extinction of Yellowstone cutthroat trout (Oncorynchus clarki bouvieri) has occurred throughout many parts of its historic range because of introgression with introduced rainbow trout (O. mykiss). However, relatively low levels of introgression have been detected in cutthroat trout within the Yellowstone River, implying they may be reproductively isolated from rainbow trout. If reproductive isolation exists, then determining its spatial and temporal components could assist managers in better conserving genetically pure cutthroat trout. Reproductive isolation was assessed by radio-tagging and tracking 164 trout (98 cutthroat, 37 rainbow, and 29 cutthroat x rainbow trout hybrids) captured in four areas of a 133-km segment of the mainstem Yellowstone River during three spawning seasons (2001–2003). A total of 72 spawning fish (42 cutthroat trout, 17 rainbow trout, and 13 hybrids) were documented moving into potential spawning sites in tributaries (n=55) or within the mainstem river (n=17) during the April through early July spawning season. Spatial overlap of spawning sites was documented between cutthroat trout and rainbow trout or hybrids in both tributaries and the river. However, both rainbow trout and hybrids spawned earlier than cutthroat trout. Therefore, differential timing of spawning is more likely the predominant mechanism for maintaining reproductive isolation. Maintaining temporal reproductive isolation may be facilitated by leasing water in tributary streams to allow for later spawning by cutthroat trout. In addition, entrainment of post-spawn cutthroat trout into irrigation diversions on tributary streams indicates that screening of diversions would be beneficial.

Temporal Patterns of Channel Migration, Fluvial Events, and Associated Vegetation Along the Upper Yellowstone River, Montana

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As part of the Governor's Upper Yellowstone River Task Force and the U.S. Army Corps of Engineers Cumulative Effects study along the upper Yellowstone River, we examined the vegetation along the river from Gardiner to Springdale, Montana. The study goal was to gain an understanding of fluvial geomorphic processes and its relation to flood plain vegetation. We used repeat photography and mapped cottonwood (Populus angustifolia) tree ages to quantify flood plain and vegetation dynamics in several geomorphic settings. The reference model for flood plain dynamics was exponential decay, which provides a rate of erosion and deposition at steady state. Flood plain dynamics and vegetation composition along the upper Yellowstone River flood plain varied by geomorphic setting, which in turn varied from broad, un-confined braided channel systems to single-thread channels with narrow flood plains confined by glacial terraces and bedrock. Although the general appearance of the vegetation and river system is similar to that of 100 years ago, retrospective age distributions and real-time trend analysis reveal a reduction in fluvial activity, cottonwood recruitment on an area basis, and cottonwood forest area. The flood plain turnover period for the braided reaches is between 550 and 1700 years. Dated flood plain area was positively correlated with flood size, and cottonwood area decay curves indicate that most flood plain erosion and deposition occurs during large floods. Agriculture caused a net reduction in forest area in the last 50 years, but loss to natural succession was about twice the loss due to agricultural conversion.

Historical Channel Changes and Geomorphology of the Upper Yellowstone River

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In response to lateral erosion and flooding caused by near 100-year floods in 1974, 1996 and 1997, extensive segments of the upper Yellowstone River and flood plain have been modified using dikes, levees, riprap, and jetties (barbs). Confinement of river channels often leads to reduced migration rates, channel incision, bed coarsening, and loss of hydraulic connectivity with side-channels. As part of cooperative investigations sponsored by the Upper Yellowstone River Task Force, we (1) mapped the contemporary (1999) fluvial geomorphology of the upper Yellowstone River (137 km reach -- Gardiner to Springdale, Montana) and historic channel changes (1948-1999), (2) developed a process-based geomorphic channel classification (e.g. modified Montgomery-Buffington) of the 1999 channel, (3) mapped contemporary and historic (1954, 1973, 1999) channel modifications and revetments, and (4) measured and analyzed retrospective geomorphic effects of channel modifications (in progress). Dikes, levees, and road prisms have increased 265% (34,700 to 92,250 feet) between 1954 and 1999; riprap increased 400% (27,400 to 111, 260 feet), and jetties and barbs increased 600% (47 to 292). Of the total channel length, 14 % (19 km) was strongly affected by channel modification (riprap, levees, etc); another 6 % (8 km) was affected by combined natural and human constraints. Local channel response to confinement includes channel incision (Livingston area), aggradation and modification of channel alignment. In spite of these modifications, the channel is remarkably resilient and the overall stability and physical characteristics of about 80% study area remain similar to those of the Yellowstone River in 1948.

Continued Invasion of Nonnative Trout and Associated Changes in Fish Communities in Shields River Tributaries from 1974 to 2003

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Nonnative brook trout (Salvelinus fontinalis) have been implicated as part of the reason for the documented decline of cutthroat trout (Oncorhynchus clarki spp.); however, a question remains as to whether brook trout continue to invade cutthroat trout habitats or whether they rapidly expanded following their initial releases in the early to middle twentieth century and have remained relatively static since that time. I assessed whether brook trout continued to invade Yellowstone cutthroat trout (O. c. bouveri; YCT) habitats, and whether they displaced cutthroat trout, in the Shields River drainage from 1974 to 2003. Sampling was repeated in during 2001-2003 in 17 sites that had been surveyed in 1974. There was no apparent change in the fish community in four sites (YCT remained allopatric in three sites and YCT and brook trout were at similar proportions in another site); brook trout had recently invaded two sites; brook trout currently made up a higher proportion of the fish community in seven sites; Yellowstone cutthroat trout made up a higher proportion of the fish community in two sites; and brown trout appeared to be replacing brook trout in two sites. These results appeared to be spatially dependent and fish community dynamics and water temperature may be playing a role. These data suggest brook trout are continuing to invade habitats within the upper Shields drainage and often displace Yellowstone cutthroat trout, similar to what has been found for westslope cutthroat trout (O. c. lewisi) although in contrast to what was found in the Snake River drainage in Idaho.

They're (Almost) Gone: Removal of Northern Pike from Milltown Reservoir, Montana- It's Just Like Pulling Knapweed, Only Less Controversial

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Illegally introduced northern pike in Milltown Reservoir represent a threat to resident and migratory native fishes. By 1999, northern pike were the most abundant species in the reservoir. I evaluated two methods to reduce the population size of northern pike and predation on native fish: summer reservoir drawdowns (targeting age-0 fish) and trap netting (to remove adults during spawning). In 2002, the population of northern pike was 2,883 ± 663 (95% CI) and trap netting removed 985 adults (34%). By 2003 the population was reduced to 786 ± 169 and I trapped 432 (55%), reducing the density of northern pike by 88% in 14 months. Between 2000 and 2002, bull and westslope cutthroat trout were seasonally common in northern pike stomachs. In 2003, none were detected in stomachs despite greater sampling, suggesting that the reduced northern pike population size reduced predation. Summer drawdowns killed an estimated 10,000 northern pike in 1999, 9,500 in 2001, 7,100 in 2002, and 3,670 in 2003. Whereas drawdowns from 1999-2002 only killed northern pike, largemouth bass, yellow perch and pumpkinseed (illegally introduced non-native fish), in 2003 largescale suckers, and northern pikeminnow were detected, signifying recovery of native fishes. Any management activity that involves killing animals has the potential for controversy, whether from concerns over pesticides or lack of understanding the program's goals. Initially, managing and removing northern pike was controversial in Missoula, but as a result of public education, the public is supportive of northern pike control and ultimately the removal of Milltown Dam.

Population Characteristics of Lake Trout in Lake McDonald, Glacier National Park: Implications for Removal

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Native species, particularly bull trout Salvelinus confluentus, have suffered dramatic population declines since the establishment of nonnative lake trout Salvelinus namaycush in Lake McDonald, Glacier National Park (GNP). In an attempt to prevent the further decline of these populations GNP is considering a lake trout removal program. This study was conducted to examine the population characteristics of lake trout and model the effects of varying exploitation on lake trout abundance and yield. Saggital otoliths were removed from 157 lake trout captured from May through September 2003. Otoliths were sectioned and aged by two readers using a compound microscope. Mean length at age varied from 235 mm at age 5 to 465 mm at age 10 and time to reach 450 mm was 9.3 years. The von Bertalanffy growth model was used to estimate theoretical maximum length (730 mm), growth coefficient (0.104), and the time when length would theoretically equal 0 mm (0.102). The overall (i.e., sexes pooled) weight-length model was $\log_{10}$weight=-5.44+3.11 ($\log_{10}$length). Growth in length and weight was typically lower than lake trout in Flathead Lake, Montana. Our model simulations for a population of 100,000 individuals indicated that an exploitation of 73% was needed to reduce the number of 450 mm lake trout to zero. Growth overfishing only occurred at 20% exploitation when conditional natural mortality was 10%. These data illustrate that complete removal of lake trout in Lake McDonald is unlikely; however, moderate levels of exploitation did reduce yield estimates when natural mortality was low.

Interactions Among Three Top-Level Predators in Harlan County Reservoir, Nebraska

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Walleye *Stizostedion vitreum*, white bass *Morone chrysops*, and hybrid striped bass *M. chrysops* x *M. saxatilis* are common top-level predators in Midwestern reservoirs. However, the ecology and interactions among these three species are not well understood. Therefore, we compared food habits and vertical distribution of walleye, white bass, and hybrid striped bass to quantify resource overlap. Food habits and vertical distribution data were collected during the evening (i.e., 2000 h to 0200 h) monthly from June through September, 2002 and 2003. Food habits and vertical distribution data were collected from 554 white bass (155-392 mm TL), 241 hybrid striped bass (315-720 mm TL), and 181 walleye (231-962 mm TL). Diet overlap was high for hybrid striped bass and walleye in June (Pianka index [O_{jk}] = 0.935), and was high among all three predators from July through September (Pianka index [O_{jk}] = 0.920-0.996). Primary diet items consisted of chironomids and freshwater drum *Aplodinotus grunniens* in June and gizzard shad *Dorosoma cepedianum* from July through September. Walleye and hybrid striped bass exhibited the greatest diet breadth (Levin's standardized index [B_A] = 0.031-0.130) during all months. Vertical distribution overlapped for all species during June in both years. Our results indicate substantial overlap among walleye, white bass, and hybrid striped bass with respect to diet and spatial distribution in Harlan County Reservoir. Thus, it is likely that competition could occur among these species when resources are limited.

Life-history Characteristics of an Adfluvial Population of Bull Trout in a Northern Idaho Stream

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We utilized a rotary screw trap and weirs to capture migrating bull trout Salvelinus confluentus in Trestle Creek, Idaho, from 2000 through 2002, in order to estimate their abundance, understand basic life-history characteristics, and to evaluate survival rates in the tributary and lake environment. Age-0 outmigrants accounted for greater than 85% of the total annual catch of juvenile bull trout in Trestle Creek in all years. We believe this is largely due to density-dependent competition for rearing habitat, rather than a successful life-history strategy. Age-2 and age-3 outmigrants accounted for the majority of the outmigration of age-1 and older juveniles. We estimated 1,276, 1,094, and 1,147 age-1 and older juvenile bull trout outmigrated from Trestle Creek in 2000, 2001, and 2002, respectively. Annual outmigration of juvenile bull trout occurred primarily at night in two pulses, one occurring in the spring and the other in the fall. The median distance moved downstream per night by juveniles captured in the fall was 315 m (n=40) and 295 m (n=17), in 2001 and 2002, respectively. Adult bull trout also migrated primarily at night, with 92% of the detections (n=631) at the PIT tag weir in 2001 and 2002 occurring between sunset and sunrise. Of those PIT tagged adults marked in 2000 that returned to spawn in either 2001 or 2002, 92.6% (n=224) returned annually versus 7.4% (n=18) returning in alternate years. We detected a total of 224 of the 393 (56.9%) adult bull trout originally marked in Trestle Creek in 2000, in Trestle Creek in 2001. Based on juvenile outmigration and adult escapement data, we speculate juvenile rearing habitat currently represents a population bottleneck in Trestle Creek. We marked 889 outmigrating juvenile bull trout with PIT tags and will be using their return to estimate lake survival over the next several years.

Assessment of Tributary Potential for Wild Rainbow Trout Recruitment in Hebgen Reservoir, Montana

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Conversion of trout stocking to self-sustaining wild trout populations has been a cornerstone of fisheries management in Montana rivers for the past 30 years. However, trout fisheries in Montana reservoirs are almost entirely maintained by stocking hatchery fish. An exception is Hebgen Reservoir, where wild rainbow trout (Oncorhynchus mykiss) were established in 1979, with annual supplementation with hatchery-reared rainbow trout. Continued, unexpectedly low catch rates of rainbow trout led to the objective of this study to assess tributary recruitment of wild rainbow trout and identify potential limiting factors. A combination of redd surveys, adult and fry trapping, and measurement of spawning and rearing habitat and water temperature, was used to assess spawning use and habitat characteristics of 11 tributaries in 2002 and 2003. A total of 5642 redds were counted, suggesting numbers of spawners was not limiting. However, most spawning production (80%) was confined to two of the 11 tributaries (Duck Creek and S.Fork of the Madison River). Redd density was associated with available spawning habitat (percent spawning gravels) and rearing habitat (percent pools and ponds). Mean daily water temperature, from May through July, varied widely among tributaries (5.6 to 16.5 ^{o}C) while most spawning production (90%) was associated with temperatures from 8.5 to 13 ^{o}C. Downstream trapping indicated that production of age 1+ juvenile trout may contribute significantly more to juvenile recruitment to the reservoir than previously thought. The apparent high juvenile recruitment to the reservoir suggests that conditions within the reservoir may be more likely limiting the numbers of adult wild trout recruiting to the fishery.

Application of a Two-Dimensional Habitat Model for Instream Flow Investigations on the Flathead River, Upstream of Flathead Lake, Montana

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A modified Instream Flow Incremental Methodology (IFIM) approach was used on the mainstem Flathead River from the South Fork Flathead River downstream to Flathead Lake. This study quantified changes in habitat for the target fish species, bull trout (*Salvelinus confluentus*) and west slope cutthroat trout (*Oncorhynchus clarki lewisi*), as a function of discharge. Two dimensional hydraulic simulations were combined with habitat suitability criteria in a GIS analysis format to determine habitat area as a function of discharge. Results of the analysis showed that habitat area is more available at lower discharges than higher discharges. Comparison of the pre-dam hydrology with post-dam hydrology showed that pre-dam baseflows provided more stable habitat than the highly variable post-dam flow regime. The GIS analysis showed that sub-adult fish, in particular bull trout, were required to use less productive stream margin areas that are constantly wet and then dried as flows fluctuate. These areas have highly varying productivity for lower trophic levels and consequently are less productive for higher trophic levels, especially bull trout sub-adults. The analysis demonstrates that highly variable flows likely put stress on a bull trout subadult and west slope cutthroat trout, due to the additional movement required to find suitable habitat. The GIS approach presented here provides both a visual characterization of habitat as well as Arcview project data that can be used for additional analysis of flow regimes and spatial variability of habitat within the three reaches of the river.

Bacterial Coldwater Disease: Hatchery Epidemiology and Control

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Bacterial coldwater disease, caused by the gram-negative bacterium Flavobacterium psychrophilum, has caused significant losses of hatchery-reared salmonids worldwide. It is especially problematic at hatcheries rearing fish for native species restoration. Washoe Park State Fish Hatchery typically loses 30 to 45 % of their annual westslope cutthroat trout production to the disease. Using Washoe Park as a test case, our goal was to develop practical hatchery-management strategies to better control the pathogen and the disease. Our main objectives were to determine where the pathogen is, how it is transmitted, and what factors cause disease outbreaks. We found the bacterium in the hatchery water source, in water within the hatchery, and in production and broodstock fish. It was transmitted both horizontally and vertically, with both male and female adults passing the pathogen on to juveniles. Chronic stress and low levels of acute stress, such as a simulated planting event, did not result in disease outbreaks. However, a combination of acute stress events involved with moving fish to an outside environment, caused a disease outbreak. Measures have been implemented at Washoe Park to reduce horizontal transmission, and tactics to reduce vertical transmission will be tested in 2004. It is unlikely that the pathogen can be eradicated completely, but management to reduce the number of fish carrying the pathogen may minimize losses during outbreaks.

Does Wildfire Favor Invasion of Nonnative Fishes?

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Many studies have documented rapid recovery of fish populations following wildfire disturbance. However, it is not known if wildfire effects can tip the balance in favor of nonnative fishes. Therefore, we are testing the hypothesis that increases in stream temperature, sedimentation, and reduced habitat complexity following wildfires favor nonnative trout in mixed native and nonnative salmonid communities. We are conducting the study in the upper Bitterroot River drainage in western Montana, the site of a 1,440 km^2 wildfire complex in 2000. Westslope cutthroat trout Oncorhynchus clarki lewisi, bull trout Salvelinus confluentus, and brook trout Salvelinus fontinalis are patchily distributed across the drainage. Pre-fire fish population data for many basins in the watershed allow unique comparisons of changes in fish species composition and abundance among sites varying in fire severity, presence of fire-induced debris flows, and distance to source populations for colonization of defaunated reaches. We found that mean daily temperatures in reaches affected by high-severity fire increased by 3.7°C compared to 0.9°C in unburned reaches. Following initial fire-induced population declines, reaches in high-severity burns averaged a 110% increase in fish abundance from 2001 to 2002. In contrast, populations in reaches affected by debris flows increased little from 2001and averaged only 8% of pre-fire abundance in 2002. Although analyses of 2003 data are preliminary, brook trout abundance appears to be increasing relative to native bull trout and westslope cutthroat trout in reaches with fire-induced sediment and temperature increases.

Predicting Post-fire Sediment Risks to Streams

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Severe erosion that commonly follows intense wildfires throughout the Mountain West radically alters aquatic habitats. Before human encroachment local fish populations survived these disturbances by escaping to and/or repopulating from unaffected refuge areas. Habitat loss and degradation limits these areas and increases the threat of post-fire erosion. Therefore we need to identify locations where the potential for severe post-fire erosion overlaps degraded or spatially limited aquatic habitat. Gully rejuvenation usually results in high volume debris flows. These flows represent the most severe form of post-fire erosion, delivering large pulses of fine sediments, rocky debris, and wood from ephemeral channels into perennial stream systems. Gully rejuvenation is more likely to occur where high severity burns impacts relatively large portions of, and is concentrated near, watershed divides. This paper presents a GIS-based technique using satellite derived burn severity mapping to identify potential sources of severe post-fire erosion. 1st and 2nd order ephemeral basins are delineated and assigned a Burn Severity Distribution Index (BSDI) value. Basins with high values are identified as highly probable debris flow sources if the burned area receives a intense rainfall soon after a fire. A model is proposed to assess the risk of severe erosion response as a function of the BSDI. A method to co-ordinate this risk analysis with aquatic habitat assessment is demonstrated. This approach may prove to be useful for Burned Area Emergency Rehabilitation (BAER) teams as they identify aquatic resources most at risk following wildland fire.

Effects of Wildfire on Aquatic Habitat of the Wigwam River 70 Years Later - Insights into Temporal Dynamics in Watershed Processes, Channel Condition and Riparian Function

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The Wigwam River situated in Southeastern B.C. – Northwestern Montana is identified as a key bull trout spawning habitat in the Lake Koocanusa basin and has been the focus of international attention for the past decade following declining bull trout populations during the late 1900's. A reconnaissance level hydro-geomorphological assessment of the Wigwam River has provided a unique insight into the long term changes in watershed processes following an extensive wildfire that removed over 70 percent of the forest in the 40000 hectare drainage during the early 1930's. The most significant changes in watershed processes following the fire included large sustained increases in sediment delivery throughout the drainage and extensive deforestation of riparian areas along much of the main stem channel and many of the tributary channels. These impacts have resulted in long term changes in the sediment budget, riparian function and channel condition that have been both beneficial and detrimental to aquatic habitat.

The Wigwam River study provides insights into the long term effects of a large wildfire event on aquatic habitat and the evolution of watershed processes and channel condition in the decades following a severe disturbance event. Recognizing these long-term changes has provided an understanding of natural disturbance regimes and temporal variability of watershed and channel processes. This information has assisted forest managers in identifying key management concerns to protect aquatic values in the Wigwam River.

They're (Almost) Everywhere: Movement Patterns and Habitat Use in Boreal Toads in Western Montana Basins

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The boreal toad Bufo boreas is widely distributed in western North America, but it has declined precipitously in the southern Rocky Mountains and may be declining in western Montana. Previous studies indicated that adult boreal toads were sedentary, and typically occupied summer habitats far from water. We devised a new method for detecting the presence of toads using upstream-facing hoop nets in two drainages in June 2003. In July-August 2003 in two streams, we conducted a more intensive study of in-channel movements using hoop nets and PIT tags and of overall movements and habitat use using radiotelemetry. In 17 streams in the Blackfoot and Bitterroot river basins, we captured 83 boreal toads at 13 sites in 8 streams. Intensive trapping in Slate and Little Blue Joint creeks in the Bitterroot River basin produced 514 captures of 117 adult and 203 juvenile toads. Juveniles dominated catches initially but declined throughout summer, whereas adult catches were unrelated to season. Of the 125 PIT-tagged toads, two-thirds were recaptured 1-7 times in hoop nets and the median total distance moved was over 1 km. The median total distance moved by radio-tagged toads was over 2 km, but up to 12 km. Only 17% of relocations of radio-tagged toads were at upland sites; 62% were in riparian zones and 21% were in or adjacent to water. We believe that hoop nets are effective for monitoring the presence of boreal toads and that boreal toad life histories may be far more aquatically oriented than previously recognized.

Age Structure, Growth Rate, and Condition of *Margaritifera falcata* (Gould, 1850), a Native Freshwater Mussel in West-Central Idaho

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The western pearl mussel, Margaritifera falcata (Gould 1850) is an ecologically important bioindicator of aquatic health because of its (1) responsiveness to environmental change, (2) widespread distribution, (3) dependence on salmonids as a host fish for distribution and survival, (4) sedentary life style after the glochidia stage, (5) visible annual growth rings, and (6) long lifespan (>100 years). Population structure and condition of M. falcata were assessed in Bear Valley Creek (BVC), Idaho 50 years after dredging activities and subsequent disturbances from restoration efforts had ceased. Mussels were collected, measured for length and weight, and aged from five randomly chosen reaches in BVC. Fewer juvenile mussels (~10 years) were observed and mussel distribution was sparser in the upper versus lower reaches in BVC. Mussel age ranged from 8-48 years, lengths ranged from 28-97 mm of which half were less than 60 mm, and overall growth rates averaged 1.28 $g \cdot yr^{-1}$. Growth patterns were not linear, but decreased with age from 3.90 $mm \cdot yr^{-1}$ (0-15 yrs) to 1.85 $mm \cdot yr^{-1}$ (15-50yrs). Overall, BVC sustains a diverse population of *M. falcata*. However, mussel distribution ceased in the vicinity of the old dredge site and upstream. Potential reasons explaining the limitation in mussel distribution include (1) chemical constituents in the water needed to create shell material are limiting, (2) range of host fish may be limited, or (3) the physical disturbance from dredging and restoration activities may have buried or removed some mussels in the past delaying recolonization.

Using Fish Assemblages as Indicators of Aquatic Ecosystem Integrity in Montana Prairie Streams

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Prairie streams in Montana are affected primarily by non-point source pollution and stream habitat degradation, which make assessment with traditional methods such as water chemistry analysis difficult. Quantitative indicators of biological integrity are generally lacking for prairie streams, and little is know about what constitutes a healthy Montana prairie stream fish assemblage. We developed a multimetric index of biological integrity (IBI) for Montana prairie streams using fish assemblages. Choosing effective fish metrics in prairie streams is challenging because native fish assemblages are often depauperate and prairie fishes are adapted to harsh environment fluctuations. We screened fish-assemblage metrics by testing for responsiveness to anthropogenic stress, lack of responsiveness to natural factors, temporal stability, and lack of redundancy. The resulting IBI was comprised of 10 fish-assemblage metrics based on species richness and composition, tolerance to human-induced stress, trophic and reproductive guilds, and age structure. The number of native species, number of native families, number of catostomid and ictalurid species, proportion of invertivorous cyprinids, number of benthic invertivorous species, proportion of litho-obligate reproductive guild individuals, proportion of native individuals, and number of species with long-lived individuals declined with increasing anthropogenic stress, whereas proportion of tolerant individuals and proportion of tolerant reproductive guild individuals increased with increasing anthropogenic stress. We propose that this IBI can be used as a quantitative measure of ecosystem integrity for use in management of Montana prairie streams faced with threats such as introduced species, agriculture, and coal bed methane extraction.

Fish Entrainment Investigations from the Yellowstone, Sun and St. Mary Rivers in 2003, with Preliminary Evaluations of an Experimental Electric Barrier at the St. Mary Diversion

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Efficient, economical methods are needed to reduce the loss of fishes to agriculture diversions. Such methods depend on developing techniques for quantifying canal entrainment and fish barrier effectiveness. Three entrainment projects performed this year were designed to both quantify entrained fish as well as evaluate any present or future fish protection measures employed at the diversions. Fort Shaw (Sun River) and Huntley Diversions (Yellowstone River) are unscreened with fyke net systems (nets) developed and installed to sieve 100% of flows. Standardized sampling efforts were incorporated into study designs and results indicated diel differences in catch for most species. At Huntley, 7628 fish were collected comprising 28 species. Over 2500 fish, comprising 10 species were collected at Fort Shaw during 2003. The St. Mary diversion entrainment sampling was initiated in 2002 with nets subsampling a large portion of the irrigation flows (60-81%) in standardized effort periods. Netting during the 2002 season showed highest entrainment at night and later in the irrrigations season. Bull (*Salvelinus confluentus*) and cutthroat trout (*Onchorhynchus clarki*) represented relatively small proportions (1.1% and 9.4%) of catch totals. An experimental electrical barrier was installed in the canal head works during 2003 and the nets were used to begin evaluating its effectiveness. First year data indicates that at the manufacturers recommended settings and voltage fields, the barrier has low effectiveness on small fish (<200mmTL). Further work is necessary to determine settings and configurations; however, effectiveness and operational data obtained from the barrier evaluation will be valuable in determination of its utility at other sites.

Configuring Libby Dam Operation for Recovering the Endangered Kootenai White Sturgeon - What Will Society Bear to Save This Ancient Species?

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Natural recruitment of white sturgeon in the Kootenai River became rare after Libby Dam became operational in 1972. Flow and temperature regulation resulting from dam operation has likely contributed to recruitment failure. Less than 600 wild individuals remain and the complete loss of the wild population is predicted by 2060. Before the wild adults vanish, 3,000-6,000 of their progeny from the Kootenai Tribe of Idaho's sturgeon aquaculture facility will have survived to maturity. However, recovery of the white sturgeon requires natural reproduction. Evidence suggests that a naturalized spring freshet is needed to initiate migration to the spawning reach. Spawning now occurs over sand substrate unsuitable for survival. The historic spawning reach, which is thought to be further upstream, is heavily embedded with sand. Previously, the spring freshet flushed fine sediments from spawning cobble and model results indicate that a higher river stage provided a survival advantage for early life stages. The US Fish and Wildlife Service's 2000 Biological Opinion (BiOp) implemented a tiered flow strategy to assess possible thresholds between recruitment success and failure. The BiOp also recommends increasing the discharge capacity of Libby Dam by 5,000 cfs in 2004 and an additional 5,000 cfs by 2007. Unfortunately, Libby Dam cannot currently pass the additional 10 kcfs without the use of the spillway, and a spill of less than 2 kcfs exceeds Montana's water quality standard of 110 percent gas supersaturation. Excess gas causes gas bubble trauma in river fish including federally listed (threatened) bull trout. Therefore, the Army Corps of Engineers is analyzing 10 alternatives to conform to the BiOp; all present challenges. Flows required to flush sediments may be prevented by human development in the flood plain. Survival of the species and public acceptance of recovery actions require shifting emphasis from a high spring peak to a gradually descending hydrograph, and from the spawning period to survival during the first few months of life.

Sheppard Creek: A Case Study of a Brook Trout Electrofishing Removal Effort and Lessons Learned

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Sheppard Creek contains one of the last, remnant westslope cutthroat trout populations in the Stillwater River basin. Unfortunately, recent monitoring indicated that this population was declining rapidly. The imminent threat to cutthroat trout persistence was judged to be competition from non-native brook trout, rather than habitat degradation. The Flathead National Forest, along with numerous partners, installed a barrier to block any further invasion and then began a systematic removal of brook trout by means of electrofishing. Electrofishing crews made multiple passes over 3.8 miles of habitat every year for three years. All brook trout were counted and removed, while cutthroat trout were released unharmed. No habitat restoration took place. Following three consecutive years of work, the brook trout population decreased by 95% from an estimated total population of 5,622 to 283. Cutthroat trout numbers are estimated to have climbed from 252 to 864. These results demonstrate that electrofishing removal of brook trout can be an effective method to stabilize and possibly recover a cutthroat trout population. A lesson learned is that this method is less controversial than chemical treatment and can be quickly implemented. This is a labor intensive method but costs can be reduced by selectively focusing efforts on key spawning areas and employing volunteers. The long-term prognosis of this project is uncertain. Crews may be able to ultimately remove all brook trout, but if not, periodic efforts should be able to keep Sheppard Creek cutthroat trout numbers more secure.

The Un-streaming of Mitchell Slough; How Landowners Along a Spring Creek will not be Required to Obtain 310 Permits

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“It looks like a stream. The fish think it’s a stream. So it must be a ditch,” is how one individual described a recent decision by the Bitterroot Conservation District (BCD). In the 4-1 vote the BCD ruled that Mitchell Slough is not a natural perennial flowing stream and therefore stream alteration work will not require 310 permits. Mitchell Slough (MS) is a 10-mile long body of water that evidence indicates was once historic sloughs and channels of the Bitterroot River. Agricultural modifications over the years have changed the flow and geomorphic patterns of MS. It is fed by Bitterroot River water diverted at a headgate, yet it gains considerable amounts of groundwater, and conductivity is significantly higher where it re-enters the Bitterroot River. Historically, it supported a diverse fishery, including a moderate population of trout. Recent work by some landowners has likely increased the trout population and it appears to be a significant spawning area for Bitterroot River rainbow and brown trout. Yet, at this time, stream alteration work will not require 310 permits. The BCD reached it’s decision largely based on data provided by consultants. Public agencies were not allowed access to key properties.

Overview of Rainbow Trout Broodstock Management and Egg Production Techniques at Ennis National Fish Hatchery

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It isn't often that two broodstock fish culturists from different facilities cross paths. Most techniques utilized at any given facility are a result of shared ideas but also, often, the result of practical inspiration formed out of ingenuity and trial and error. Over the last twenty years there have been several important advances in broodstock management, spawning, and egg handling methods. Many of these ideas have either been adopted or developed at Ennis National Fish Hatchery. What follows is a survey of methods and techniques currently applied here and include four significant aspects of broodstock management- Genetics, Nutrition, Egg Handling/ Incubation and a review of Spawning Technique. It is hoped that through sharing information some of the above mentioned ideas will provide material for other broodstock/ production facilities and vice versa.

Poster Presentations

Trammel Net Efficiency for Juvenile Pallid and Shovelnose Sturgeon

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Pallid sturgeon Scaphirhynchus albus and shovelnose sturgeon Scaphirhynchus platorynchus have declined throughout the Mississippi River basin because of anthropogenic habitat alterations. To accurately document continued decline or recovery of sturgeon *Scaphirhynchus* spp., the efficiency of sampling these species needs to be evaluated. Drifting trammel nets are considered to be an important tool for sampling sturgeon in lotic systems. However, little information exists on the efficiency of drifting trammel nets for sampling sturgeon. Thus, our objective was to evaluate the efficiency of drifting trammel nets for sampling juvenile pallid sturgeon and shovelnose sturgeon. In July and August of 2003, we attempted to recapture 10 radio-tagged juvenile pallid sturgeon and shovelnose sturgeon in the Missouri River above Fort Peck Reservoir. After a radio-tagged fish was located, a trammel net was deployed 75 m upstream and retrieved 45 m downstream of the fish location. A maximum of four drifts were attempted at each location. Overall efficiency was 35%; whereas, first drift efficiency was 40%, second drift efficiency was 50%, and all remaining drifts were unsuccessful. Capture efficiency was 60% when combining the first and second drifts. Stepwise logistic regression was used to model the probability that a drift would not capture a sturgeon. However, none of the abiotic variables were significant ($P > 0.05$) in the logistic regression model. Nevertheless, these results suggest that drifting trammel nets are a relatively effective sampling gear for pallid sturgeon and shovelnose sturgeon.

Food Habits of Hatchery-Reared Juvenile Pallid Sturgeon and Juvenile Shovelnose Sturgeon in the Missouri River above Fort Peck Reservoir, Montana

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Natural recruitment of pallid sturgeon Scaphirhynchus albus has not been observed in the Missouri River above Fort Peck Reservoir, Montana, for at least the past 20 years. In an effort to recover the species, 736 age-1 hatchery-reared juvenile pallid sturgeon (HRJPS) were released in 1998 and 2,300 were released in 2002. However, the ecology of juvenile pallid sturgeon is relatively unknown, and more scientific information is needed to assist in the recovery of the species. Therefore, we examined the stomach contents of HRJPS and juvenile shovelnose sturgeon (JSNS) Scaphirhynchus platorynchus from the Missouri River above Fort Peck Reservoir from June through September 2003. Stomach contents from HRJPS and JSNS were obtained using a gastric lavage to allow captured fish to be released unharmed. Gastric lavage was performed on 61 JSNS and 16 HRJPS. Stomach contents were obtained from 50% of the HRJPS and 71% of the JSNS. Fish remains, Ephemeroptera nymphs, Chironomidae larvae, Trichoptera larvae, plant material, and detritus were found in HRJPS stomach contents. Fish composed the majority of the wet weight of HRJPS diets (82%), while Chironomidae composed 93% of the diet by number. Aquatic invertebrates composed the majority of the diet for shovelnose sturgeon. In addition, no fish were found in any shovelnose sturgeon stomach contents. This is the first documented food habits data for juvenile pallid sturgeon and these data illustrate that pallid sturgeon are piscivorous as juveniles.

The Kootenai River Network (KRN)

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The Kootenai River Network (KRN) is an international alliance for water quality and aquatic resources. The group formed late in 1991 in response to citizen's concerns of threatened or deteriorating water quality and aquatic resources in the Kootenai River Basin. KRN's mission is to operate as "a cooperative international partnership of individuals, diverse citizen groups, and agencies dedicated to the utilization, restoration, promotion and protection of water resources in the Kootenai-Kootenay River watershed". To accomplish this mission, the following goals have been developed: 1) Involve individuals and their communities in sharing the value of the Kootenai/ay watershed; 2) Improve communication among agencies and diverse citizen groups throughout the Kootenai/ay watershed; 3) Facilitate habitat enhancement and rehabilitation; 4) Fully use best available science practices to facilitate proactive water resources management; 5) Pursue coordination of efforts regarding Water Resources models and measurement techniques. The KRN has been successful in bringing together interstate, international, and tribal interests of different political jurisdictions to form a watershed-based organization dedicated to solving priority environmental problems and bridging jurisdictional obstacles to achieve watershed management. The KRN would like an opportunity to set up an educational display at the MT AFS meeting. The function of the display is to convey, at a glance, the essence of the Kootenai/ay River network. In order to capture viewer's attention and convey our messages, we are using a combination of pictures with cut-lines of text on an upright display. The display demonstrates KRN activities such as partnerships, educational workshops, site tours, committees, mission statement, and profiles habitat restoration activities in the Kootenai/ay to benefit native fisheries and wetland dependant wildlife. The display will either be a stand-up or table-top display.

A Stream Table will be Displayed that is Used for Educational and Outreach Purposes, Demonstrating the Function of Watersheds, Floodplains, Riparian Areas and Stream Channel Systems.

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In 2003, Kootenai River Network purchased a Stream Table for educational and outreach purposes. The stream table demonstrates functioning of watersheds, floodplains, riparian areas, and stream channel systems. Recently, MFWP, NRCS, and Conservation District personnel, had the opportunity to attend stream table training to learn about the mechanics and educational components of the table. In February, the MT AFS meeting would present an opportunity to display the stream table for meeting attendees. The table would supplement the agenda focus on stream restoration projects and allow the public to visualize stream dynamics on a smaller scale. A presenter from an agency will be available for one day (or ½ day) to set up the stream table and present information to the public. The utility trailer is 5-10 and can be set up outside at a convenient location.

Wild Fish Habitat Initiative: Technical Resources on Habitat Restoration for Resource Professionals and Project Managers

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Habitat degradation is one of the principal reasons for the listing of wild fish as “threatened” or “endangered” under the Federal Endangered Species Act and can exacerbate the detrimental effects of fish predators, exotic competitors, and diseases such as whirling disease. In addition, land values are diminished by habitat degradation and the subsequent loss of wild fish populations. In recent years, many fish habitat enhancement and restoration techniques have been implemented; project results, however, have not been shared widely and their efficacy is not well understood. The Wild Fish Habitat Initiative seeks to augment the success of habitat restoration programs by conducting targeted research related to habitat restoration techniques, and by implementing a technology transfer program to share information on project results and to provide technical information to land owners and project managers. Research projects administered through the Initiative include investigations on thermal tolerances of westslope cutthroat trout, the epidemiology and control of Bacterial Coldwater Disease, and the effectiveness of irrigation diversions in western Montana. The technology transfer program includes online bibliographic and restoration manual resources, as well as a case histories database of restoration projects implemented in the intermountain west.

Fridley Creek Reconnection Project

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Fridley Creek is located south of Emigrant, Montana flowing east out of the Gallatin Range into the Paradise Valley. The stream was historically a tributary to the Yellowstone River but has been disconnected due to interception by an irrigation canal.
Reconnection of Fridley Creek to the Yellowstone River allows a positive exchange of fish between the two systems that did not occur before the project. Re-establishing fish exchange is especially beneficial at this location because so many tributaries in this portion of the drainage are disconnected or are severely dewatered each year. Fridley Creek already supported a self-sustaining population of native Yellowstone Cutthroat trout. The reconnection will aid increased spawning and recruitment of Yellowstone Cutthroat to the Yellowstone River. The poster presentation will discuss: Benefits to native trout, water rights, fish passage, sediment transport and other design considerations of reconnection of Fridley Creek to the Yellowstone River.

Distribution, Species Richness, and Predictive Modeling of Montana Prairie Fishes

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The distribution and abundances of fish in prairie streams of eastern Montana are poorly known. Knowledge of fish assemblages and their habitat is critical to effectively conserve species and their environment. In 1999, the Montana Cooperative Fishery Research Unit initiated a large-scale research program to gain a better understanding of prairie-stream ecosystems; four Montana Fish, Wildlife, and Parks regions joined the effort in 2003. Most sampling locations were at streams that had no previous fish collections. Thirty-eight fish species were sampled; 28 species were native and 10 were introduced. Species richness varied from 0 to 17 per sample. The most common native species was fathead minnow *Pimephales promelas* and common carp *Cyprinus carpio* was the most prevalent introduced species. Although many streams sampled were intermittent with isolated pools, most (82 %) sites had fish present. In-stream habitat features, including widths, depths, and substrates were measured. Landscape habitat features including elevation, watershed area, soil type, and connectivity were obtained from GIS databases. As a pilot effort, we prepared models for the Musselshell River basin using landscape and site-level habitat data to predict the presence or absence of fish species. Additionally, we will construct models for all fish species in the prairie ecoregions of Montana, and assess the relative importance of site-level and landscape habitat features. By identifying the relationships between fish distribution and habitat characteristics, we hope to identify critical habitat for conservation of native fish species and assemblages.

Influence of Water Temperature and Competition on Growth and Survival of Westslope Cutthroat Trout, *Oncorhynchus clarki lewisi*

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Historically, westslope cutthroat trout Oncorhynchus clarki lewisi ranged widely over western Montana, Idaho, and portions of eastern Washington and Oregon. Like many cutthroat and other native trout, westslope cutthroat trout now persist in only a small portion of their native range, and are listed as a "species of special concern" in Montana. Leading causes for their decline are habitat degradation and displacement by nonnative rainbow trout Oncorhynchus mykiss, and brook trout *Salvelinus fontinalis*. Many remaining populations are isolated in cold, headwater portions of streams that westslope cutthroat trout previously occupied entirely. Water temperature may play a critical role in segregating westslope cutthroat trout because it significantly influences the distribution, growth, and survival of salmonids. In addition, increased water temperature is thought to favor non-natives in many cases, yet the effect of temperature on competition between westslope cutthroat trout and non-natives is unknown. Furthermore, hybridization between westslope cutthroat trout and nonnative rainbow trout has resulted in a decline in populations of genetically pure westslopes. However, little is known about the thermal requirements of westslope cutthroat trout and of westslope cutthroat x rainbow trout hybrids, which now occur widely across the historical range of pure westslope cutthroat trout. This laboratory study aims at testing how temperature affects the vital processes of growth and survival of westslope cutthroat trout. This study will use a laboratory design that allows simultaneous assessment of fish growth and survival under different thermal regimes over long time periods. This study will compare the thermal requirements of westslope cutthroat trout, rainbow trout, brook trout, and westslope cutthroat x rainbow trout hybrids. With increased global warming, warmer water temperature in streams may constitute a major problem for native, cold-water species such as westslope cutthroat trout. Understanding the effect of water temperature on this unique trout will help guide protection and restoration efforts in the future.

New Tools to Mosaic and Georeference Imagery:
DIME "the New Tool"

Showcasing the Flathead National Forest Post Fire Management

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With the introduction of new imagery from satellites, digital cameras and the increased use of scanned film aerial photography, there is a great need for tools that quickly and cost effectively mosaic and georeference imagery to use in a GIS or Image Processing Systems. New technology and production processes, such as those found in the DIME Software, have recently been developed to allow users to preprocess their imagery more efficiently so that it can easily become a useful addition to their GIS. This new, lower cost, capability is particularly useful in applications such as Timber Management, Environmental Monitoring, or other Land Management activities and applications. The Poster will show a recent image mosaic of the Flathead National Forest, 2003 fire and discuss potential uses of that imagery. Positive Systems is a products and service company based in Whitefish Montana. Past and current customers include NASA, the USDA Forest Service and Farm Service Agency.

Preliminary Evaluation of Entrainment Losses and the Efficiency of Fish Screens at Skalkaho Creek

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We are quantifying entrainment of downstream-migrant westslope cutthroat trout (Oncorhynchus clarki lewisi) into seven irrigation canals on Skalkaho Creek, a 40.1-km long tributary of the Bitterroot River. Post-spawn adults migrating back to the Bitterroot River, age-1 juveniles migrating downstream from nursery reaches, and age-0 juveniles migrating downstream after emergence are believed to be entrained, become trapped, and die in the irrigation canal system, but the magnitude of this loss is unknown. Private landowners and irrigators in the drainage have expressed concern over this problem and the Montana Department of Fish, Wildlife and Parks will install fish screens in 2004 at three diversions to preclude such losses. We are quantifying the entrainment of westslope cutthroat trout before (2003) and after (2004) installation, as well as the efficiency of the three fish screens after installation. Radio telemetry is used to track movements of 30 adult and 50 age-1 westslope cutthroat trout annually in Skalkaho Creek to determine their fate. Trap netting in irrigation ditches is used to estimate abundances of entrained age-0 juveniles. Passage efficiency of fish screens is assessed by PIT-tagging entrained fish to determine bypass success rates and durations. No radio tagged adults were entrained in 2003. Fluvial adults were able to migrate upstream and downstream past the diversion dams. Both age-0 and age-1 juveniles were entrained by the Highline Ditch, the furthest upstream canal. It diverts most of Skalkaho Creek during the peak of the irrigation season, which corresponds to the peak of emergence and downstream movement of age-0 westslope cutthroat trout.

Clark Fork River Response to Reduction in Nutrient Loading from Watershed

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In 1998, a public-private partnership signed an agreement to reduce nutrient loading to the Clark Fork River to address nuisance algae growths in the river. In the intervening years, nutrient loads and concentrations have been reduced at most sites for some nutrients, but not for the critical nutrient soluble nitrogen. Changes in algae levels are more difficult to detect because of the great variability in algae levels which are influenced by many factors in addition to nutrients. Statistical trends in instream nutrient and algae levels from 1998 to 2002 are presented. Recommendations are made for future monitoring and restoration actions.

Can Passive Solar Heating Be Used To Control The Spread Of New Zealand Mud Snails?

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Since the first discovery of New Zealand mud snails, *Potamopyrgus antipodarum*, in Idaho's Snake River in 1997 they have spread to many waters in the West. Anglers and other recreationists are likely vectors in the transfer of this invader and all prevention programs must include public participation. Unfortunately, the public requires practical solutions before they will voluntarily change their behavior. It is known that *Potamopyrgus* is sensitive to high temperatures. 40° C (104° F) for two hours can be lethal to *Potamopyrgus* and exposures to hotter temperatures prove lethal in shorter times. This experiment was designed to determine if solar heated equipment storage containers could produce lethal temperatures. A variety of equipment storage containers were tested under differing conditions to determine if passive solar heating would develop and sustain temperatures that were high enough to provide sterilization. Our results show that although air temperatures inside the storage boxes exceeded 68° C (155° F) the insulating effects of the materials placed in the containers resulted in a failure to achieve lethal temperatures in all areas of the containers.