Abstracts

Biological Sciences – Aquatic

Abstracts of the 2006 Annual Meeting of the Montana Chapter, Co-Convening with the Western Division of the American Fisheries Society

Natives and Newcomers
May 13-20, 2006
Montana State University, Bozeman

Introduction

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The Montana Chapter of the American Fisheries Society is an organization of professional fisheries scientists and students from agencies, universities, and the private sector across Montana. Our objectives are: conservation, development and wise utilization of Montana's fisheries; promotion of educational, scientific and technological development; advancement of fisheries science and practice; and exchange and dissemination of knowledge about fish, fisheries and related subjects.

This year, our Chapter hosted our meeting with the Western Division of the American Fisheries Society. We had over 450 professionals attend our joint meeting!

- Over 100 people attended the three continuing education workshops on Dydimo algae (Didymosphenia geminate), hydroacoustics, and study design. The Dydimo workshop attracted professionals from as far away as New Zealand and was attended by 60 people.
- We started off the main meeting with a plenary panel on "Water in the West" moderated by Kathleen Williams of the Instream Flow Council. The panelists presented their perspectives on challenges facing fisheries resources due to the expanding human impacts on water-limited evirons in the West.
- The meeting then continued with three days of multiple concurrent sessions, a first for our Chapter. Our sessions and symposia were packed with presentations on Sturgeon, Bull Trout, Fisheries Conservation, Prairie Streams, and Bioassessment. It was inspiring to see presentations from across the West on issues so pertinent to Montana fisheries and to be able to renew old contacts and make new ones. It was a wonderful opportunity to showcase the caliber of professionals working in the state of Montana.

The Montana Chapter of the American Fisheries Society offers the abstracts of its 2006 Annual Meeting to the readers of the Intermountain Journal of Sciences in the spirit of

exchanging ideas and information regarding the aquatic sciences. This is a selection of the more than 250 abstracts submitted and includes only those abstracts from Montana Chapter members. The entire set of abstracts can be read on the WDAFS website. Many of the included abstracts reference ongoing research and management projects, and may include data that are not comprehensive or fully analyzed. Thus, these abstracts should not be cited in other works without permission of the author(s), whose contact information is provided. We hope that you enjoy our proceedings, and urge readers to attend and participate in our next meeting to be held on February 12-16, 2007 in Missoula, Montana.

Assessment of *Tubifex tubifex* Habitat and Myxobolus Cerebralis Distribution in Pelican Creek, Yellowstone National Park

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The introduced parasite that causes whirling disease (WD) in salmonids, *Myxobolus cerebralis*, poses a significant threat to the Yellowstone cutthroat trout (YCT) population of Yellowstone Lake. Although, numbers of YCT have declined significantly in Pelican Creek, a large spawning tributary to Yellowstone Lake, similar declines have not been observed in other nearby spawning tributaries. Infection risk in Pelican Creek was quantified using infection prevalence in the alternate host, *Tubifex tubifex* (Oligochaeta: Tubificidae) and compared with infection prevalence and severity in sentinel fish. The development of tubificid habitat assessment and detection tools based on variation among tubificids and habitat in the Pelican Valley are in progress. Uniform (100%) infection prevalence and high infection severity in sentinel fish suggested that WD risk was high among sites in the Pelican Creek watershed. In contrast, patchy patterns of infection in tubificids suggested that *M. cerebralis* does not have uniform distribution throughout the watershed. Thus, the highly variable patterns of tubificid and infected tubificid abundance relative to habitat type warrants further investigation. Knowledge of the distribution of *M. cerebralis* is important for understanding the factors affecting WD risk and YCT population declines, and to facilitate YCT conservation efforts within Yellowstone National Park.

Utilization of Floodplain Habitats by Native Fish Species and Non-Native Brook Trout

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Brook trout (*Salvelinus confluentus*) are broadly introduced in western North American rivers and lakes with variable impacts on native aquatic ecosystems. Influences on native fish communities in floodplains are particularly inadequately understood. The objective of our study is to examine habitat utilization by native fish species and non-native brook trout across a flood plain of the Middle Fork Flathead River (MT). We quantified fish

communities and habitat structure of main channel riffle, run, and pool reaches and lateral shallow shoreline, backwater, parafluvial springbrook and orthofluvial springbrook reaches. Parafluvial habitats are those scoured by annual flood flows while in orthofluvial zones annual floods predominately deposit sediment. Habitat use was measured using visual streamside observation, snorkeling, benthic surveys, and electrofishing in 2004-2005. Backwaters and parafluvial springbrooks contained the most diverse native fish communities for species and life history stages. While brook trout were found in all floodplain habitats, they achieved an order of magnitude higher density (1.26 fish/m^2) and biomass (3.81 g/m^2) in orthofluvial springbrooks. Orthofluvial springbrooks provide low scouring flood frequency, high physical habitat complexity, stable thermal regimes in the preferred temperature range for salmonids (5-15 ° C), abundant high quality spawning sites, and terrestrial food subsidies from riparian vegetation.

Use of In-Stream Pit-Tag Detectors to Monitor Bull Trout Populations in Washington and Montana

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We installed in-stream PIT-tag detectors in the Tucannon River, Washington, and in Trail Creek, Montana, to monitor population demographics and life history characteristics of bull trout (*Salvelinus confluentus*). The Tucannon River project is funded by the U.S. Army Corps of Engineers and managed by the USDA Fish and Wildlife Service, and the Trail Creek project is funded by the Bonneville Power Administration and Montana Fish, Wildlife and Parks. Biomark Inc. developed a weir antenna design because it may be less susceptible than pass-through antennas of being displaced by debris or high flow events. Weir antennas were installed at both sites, while flat plate and pass-through antennas were also installed in the Tucannon River. The flat plate "log" antennas are approximately 3 m long, the pass-through antennas openings measure 1-by-6 m, and the weir antennas are each 2 m wide. In Trail Creek, we implanted 300 juveniles upstream of the antenna during fall 2005, and 295 fish were tagged in the Tucannon River. As of January 2006, ten PIT-tagged bull trout were detected passing downstream over the Trail Creek detector system, and 12 bull trout released in the Tucannon River were detected. Future work will assess detection efficiencies of adult spawners and potential design modifications. These data will be used to help fisheries biologists to more precisely monitor population trends, identify recovery and extinction thresholds for conservation and recovery programs, and examine effects of recovery and restoration activities.

An Assessment of Native Fish Losses to Irrigation Diversions on Lost Horse and tin Cup Creeks, Montana

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Information about entrainment rates of fish into irrigation diversion canals in riverine systems and the factors that influence these rates is limited. Entrainment is especially prevalent among migratory native salmonid species, which can enter diversions as post-spawn adults migrating downstream or as juveniles emigrating from nursery tributaries. Such problems appear to be particularly common among westslope cutthroat trout (Oncorhynchus clarki lewisi) and bull trout (*Salvelinus confluentus*) populations in tributaries of the Bitterroot River, where irrigation losses may be responsible in part for low abundances and restricted distributions of these species. Our goals were to quantify entrainment rates of fish into all diversions on two tributaries of the Bitteroot River and to identify physical, spatial, and temporal characteristics of these diversions that correlate with rates of entrainment. We sampled fish species in 2005 by snorkeling, electrofishing, fry trapping, and reconnaissance at 60 sites located in irrigation diversions on Lost Horse and Tin Cup Creeks. A total of 9256 adult and juvenile fish in Lost Horse Creek diversions and 2819 adult and juvenile fish in Tin Cup Creek diversions were observed or captured. Preliminary analysis of our data indicates that the highest entrainment rates occurred in canals diverting the greatest amounts of water.

Native fish and Habitat Surveys in Two Southeastern Wyoming Prairie Watersheds

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In southeastern Wyoming, the Lower Laramie River and Horse Creek watersheds are considered aquatic priorities due to their high densities of native fish species and state species of concern. Yet, little is known about the distribution and habitat requirements of native fishes within these two prairie watersheds. The recently developed Warmwater Stream Assessment (WSA) was applied throughout these two regionally important watersheds to assess native species presence and habitat conditions. Assessments were applied to 30 sites in the Lower Laramie River and Horse Creek watersheds in 2005. A total of 16,991 fish were captured in the surveys representing twenty native species, ten introduced species, and nine families. Four species of concern were collected including common shiner, hornyhead chub, plains topminnow, and suckermouth minnow. Overall, instream habitat varied among the sites and was mainly influenced by water development practices throughout these watersheds. The fish distribution and habitat information collected from these two watersheds will aid in future conservation efforts focused on species of greatest concern in southeastern Wyoming prairie watersheds.

Factors Influencing the Distribution of Cottids in Small Forested Watersheds Upstream from Naturally Occuring Migration Barriers in Wester Oregon

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In small forested watersheds of western Oregon, upstream from natural barriers to migration, fish communities are dominated by coastal cutthroat trout (*Oncorhynchus clarki clarki*) and Cottid spp. Although cutthroat trout are more ubiquitous in these environments, cottids represent a potentially important, though poorly understood component. To evaluate distribution and spatial extent of cottids, we conducted spatially continuous surveys of stream habitat noting the presence or absence of cottids throughout the entire fish bearing portion of the channel in thirty five randomly selected watersheds (500–1000 ha) in the Cascades, Coast Range, and Klamath Mountains ecoregions of western Oregon. A regression tree approach was used to identify variables useful in separating watersheds where cottids were present from those where they were absent. Cottids were present in 10 of the 35 watersheds and the two factors most effective in delineated presence or absence were the number of fish-bearing tributaries and watershed area upstream from the migration barrier. These results suggest that cottid presence in headwater streams is linked to the spatial distribution of refugia, channel connectivity, and how those factors influence the process of ebb and flow.

Prioritization of Eastern Wyoming Prairie Streams for Conservation

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The abundance and distribution of native fish species in warmwater streams has declined throughout North America, but little is known about the current distribution, abundance, and habitat requirements of native fishes in eastern Wyoming streams. Prairie streams are an imperiled resource and future monitoring and conservation of these streams is crucial for the protection of native fishes in these streams. Therefore, in 2004 and 2005, 104 Warmwater Stream Assessment surveys were conducted to assess the status of habitat and native species in prairie streams of eastern Wyoming. A total of 56,931 fish were captured, representing 39 species (14 nonnative) and nine families. A fish assemblage index of biotic integrity (IBI), originally developed in Montana for Northwestern Great Plains streams, was modified for use in Wyoming. This index used metrics based on species richness, species composition, and trophic and reproductive groupings to determine the biologic integrity of streams. The IBI scores and presence of species of concern were then used to prioritize streams for future conservation efforts.

Bozeman Fish Technology Center – Aquatic Nuisance Species and Aquatic Animal Health Program

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The USDI Fish and Wildlife Service - Bozeman Fish Technology Center (BFTC) added a new program to the facility in April, 2005. The Aquatic Nuisance Species (ANS) and Aquatic Animal Health Program mission is to increase knowledge of aquatic nuisance species threats to aquatic systems and promote aquatic health through research, outreach and technical assistance. There are five main goals of this program: 1. Improve ANS detection and identification of colonization pathways, 2. Acquire biological and ecological information on ANS and important indicators of aquatic system health, 3. Determine effects to natural ecosystems, threatened and endangered species and industry, 4. Disseminate information through education, outreach and technical assistance, and 5. Survey National Fish Hatchery water supplies and effluent systems to identify ANS and potential hazards. The BFTC has been working together with State and Federal agencies on a regional and national level to support the mission and goals of this program.

Resource Similarity Between Sauger and Walleye in the Missouri River, Montana: Implications for Declining Sauger Populations

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Sauger (*Sander canadensis*) populations throughout Montana and North America have exhibited declines over the past few decades. Various factors may be contributing to the reduced population abundance of sauger in Montana, including interspecific competition with walleye (Sander vitreus). To assess competition potential, movement, habitat use, and food habits of both species were compared in the Missouri River, Montana. Sauger and walleye were tracked using radio telemetry to establish and compare seasonal movement patterns. Habitat was quantified at fish locations and food habits were collected on fish sampled using electrofishing. Prior to the spawning period, all sauger and 57 percent of the walleye migrated downstream as far as 273 km. After spawning, both species returned to previously occupied river reaches and demonstrated site fidelity during the summer. Habitat use and selection by sauger and walleye was similar. Diet overlap (Pianka Index) was high during the spring [0.72 (SE = 0.003)] and summer [0.95 (SE = 0.0008)] and moderate during autumn [0.49 (SE = 0.003)]. These results suggest that sauger and walleye in the Missouri River, Montana exhibit similarities in movement, habitat use, and food habits. Thus, the potential for competition between these two species is high, which may preclude the recovery of native sauger populations if resources are limiting.

Electrofishing as a Technique to Remove Lake Trout from a Spawning Site in Yellowstone Lake

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The Yellowstone cutthroat trout of Yellowstone Lake is seriously threatened by a recently established lake trout population. The National Park Service has directed an extensive gillnetting program toward removal of the lake trout. Despite substantial removal efforts, where almost 20 km of gillnet are in place each day fishing from June through September, lake trout in Yellowstone Lake are still present in high numbers and pose a serious threat to native cutthroat trout. During the 2004 and 2005 spawning seasons, efforts were expanded to include use of electrofishing to remove lake trout congregating in shallow water for spawning. When traditional electrofishing settings were used, designed to stun and not harm fish, many lake trout were able to escape capture because the sheer density of fish in the area precluded netting them all. However, after increasing the amperage three-fold, electrofishing was found to be a very efficient means of incapacitating lake trout. Although electrofishing was used only 5 nights in 2004 and 8 nights in 2005, we captured 13 and 23 percent, respectively, of the annual spawning lake trout catch using this method.

Improving Invertebrate Biological Monitoring

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Statistical power analysis contributed to the design and implementation of a reservation-wide biological monitoring program for streams on the Confederated Salish and Kootenai tribal lands. Invertebrate bioassessment metrics and indices were studied and sampling intensity was adapted to increase the likelihood of detecting small-to-moderate changes in community attributes thought to be related to disturbances. We compared results between watersheds to test whether a single sampling scheme could be generalized to the variety of streams on the reservation.

Dispersal and Introgression of Non-Native Rainbow Trout Genes in Native Westslope Cuttrhoat Trout Populations

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We used diagnostic microsatellite loci and Bayesian admixture analysis to describe the dispersal pattern of hybrids between native westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and introduced rainbow trout in the North Fork Flathead River drainage, Montana. Hybridization was detected in 17 of 31 sites and the proportion of admixture and number of rainbow trout alleles within hybridized sites showed a significant negative correlation

with fluvial distance from Abbot Creek, a suspected source of rainbow trout introgression in the drainage.Most (85%) of the rainbow trout alleles found among hybridized sites were present in Abbot Creek and several F1 individuals were detected in upstream sites lacking pure rainbow trout. Sites with low levels of admixture contained individuals classified as later-generation backcrosses. These findings suggest that straying from a downstream source population ultimately facilitates the spread of rainbow trout alleles in this drainage. Over time, this pattern of gene flow and introgression may lead to a loss of inter-population genetic diversity and local adaptation in native westslope cutthroat trout populations.

Comparison of Scuba Strip Surveys Assessing the Abundance and Distribution of Razorback Suckers in the Colorado River Below Hoover Dam: 1983 Versus 2003

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Razorback suckers (*Xyrauchen texanus*) were originally found throughout the Colorado River system but populations were isolated in the 20th century by the construction of high dams. The population in Lake Mohave, AZ-NV appeared to be the most abundant throughout the river as late as the 1980's. While abundance surveys have been conducted in the reservoir proper for decades, little work has focused on the riverine habitats of Black Canyon below Hoover Dam due to difficulties of conducting surveys. Strip counts conducted by paired divers using scuba gear were conducted in the spring of 1983 and again in 2003 to assess changes in the abundance and general distribution of razorback suckers in the Colorado River from 0.3 to 24.6 km below Hoover Dam. In both surveys razorback suckers observed were restricted to the more upstream (i.e., less impounded) river reaches. However, the 2003 strip surveys clearly showed fewer adult razorback suckers than in the 1983 strip surveys, they were also less widely distributed, and were associated with warm geothermal springs. These observations suggest that numbers of razorback suckers are declining in riverine portions of the reservoir, which concurs with surveys in the reservoir indicating that the overall population is in decline.

A Mechanistic Model to Explain Differential Recruitment Success of Pallid Sturgeon and Shovelnose Sturgeon in the Upper Missouri River Basin

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Shovelnose sturgeon (*Scaphirhynchus platorynchus*) and the federally endangered pallid sturgeon (*S. albus*) inhabit in the lower Yellowstone River and fragmented hydroscape of the Missouri River between Fort Peck Dam and Lake Sakakawea. Populations of both species contain reproductively mature individuals that produce viable eggs and sperm, and spawning

is known to occur in both species. Whereas shovelnose sturgeon exhibit annual recruitment success, there is little to no evidence of recent recruitment in pallid sturgeon. Experimental studies of larval sturgeon drift dynamics provide a mechanism to explain the differential recruitment success in these species. Larval pallid sturgeon drift for 11-17 days after hatching, and may be transported 435 km downstream after hatching. Larval shovelnose sturgeon have a shorter drift duration (6 days), and drift only 200 km downstream after hatching. Larval drift models suggest that an adequate length of river is not available downstream from suspected spawning areas currently used by pallid sturgeon to meet the larval drift requirements. Thus, if spawning occurs in the pallid sturgeon population, export of larvae to the downstream reservoir likely accounts for lack of survival and recruitment. In contrast, due to the shorter drift distance required by larval shovelnose sturgeon, sufficient river length is available to facilitate larval survival and recruitment.

Barriers to Prevent Non-Native Fish Movement: A Survey

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Barriers to non-native fish movement are important tools in the conservation of native fish species. Natural and manmade barriers provide protection to some of the last populations of native fish and barriers are frequently used to help restore a species to a larger portion of its native range. Barrier design, longevity, cost, and functionality vary, and those designing barriers often lack all of the information necessary to build the best barrier to meet their management needs. The goal of this project is make information about barrier designs and associated benefits and drawbacks easily accessible to fish managers. We surveyed barriers in six western states currently being used to prevent non-native fish movement. The falls barrier was found to be the most common type of barrier. Other types included mesh, perched culverts and velocity barriers. Results of this survey are stored in a database that can be accessed by the internet. An array of barrier designs has been entered into the database and has helped to expose gaps in the knowledge base necessary to construct effective barriers, such as the jumping performance of wild fish, proper barrier siting, and barrier designs that accommodate high and low discharge.

The Isolated Effection of Sunlight, Organic Matter, and Turbulence on the Piscicides Rotenone and Animycin

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Piscicide persistence in streams is perhaps the most pressing unknown factor associated with piscicide application. Sunlight, turbulence, and organic matter detoxify piscicides but their effects have not been studied in sufficient detail to recommend appropriate adjustments to application techniques. In the absence thereof, applicators commonly use higher than necessary concentrations of piscicides or overlap piscicide applications in water bodies where one or several of these environmental conditions might affect piscicide toxicity.

These practices result in wasteful use of piscicide and unnecessary invertebrate mortality. The objective of this study is to determine the isolated amount of exposure to sunlight, organic matter, and turbulence necessary for the piscicides rotenone and antimycin to become ineffective. We exposed water treated with rotenone or antimycin to a simulated environmental condition and determined the toxicity, after exposure, using a modified toxicity test. Fish were exposed to piscicide treated water for 8 hours, after which they were removed from piscicide treated water and dead fish were counted. The remaining fish were placed in fresh water and the number dead were counted every 24 hours for a period of 96 hours. Preliminary results indicated that even low levels of sunlight exposure significantly degrade piscicides.

Two and Three Dimensional Water Velocities in Culverts

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A full understanding of the challenges that fish encounter when navigating culverts requires adequate consideration of the diversity of water velocities that exist in the culvert barrel. Contemporary models and design tools are largely based on one-dimensional hydraulic computations. While the mean velocity in the culvert barrel is informative and will often suffice for conservative predictions of passage concerns, it does not adequately express the nuances of the system that may ultimately determine whether a given fish can pass through the culvert or not. This presentation is a progress report on two studies dealing with velocity diversity in culverts. We are modeling culverts located on Mulherin Creek, a tributary to the Yellowstone River near Gardiner, Montana, using three dimensional finite volume models (CFX running on the Ansys platform). Our goal is to determine the extent to which velocity diversity as measured at the culvert inlet perpetuates through the length of the culvert. We have measured several sets of three dimensional velocities in the field using an acoustic Doppler velocimeter that we will use to validate the computational model. With the model functional, geometric or boundary condition alterations can be imposed to determine if culverts can be made more hospitable for fish passage by intentionally causing diverse inlet velocities to propagate. A related study is to use field data and interpolation methods to determine just how many velocity measurements should be made to establish usable inlet boundary conditions for three dimensional modeling.

The evolution of fish, Science Education and Why We Should Care

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The evolution of fish bridges a span of roughly 200 million years from early multi-cellular invertebrates through land dwelling vertebrates. During the Devonian Period or "age of fishes" many different forms of fish evolved and many interesting examples of evolutionary processes are evident in fish today including sticklebacks, cichlids, guppies, cavefish, notothenioids and others. Theodosius Dobzhansky made the famous quote: "Nothing

in Biology makes sense except in the light of evolution." Evolution is a well-substantiated theory that has been described as the unifying concept of biology. Since Charles Darwin put forth his ideas about the theory of evolution and natural selection, acceptance has been mixed. The scientific community overwhelmingly accepts the theory; however, within the general population considerable skepticism exists. Most of this skepticism is rooted in the idea that the theory is in conflict or at least troublesome to some religious beliefs. Efforts to teach Creationism, Intelligent Design or alternatives to evolution can undermine quality science education.

Bozeman Fish Technology Center – A Multidimensional Research Facility

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The Bozeman Fish Technology Center (Center) is one of seven USDI Fish and Wildlife Service fish research centers. The Bozeman Center partners with several other research programs that includes the Aquatic Animal Drug Approval Program, USDA Agricultural Research Service Trout-Grains Program, Montana Microbial Products, a private company, Montana State University, and U.S. Geological Survey. The Center research has six areas of emphasis: (1) Traditional Fish Culture and Water Treatment Systems, (2) Fish Reproductive Physiology, (3) Pallid Sturgeon (Scaphirhynchus albus) Recovery, (4) Fish Nutrition and Feed Development, (5) Sensitive Fish Species Conservation, and (6) a newly initiated Aquatic Nuisance Species and Aquatic Ecosystem Health program. Through these programs the Center offers a unique opportunity to collaborate, offer technical assistance and answer cutting-edge questions to promote fisheries sciences.

Coalbed Natural Gas Development in the Powder River Basin: Implications for Warmwater Stream Fish Assemblages

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The Powder River Basin in Wyoming and Montana is currently undergoing one of the world's largest coalbed natural gas (CBNG) developments. Because CBNG development involves production and disposal of large quantities of coalbed ground water that differs from surface waters, potential exists for substantial effects on aquatic ecosystems. Coalbed natural gas product-water typically has high concentrations of dissolved solids, including elevated levels of sodium and bicarbonate ions. Information on chronic toxicity of CBNG product-water to warmwater fishes is lacking, presenting a substantial gap in predicting the effects of saline discharges in the Great Plains ecosystem. We employed three different approaches to determine the effects of coalbed natural gas development on fish assemblages in streams of the Powder River Basin in 2005. First, we compared fish assemblages in streams with CBNG development and streams without development. Second, we compared the longitudinal distribution patterns of fish assemblages at multiple points above and below CBNG development. Finally, we compared fish assemblages present in 2005 to fish survey data from the mid 1990s in areas with and without CBNG development. Streams in drainages

with CBNG development had an average of less than 4 species/stream whereas those without development had an average of 5.4 species/stream.

Changes Observed in the Spawning Population of Lake Trout of Yellowstone Lake After a Decade of Mechanical Removal Efforts

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Lake trout a predominantly piscivorous fish were officially documented in Yellowstone Lake in 1994. Yellowstone Lake contains the world's largest lentic population of Yellowstone cutthroat trout. Spawning run counts and index netting catch of Yellowstone cutthroat trout decreased steadily starting in 1990 and 1996 respectively. Bioenergetic research determined individual adult lake trout could eat an average of 42 cutthroat trout annually. To lessen the impact lake trout were having on cutthroat trout, efforts to mechanically remove lake trout began immediately after discovery in 1994 and continue at present. Age analysis using otoliths collected from lake trout captured on spawning grounds from 1997 through 2005 has shown the spawning population is relatively young and fast growing. Mature lake trout ranged in age from 6-21 years in 1998 and 4-17 years in 2005. During the August-October spawning season mean total length of mature lake trout caught on spawning grounds or staging areas has progressively decreased from 1996 to 2005; mature males from 601 to 517 mm, mature females from 675 to 555 mm. Excellent growth rates, relative young age at maturation, and few old fish indicate removal efforts are impacting this population.

Migratory Response of Bull Trout in the Clark Fork River Drainage Following Upstream Transport

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Electrofishing and a fish ladder/trap were used to capture 129 adult bull trout (*Salvelinus confluentus*) in the Clark Fork River downstream of Cabinet Gorge Dam, from 2001 through 2004. A portion of these fish were presumed to have migrated downstream as juveniles from Montana tributaries through or over the dam and reared in Lake Pend Orielle, Idaho. Captured adult bull trout were radio tagged, transported upstream, and released in Cabinet Gorge Reservoir, Montana. Of the 129 bull trout released in Montana, 78 were detected in tributaries to Cabinet Gorge Reservoir during the spawning season. Forty of the 129 bull trout were detected at Noxon Rapids Dam, the second dam on the Clark Fork River, with 70 percent (28) of these fish now known to have originated upstream of Noxon Rapids Dam. In 2004, a "Rapid Response Genetic Analysis" was employed to determine natal tributary of origin of captured fish prior to transport above Cabinet Gorge Dam. Genetic assignments to tributaries of origin were accomplished for most fish captured over the 4-year study period, with fish movements of transported fish now correlated to genetic assignment. Of the 112 viable

genetic samples collected below Cabinet Gorge Dam, 90 percent were assigned to upstream tributaries.

Sampling Efficiency for Burbot in Standing Waters of the Wind River Drainage, Wyoming

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Burbot are poorly understood by fishery managers in Wyoming, despite their importance as a native sportfish. Previous attempts to study burbot have been hindered by ineffective sampling techniques. We tested the efficiency of three different gear types (hoop net, cod trap, trammel net) for sampling burbot in lakes and reservoirs of the Wind River drainage. Hoop nets and cod traps have been used successfully to sample burbot in other states, but trammel nets have never been tested. We established three study areas to represent a diversity of standing water habitats, varying from a small, natural lake to a large reservoir. Within each study area, nine sampling sites were selected. Gears were randomly rotated through the sites, allowing each gear to fish at a site for one night during a three night period. We also evaluated seasonal differences in burbot sampling efficiency. Burbot are most active from late-autumn through early-spring, so we sampled each study area prior to ice-up in 2005 and replicated sampling soon after ice-out in 2006. This study is the initial step towards developing statewide sampling protocols for burbot in Wyoming and will lead to more detailed burbot population assessments.

Gathering and Using Information: Two Montana Projects Where Information Research Can Lead to On-The-Ground Wetland and Stream Protection

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As more and more people choose to build homes next to Montana's streams, rivers, lakes, and ponds, and as property values increase, the pressures to develop our state's wetlands and riparian areas are increasing—often to the detriment of fish and wildlife. Two research projects about Montana's wetlands and streams, how development projects impact those areas, and how to implement protection measures were developed to facilitate on-the-ground protection of these important resources. The first publication, A Planning Guide for Protecting Montana's Wetlands and Riparian Areas, explains how impacts to these areas can be avoided by land use planning decisions made at the local level. An overview of the handbook will be presented, along with examples of how communities in Montana have used the principals outlined in this book to protect stream and wetland resources. The second publication, Impacts of the 404 Permit Program on Wetlands and Waterways in Montana and Recommendations for Program Improvement, examines 13 years of information on Section 404 of the Clean Water Act, administered by the Army Corps of Engineers, to identify where and how development projects are impacting Montana's streams and wetlands.

Use of the Total Maximum Daily Load (TMDL) Process in Conservation of Fluvial Arctic Grayling, A Candidate for Protection Under the Endangered Species Act (ESA)

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Development of TMDL plans for impaired waters is a requirement of the Clean Water Act and supports the goal of restoring water quality to meet state standards and promote full support of beneficial uses. Among listed pollutants in the upper Big Hole River is temperature, which poses a considerable threat to a remnant population of fluvial Arctic grayling, a candidate for ESA listing. Factors contributing to warm water temperatures in the Big Hole River include chronic dewatering from irrigation withdrawals, removal of shade-producing willows, and associated changes in channel geometry. Targets included mean and maximum daily temperatures, shrub cover, stream flow, and width-to-depth ratios. Application of a thermal model indicated substantial decreases in mean and maximum daily temperatures were possible with target attainment. Allocations for thermal loading among the identified influential factors followed a performance-based approach that will provide adequate shading and flows, and suitable channel geometry to maintain cooler temperatures. Proposed restoration and monitoring activities build on agreements among federal and state agencies and landowners designed to promote grayling recovery in a working watershed. Specific restoration activities call for maintenance of flow targets, re-establishment of functioning shrub communities, channel restoration where warranted, and implementation of agricultural best management practices.

Distribution and Movement of Adult Yellowstone Cutthroat Trout in the Upper Yellowstone River Drainage

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Yellowstone cutthroat trout were historically the most widely distributed subspecies of cutthroat trout in the world, but now occupy less than 10 percent of their historic range. The largest remaining population of genetically pure, adfluvial Yellowstone cutthroat trout is found in the Yellowstone Lake basin. The Yellowstone River is the largest of 127 tributary streams in this system, providing over 30 percent of the water that enters Yellowstone Lake. While long-term data exists for several tributaries in the northern portion of the lake, prior to this study, no comprehensive fisheries assessment had been conducted on the upper Yellowstone River and its tributaries. We surgically implanted radio transmitters into 151 adult cutthroat trout in the Yellowstone River drainage. Fish were tracked weekly during the spawning season (May- Aug) and monthly for the rest of the year over a 3-year period. These data will be used to help determine the contribution of the upper Yellowstone River to the Yellowstone Lake cutthroat trout population and identify resident versus migratory populations of cutthroat trout within the system.

Automated Real Time Fish Tracking and Plant Operations Data Capture

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Fully automatic radio telemetry based systems are being used to simultaneously monitor fish movement and plant operations data to help support the development of effective fish passage strategies at a hydroelectric installation near Thompson Falls, Montana. Approximately 120 fish of varying ages, weights, and species, have been fitted with surgically implanted radio transmitters and released downstream from the plant. Fish location data are then gathered by an array of automated radio receiving stations that monitor individual fish movements. The plant SCADA system provides simultaneous operations data such as turbine flow, flashboard configuration, gate position data, lake levels, and other information. Automated systems download the data, perform additional processing, and then upload the results to a dedicated Internet site for user interactive display and analysis. An animation application was also written to incrementally display simultaneous plant operations and fish location data through time, so that analysts and designers can assess the behavior of fish based on plant operations and other physical conditions.

Restoring Pallid Sturgeon Populations in the Upper Missouri River Basin, Montana

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Pallid sturgeon (*Scaphirhynchus albus*) was listed as endangered throughout its range in 1990. Very few adult pallid sturgeon remain in Montana with about 160 individuals in Area 2 and < 50 individuals in Area 1. No significant recruitment has occurred in over 30 years. Stocking hatchery-reared pallid sturgeon back into these areas is a short-term goal of the Recovery Plan. Survival, growth and dispersal of hatchery-reared pallid sturgeon were monitored over the course of seven years to determine the effectiveness of the present stocking program. Survival rates for the five year-classes of stocked pallids could only be assessed for the 1997 year-class. The survival rate for this year-class after seven years in the wild was 42 percent and was 4 times greater than the stocking plan model predicted. The recaptured hatchery-reared pallid sturgeon grew at a surprisingly slow rate, averaging 38 mm year –1. Initial results of the stocking program will be used to make appropriate modifications so that anticipated goals will be met.

Extraction of Myxospores from Sediment Utilizing a Soil Texture Centrifuge Technique and Sodium Hexmtaphosphate

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Myxobolus cerebralis (causative agent of whirling disease) is the most intensively studied member of the phylum Myxozoa. Although there is much information about the

development of myxosporean spores, little is known about the movement of spores in water and their interactions with sediment. Varying quantities of sediment and stained myxospores were combined with aqueous sodium hexametaphosphate ($[NaPO_3]_6$). We were able to extract myxospores from all of the sediment and myxospore samples using a soil texture centrifuge technique to separate particles by density. The mean percent myxospore recovery declined as the quantity of sediment added to each sample increased. These results support previous research indicating that even small quantities of sediment in a sample can negatively affect myxospore extraction. The soil texture centrifuge technique used with aqueous $[NaPO_3]_6$ effectively isolated M. cerebralis myxospores from water samples with no sediment. This technique could be used to assess whirling disease infection levels in water samples without sediment.

Movement of Resident and Non-Resident Anglers in the Greater Yellowstone Ecosystem: Implications for Transferring Aquatic Nuisance Species

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Humans play an influential role in the transport of aquatic nuisance species throughout the world. Understanding the movement patterns of anglers in Montana will provide information regarding the potential transport of aquatic nuisance species among drainages, states, and globally. We surveyed anglers at access sites on the Beaverhead, Madison, Gallatin, Missouri, Yellowstone, and Bighorn Rivers in Montana from June through August of 2005. Anglers were asked questions regarding their most recent prior fishing trip, fishing trips in the past month, planned fishing trips in the coming week, and their state or country of residency. Of the anglers surveyed, 60 percent were Montana residents while 40 percent where non-residents. Non-residents represented 39 states and two foreign countries. Over half of all nonresidents surveyed had fished in at least one other state than Montana in the past month. The average distance traveled by Montana residents from their home zip code was 59.2 miles (± 67.1, [95% CI], $n = 112$). The average distance traveled by non-residents was 1526.4 miles (± 5,943.9, [95% CI], $n = 162$). Our results indicate that anglers in Montana are highly mobile and that increased angler awareness campaigns and access site monitoring could be of value in preventing the spread of aquatic nuisance species.

Effects of Exposure to Low Dissoved Oxygen on Survival, Development, and Growth of Snake River Fall Chinook Salmon Eggs and Alevins

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Fall Chinook salmon eggs were exposed to water temperatures of 15-16.5 °C at dissolved oxygen (DO) levels of 4-8 mg O_2/L, and 100-percent air-saturation. Water temperatures were immediately adjusted downward 0.2 °C/day while initial DO was adjusted upward 2 mg O_2/L on day 17 post-fertilization (PF). On day 39 PF, all embryos were moved to saturated DO to complete

development through emergence. Survival to emergence was greater than 83 percent for all treatments. At the lowest DO level, the eggs took 6-10 days longer to reach hatch and 13-24 days longer to reach emergence than eggs exposed at the same temperature to saturated DO. The yolk weight at emergence was higher from eggs initially exposed to saturated DO than in groups exposed to 4-8 mg/L DO (7.5 mg). Survival at low DO may have been possible by reducing metabolism and slowing growth. The consequence of this strategy is that emergence was significantly later for those fry that were initially exposed to low DO at the egg stage. Delaying emergence may be detrimental to fall Chinook salmon survival because late migrants encounter unsuitable conditions in downstream reservoirs that may reduce their probability of reaching the ocean.

Hydropower Relicensing Using the New Integrated Licensing Process: The Mystic Lake Example

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The Integrated Relicensing Process or ILP became the obligatory Federal Energy Regulatory Commission standard licensing process in 2005 for future relicensings. Although 13 ILP proceedings are in process, no Licensee has yet received a new FERC license under ILP rules. The ILP process differs from previous relicensing processes because the schedule of activities is rigorous and unforgiving. Disputes are resolved via an appointed dispute resolution panel with on a specified timeline. There are incentives for stakeholders to collaborate and participate early on. The Mystic Lake Project, owned and operated by PPL Montana, is in the first group of projects to undertake this new licensing process. I will use the Mystic Lake relicensing as an example to highlight some of the opportunties and potential pitfalls in the ILP process.

Influence of Discharge Patterns on Movement of Coastal Cutthroat Trout

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To understand physical and biological processes in headwater streams, we have been investigating distribution and movement patterns of coastal cutthroat trout in two watersheds in western Oregon since 2002. In each watershed, all pool and cascade habitat-types are surveyed annually using single-pass electrofishing, and cutthroat trout ^{3} 100 mm are implanted with a passive integrated transponder. A network of fix-station antennae recorded relocation information as fish pass by a station, and every 3 months continuous stream surveys using mobile antennas were conducted to relocate tagged trout.Flow and temperature are being measured throughout the stream network, and instantaneous sediment readings were collected during storm events. Resulting data provided new insights into the relationships between magnitude and timing of stream flows and patterns of fish movement in headwater streams. Specifically, we are investigating how the timing, magnitude, and duration of flow events influence fish movement and migration at the network scale. Relationships between movement and fish species, length, and location in the network are also being evaluated. This information is critical for assessing the passage effectiveness of existing crossing structures and will provide new insights into the design of future structures.

The Plight of the Pallid: The Cost of Living in an Endangered Ecosystem

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Although sturgeons have been in existence since the Mesozoic Era, currently many sturgeon species are in jeopardy of extinction. The pallid sturgeon was listed as endangered in 1990, however naturally recruiting populations remain in real danger of going extinct. We argue that no significant efforts have been made to resolve the fundamental ecosystem alterations that originally caused the decline of pallid sturgeon. For example, to date we have failed in addressing the most pressing "Actions needed" as listed in the 1993 Recovery Plan. Therefore, is there any reason to expect that our current trajectory will avert the pallid sturgeon's extinction? The rivers inhabited by pallid sturgeon will remain highly modified unless societal values change regarding dams and the services they provide versus services provided by naturally functioning large river ecosystems. Thus, society should be realistic about what can be expected regarding recovery of pallid sturgeon. We surmise the next era for pallid sturgeon will be the "Propagation Era" and we propose some ideas that will be necessary to cross the threshold into the "Recovery Era."

Determining the Appropriate Location for a Fish Passage Facility at a Complex Tailrace at a Western Montana Hydroelectric Facility

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Thompson Falls Dam located on the lower Clark Fork River, MT, is owned and operated by Pennsylvania Power and Light, Montana (PPL Montana). The dam consists of a complex arrangement of two separate powerhouses and dams. Due to presence of bull trout (Salvelinus confluentus) and westslope cutthroat trout (Oncorhynchus clarki lewisi) in the project area, PPLM is currently studying the feasibility of a fish passage facility at the project. We used radio telemetry to understand the ideal location for a permanent fish passage facility. In all, over 60 salmonids were tagged with coded radio telemetry transmitters between 2004 and 2005. Preliminary results indicate that even with many attraction flows in project area, migratory fish tend to travel to the most upstream area that they can navigate. Therefore, we believe that the main channel dam (the most upstream area) is the best alternative for a permanent fish passage facility. Studies in 2006 should lend valuable information on the specific location to construct the entrance to the future fishway.

Efforts to Reduce Lake Trout in Flathead Lake to Benefit Bull Trout

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Flathead Lake was once noted for its abundant bull trout population (*Salvelinus confluentus*). *Mysis relicta*, first documented in 1981, started a cascade of trophic shifts, including increased survival of lake trout. Predation by lake trout has restructured the fish assemblage and suppressed native trout. Montana Fish Wildlife and Parks and the Confederated Salish and Kootenai Tribes co-manage Flathead Lake and have chosen to reduce lake trout by means of public angling, even though lake trout represent over 80 percent of the fishery in most years. To achieve this goal, managers are employing liberalized regulations, i.e., two lines, a bag limit of 20, and fishing contests. Based on a lottery system, the contests target fish < 710 mm (TL). The contests change angler behavior by motivating them to catch and harvest 100 percent of their limits. Currently harvest in the contests had risen to equal about 25 percent of the annual harvest. Despite these successes, there are currently no strong indicators that the present level of harvest is reducing the lake trout population size. Managers are currently evaluating whether it is more prudent to stay the course with public angling as a tool for reducing lake trout numbers, or to employ another method of reduction.

Fish Screens: Efficacy and Population Effects on Skalkaho Creek, Montana

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Irrigation canal entrainment has largely eliminated migratory westslope cutthroat trout in Skalkaho Creek, a tributary of the Bitterroot River. Our goal is to determine the efficacy of fish screens recently installed in three of seven irrigation canals on Skalkaho Creek, and their effect on downstream migrating juvenile westslope cutthroat trout. The efficacy of screens at preventing entrainment of age-1 through 4 juveniles is quantified using half duplex PIT tags and PIT tag-detecting antennae. Fish screens were effective at precluding entrainment of PIT-tagged juveniles in 2005. The effect of screening on age-0 westslope cutthroat trout movements is determined by estimating the number of age-0 fish moving downstream above, between, and below the screened diversions. At unscreened diversions entrainment rates are quantified by estimating the numbers, and determining the fate of migratory fish that encounter these diversions using traps, half duplex PIT tags and PIT tag-detecting antennae. By quantifying fish screen efficacy, and gaining an understanding of the effects of screened and unscreened canals on downstream-migrating juveniles, we may determine whether the existing fish screens are an effective management tool for enhancing the migratory life-history strategy of westslope cutthroat trout in Skalkaho Creek or whether entrainment-preventing measures are required on remaining unscreened canals.

USDA Forest Service Northern Region Fish Passage Assessment at Stream/Road Crossings

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An assessment of aquatic passage at streams/road intersections in the Northern region is critical to address restoration needs for aquatic organisms. Fragmentation of fish populations is one of the key factors to address in recovery planning of threatened, endangered, and sensitive fish species including bull trout, steelhead salmon, Chinook salmon, westslope cutthroat trout and Yellowstone cutthroat trout. In 2002, the Northern Region identified the need for an assessment of stream crossings in the Region that were barriers to aquatic passage. This information was necessary to better define the issue in the Region and the anticipated program of work. This presentation summarizes survey efforts for aquatic passage in the Northern Region from 2002 to 2004 when > $750,000 was spent inventorying culverts at potential fish-bearing stream and road crossings. These surveys were performed primarily on Forest System roads and do not represent private, state, and county roads systems. Surveys were conducted using the guidelines of the National Inventory and Assessment Procedure for Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings (Clarkin et. al. 2003). Data are stored in an Access Database located at each Forest/Grassland and also available on the Regional Aquatic Organism Passage intranet website (http://fsweb.r1.fs.fed. us/wildlife/wwfrp/fisheries/Fish_Passage_Web_Page.htm). These data have been aggregated to determine the extent of fish passage issues. Approximately 2800 culverts have been inventoried and assessed for fish passage within the Northern Region and their results are summarized for adult and juvenile salmonids. The adult results indicate that approximately 80 percent of the inventoried crossings in the region are an upstream barrier to migrating fish during some timeframe throughout the year, 13 percent are indeterminate (Gray), and seven percent are not considered barriers. Results for juveniles were similar to the adults in that 84 percent are barriers, 9 percent were indeterminate, and 7 percent were passable. The Lolo National Forest completed a hydraulic assessment for their Gray culverts and used calculated flow values with the FishXing program. FishXing determined that approximately 80 and 20 percent of the Gray culverts (~ 45) turned to Red and Green, respectively. Although a small sample, it gives an idea of what Gray pipes from other Forests may be determined if flows were calculated and run through FishXing.

Effects of Sediment Pulses on Channel Morphology and Sediment Transport in a Gravel-Bed River

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Sediment delivery to stream channels in mountainous basins is strongly episodic with large inputs of sediment typically delivered by infrequent landslides and debris flows. Identifying the role of large but rare sediment delivery events in the evolution of channel morphologies and fluvial sediment transport is crucial to an understanding of the development of mountain basins. In July of 2001, intense rainfall triggered numerous debris flows in the severely burnt Sleeping Child watershed, Sapphire Mountains, Montana. Ten large debris flow fans were deposited on the valley floor. Investigations focused on the channel response

to the large input of sediment. The channel has aggraded immediately upstream of the fans, and braided in reaches immediately downstream. Channel incisement through the fans has created sets of coarse-grained terraces. The deposition upstream of the pulses consists almost exclusively of fine material resulting in a median bed material size (D50) 1-2 orders of magnitude lower than the ambient channel material. The volume of sand being transported is so great that these aggrading reaches can extend hundreds of meters upstream of the pulses with 1-2 meters of sand deposited across the entire valley floor. In a 10-km study reach with 10 debris flow fans, cross section surveys, longitudinal profiles, and pebble counts chronicle channel response to a major increase in sediment supply and provide insight on the processes of sediment wave dispersal.

Distribution and Relative Abundance of Burbot in the Upper Missouri River, Montana

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A paucity of information exists on the basic ecology of burbot in the Upper Missouri River. The primary objective of this study was to determine the relative abundance of burbot on a spatial scale in the Missouri River from Holter Dam to Black Eagle Dam in northcentral Montana—a 142-km reach of river. Secondary objectives were to determine exploitation, movement, size structure, and body condition. The study area was divided into eight 17.8-km reaches. Reaches were randomly selected from the upper and lower half of the river weekly; all reaches were sampled in March 2005 and 2006. Six hoop nets were fished systematically so that both sides of the river were sampled for a 2-night period every 2 km in each reach. When suitable backwater habitat existed, one cod trap was fished for three 2-night periods within each reach. Sampled burbot were tagged with a Floy tag and a PIT tag. A spatial density gradient exists within the river, where burbot density is highest near Holter Dam and progressively decreases downstream. For example, average hoop net CPUE in 2005 was 2.44 in the upper half of the study area compared to 0.48 in the lower half of the study area.

The Effect of Macro-Scale Habitat Features on Post-Stocking Dispersal of Hatchery-Reared Juvenile Pallid Sturgeon

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Although there is evidence that pallid sturgeon (*Scaphirhynchus albus*) may successfully spawn in the Yellowstone River below Intake Diversion (river kilometer 115), long downstream drift times following hatching preclude recruitment; larval pallid sturgeon likely drift into Sakakawea Reservoir and die. Therefore, establishing spawning populations far

upstream of reservoirs is necessary if natural recruitment is to occur. However, no stocking has occurred above Intake Diversion partly because these habitats were considered unsuitable; pallid sturgeon are thought to prefer habitats with more complex channel patterns, lower gradients, and sand substrates. To assess suitability of the Yellowstone River above Intake Diversion, post-stocking dispersal patterns of telemetered juvenile hatchery-reared pallid sturgeon released below Cartersville Diversion (rkm 379) were compared to those of fish released below Intake Diversion. Cartersville Diversion fish dispersed further downstream (229 km) than Intake Diversion fish (38 km), although half of the Cartersville Diversion fish remained above Intake Diversion. Most fish dispersed to reaches in river breaks ecoregions that had complex (anabranching or meandering/islands) channel patterns. Fish were evenly distributed between higher gradient (0.000551) cobble-gravel reaches and lower gradient (0.000189) fines-sand reaches. Initial results suggest that parts of the Yellowstone River upstream of Intake Diversion are suitable for pallid sturgeon stocking.

Influences of Reach- and Watershed-Scale Habitat Features on Fish Distribution in Streams in the Great Plains of Montana

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The prairie biome has become one of the most endangered regions in North America. Consequently, the chance of extinction for many prairie fishes is greater than fishes of other regions; however, prairie streams and fishes have been largely ignored until recently due to a lack of angler interest in these species. In order to effectively conserve fishes, managers must first have insight into the ecology of the species and how communities of fishes may be impacted by natural and human-induced disturbances. This study examines small warmwater streams of the Great Plains of Montana in depth and specifically focuses on how physicochemical, biotic, and watershed-scale characteristics influence the distribution of species and trophic and reproductive guilds are influenced by environmental gradients at the reach and watershed scale. Comparisons of individual species models produced somewhat unexpected results in that no single type of variable (physicochemical, biotic, or watershed) was superior in explaining species distributions. However, these comparisons did highlight the importance of biotic interactions in prairie streams and how they may influence the persistence of prairie fishes. This study provides information into the ecology of fishes of small Great Plains streams but also highlights a need for further research of these systems.

Factors Influencing Variation in Scale-Based Ages of Cuttrhoat Trout from Yellowstone Lake

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Reliable assignment of age to fishes is important for estimation of age-class abundances. As part of an ongoing investigation of the historic environment-recruitment relations for Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) (YCT) in Yellowstone Lake, the extensive time series (spanning 35 years) of scale-based YCT ages was examined. The YCT were caught during September in gill nets used to annually monitor the YCT population at 11 lake sites. Multiple regression revealed that variation in mean total length at capture of YCT, considered age-2 or age-3 on the basis of scale annuli, was attributable to lake site and environmental effects as well as scale-reader error. Logistic regression models based on these key effects correctly classified ~90 percent of the age-2 and age-3 YCT to their scale based ages and provided an objective means of assigning ages to YCT whose scale-based ages were otherwise questionable or only their length at capture and netting site were known. The resulting data set is more reliable and extensive than its predecessor, particularly for the recruitment age classes , i.e., age-2 and age-3, of YCT whose abundances will be key response variables in subsequent analyses of historic environment-recruitment relations for the population.

Effects of Temperature on Egg Development and Larvae Survival of Shovelnose Sturgeon

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Understanding the developmental biology and thermal requirements of shovelnose sturgeon (*Scaphirhynchus platorynchus*) early life stages has hatchery rearing implications and may increase our ability to manage and protect habitat to ensure their persistence. All fish species have a preferred temperature range for egg incubation within which egg survival is high. Temperatures outside the optimum impede normal cellular functions resulting in abnormality and death. Temperature tolerances of early life stages are more limited than those of older fish, and reproduction and stock recruitment are the most vulnerable phases of sturgeon life history. Temperature ranges tolerated by fish eggs and larvae are related to adult distribution in the wild. The laboratory study we performed was designed to determine the optimal incubation temperature range for development and survival of eggs and larvae, determine threshold temperatures that impede survival, and determine egg developmental rates. We incubated shovelnose sturgeon eggs at 8, 12, 16, 20, 24, and 28 °C. Developmental rates are discussed and compared to other sturgeon species. Egg development ceased and mortality was 100 percent for eggs incubated at 8 and 28 °C. Survival was highest at temperature from 12 – 20 °C and optimal temperature range appears to be between 16 and 20 °C.

Determination of Thermal Optima and Tolerance for Young-of-the-Year Shovelnose Sturgeon Growth and

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Shovelnose sturgeon (*Scaphirhynchus platorynchus*) are considered abundant in Montana in the Missouri River and smaller tributaries, but their numbers have been significantly reduced throughout the lower Missouri and Mississippi. Water temperature plays a key role in determining the persistence of this species, however specific thermal optima and tolerances are not known. We performed a replicated lab experiment that exposed juvenile shovelnose sturgeon to twelve temperatures ranging from 8 to 30 °C at 2 degree intervals to determine the specific thermal optima for growth and survival. This study has important implications to understanding the life history of shovelnose sturgeon in the wild and significant hatchery implications. The thermal requirements established in this work may help protect habitat critical to the species and guide restoration efforts, such as determining temperature regime requirements for regulated and hydroelectric impacted rivers and establishing new guidelines for conservation propagation. By reducing thermal stress in hatcheries, we can increase growth, decrease incidence of disease and infection, and produce healthier fish that are more suited to survival upon release. The information we present will also be relevant to pallid sturgeon recovery initiatives and may help explain why shovelnose sturgeon thrive while pallid sturgeon remain threatened in the same rivers.

Analysis of Potential Mitigation Efforts and Harvest Effects on a White Sturgeon Population Using Extinction Risk and Biomass Dynamic Models

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Fishery managers are determining methods to recover the Hells Canyon Snake River white sturgeon population. This population has been impacted by over fishing and habitat alterations. Harvest restrictions have been in effect for thirty years but recovery has not met managers' expectations. Managers are interested in knowing if the current population can sustain a larger harvest and, if not, what the best mitigation strategies are to achieve this goal. Studies to determine abundance and structure of this population were performed beginning in the 1970's with the latest performed from 1997- 2001. Though methods for these population estimates differ and parameter uncertainty around this population is variable, this is the best information available to analyze this population. We fitted Hells Canyon Snake River sturgeon population estimates to a Logistic Model estimating intrinsic growth rate and the carrying capacity. Using the parameter estimates obtained from the logistic model fitting, and looking at both deterministic and stochastic estimates of population size over the next 50 years, we assessed maximum sustainable harvest levels that would allow the population to persist. We evaluated extinction risk for this population over the next 50 years and examined the effects mitigation actions might have on population persistence.

Wild Fish Habitat Initiative

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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. Habitat degradation 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. A critical national effort towards the restoration of important fish and wildlife habitat is the Partners for Fish and Wildlife Program, administered by the USDI Fish and Wildlife Service. This voluntary program provides financial and technical assistance to private landowners interested in restoring habitat on their lands. The Wild Fish Habitat Initiative seeks to augment the Partners Program and other programs by conducting targeted research related to habitat restoration techniques, by implementing a technology transfer program to provide technical information to land owners and project managers, and by collating information on habitat restoration projects completed within the intermountain west. The Wild Fish Habitat Initiative began in summer 2002 with a grant from the US USDI Fish and Wildlife Service to the Montana Water Center. It is being carried out by Montana State University biologists in collaboration with several private- and public-agency biologists.

Evaluation of Thermal Requirements for June Sucker Propagation

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A laboratory study was conducted to monitor June sucker (*Chasmistes liorus*) performance when reared at an average of approximately 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, and 30 °C for 16 weeks. The June sucker is an endangered fish native to Utah Lake, UT. A meeting was held in November, 2004 to discuss and prioritize June sucker propagation issues. Rearing temperature was identified as a key component necessary for the design of a new June sucker hatchery and for achieving the June Sucker Recovery Implementation Program supplementation goal of 350,000 8-in fish annually. In this study weight gain, mortality, and feed efficiency were affected by water temperature with 21.9 °C being the optimum for June sucker growth using quadratic regression analysis. The acclimated chronic exposure water temperature (50% survival for 60 days) exceeded 27.9 °C. Deformities did increase during this study but did not appear to be temperature related. Continued research is needed on other propagation issues such as diets for different life stages, deformities, and spawning and reproductive physiology requirements. This data may be applicable for the propagation and habitat requirements of other Chasmistes spp.

Hybridization Between Westslope Cutthroat Trout and Rainbow Trout in an Area of Natural Sympatry: The Kootenai River Drainage, USA

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Trout populations (n = 103) in the Kootenai River drainage were determined to be native westslope cutthroat trout (38), native redband trout (36), or hybrid swarms between rainbow (coastal rainbow and/or redband) and westslope cutthroat trout (29) using data from four diagnostic allozyme loci. There are no known diagnostic allozyme loci between redband and coastal rainbow trout. Coastal rainbow trout populations, however, generally have lower LDH-B2*76 and higher sSOD-1*152 frequencies than redband trout populations. A higher proportion of coastal rainbow trout populations (80%) possess sSOD-1*152 than redband populations (50%). Therefore, if coastal rainbow trout had a significant genetic contribution to hybrid swarms, three trends should be apparent in the data: 1) a higher proportion of hybrid swarms should possess sSOD-1*152 than redband populations, 2) on the average hybrid swarms should have lower LDH-B2*76 and higher sSOD-1*152 frequencies than redband populations, and 3) when hybrid swarms are included with redband populations there should be a negative correlation between the LDH-B2*76 and sSOD-1*152 frequencies. All three trends were observed in the data indicating that the introduction of coastal rainbow trout is the likely mechanism for the breakdown of reproductive isolation between westslope cutthroat and redband trout in the Kootenai River drainage.

Expanding Management Objectives with Baseline Surveys– You Can't Always Get What you What, But... Yellowstone Cutthroat Trout vs. Finespotted Cutthroat Trout in the Snake River Headwaters

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A multi-year survey of the Snake River headwaters attempted to delineate the distribution of Yellowstone cutthroat trout and the closely-related Snake River fine-spotted cutthroat trout in the watershed by assigning individual fish to their respective subspecies based on their spotting patterns. Although most of the specimens had typical Yellowstone cutthroat trout features and a few trout appeared to be the classic fine-spotted form, numerous individuals exhibited an intermediate pattern that yielded equivocal classification. Results suggest that either the fine-spotted form is extremely rare upstream from Jackson Lake, or the predefined field classification criteria do not consistently distinguish between the two subspecies. However, several results unrelated to the original study objectives were obtained during the survey. Among these were: persistence of a Yellowstone cutthroat trout isolate population in

an intensely burned watershed; widespread distribution of mottled sculpins upstream from apparent barriers; and restricted distribution of non-native species, including brown trout and brook trout, despite the absence of barriers to upstream movement. Only limited anecdotal historical information exists with which to compare the current survey; yet these results indicate that systematic inventories of the occupied length of stream may yield additional management considerations beyond the scope of the original survey objectives.

Temperature and Competition Between Bull Trout and Brook Trout: A Test of the Elevation Refuge Hypothesis

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We tested the elevation refuge hypothesis that colder temperatures impart a competitive advantage to bull trout (*Salvelinus confluentus*) thus accounting for increased biotic resistance to invasion by brook trout (*Salvelinus fontinalis*) in headwater streams. Growth, survival, and behavior were compared in allopatry and sympatry at temperatures of 8 to 20 °C in the laboratory. In allopatry, bull trout and brook trout grew at similar rates at temperatures of 8.0 to 14.5 °C, but brook trout grew significantly faster at higher temperatures. In sympatry, bull trout grew significantly less than brook trout at all test temperatures, with growth differences increasing linearly with increased temperature. Bull trout feeding and aggression rates were significantly less when sympatric with brook trout at 8 and 16°C whereas bull trout had no effect on feeding and aggression in brook trout. Modeled growth based on tributary temperature data from a high (10 °C mean summer temperature) and low elevation site (14.5 °C) was similar for both species in allopatry. However, brook trout achieved much greater size than bull trout in sympatry, particularly at the warm site where predicted size of brook trout was 21.7 mm (23%) greater in length and 4.9 g (60%) greater in weight. Brook trout have a marked behavioral and physiological advantage over bull trout at warmer temperatures, but the evidence was equivocal for bull trout gaining a similar advantage over brook trout at colder temperatures.

Fish Assemblages of Glacier National Park, Montana

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Little information is available related to the distribution of fishes among lakes within Glacier National Park, Montana. The distribution of sport fishes among park lakes draining into the Flathead River system has received some attention; however, sampling efforts have rarely targeted non-game species. Fish assemblages were sampled in 17 lakes in Glacier

National Park using multiple sampling methods, including experimental gill nets, backpack electrofishing, and hook and line. A total of 5,742 fish comprised of 15 species were sampled, including native and nonnative species that have invaded from downstream sources in the Flathead drainage, e.g., lake trout Salvelinus namaycush, or that were intentionally introduced, e.g., brook trout S. fontinalis. Fish assemblages varied from monospecific, e. g., Upper Kintla Lake, to lakes containing at least 12 fish species, e.g., Lake McDonald. Use of multiple sampling methods often resulted in detection of more species within a lake than would have been detected using a single method. Additionally, some fish species were detected in waters where they had not previously been reported. These data provide baseline distribution data for park waters draining into the Flathead River system and may be used to develop sampling protocols for monitoring fish species assemblages within Glacier National Park.

Effects of Lake Trout Presence and Lake Morphometry on the Relative Abundance of Adfluvial Bull Trout in Glacier National Park, Montana

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The relative abundance of adfluvial bull trout (*Salvelinus confluentus*) was compared between lakes invaded by and not invaded by nonnative lake trout (S. namaycush). Bull trout catch per unit effort (C/f) and lake trout presence were determined by experimental gill nets set overnight in 14 lakes in Glacier National Park, Montana. Bull trout C/f was greater and more variable in lakes not invaded by lake trout (2.5 ± 3.1 bull trout per net night; mean ± one standard deviation) than in lakes invaded by lake trout (0.6 ± 0.7). Bull trout C/f was related to lake trout presence and lake surface area. Bull trout C/f remained relatively low and consistent among lakes invaded by lake trout; however, bull trout C/f increased with increasing lake surface area among lakes not invaded by lake trout. These data indicate that invasion by nonnative lake trout may result in maintenance of bull trout populations at numbers below that which may be possible in lakes not invaded by lake trout.

Observer Error Structure in Bull Trout Redd Counts in Monana Streams: Implications for Inference on True Redd Numbers

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Despite the widespread use of redd counts to monitor trends in salmonid populations,

few studies have evaluated the uncertainties in observed counts. We assessed variability in migratory bull trout (*Salvelinus confluentus*) redd counts among experienced observers in Lion and Goat creeks, tributaries to the Swan River, Montana. We documented substantially lower observer variability in bull trout redd counts than previous studies. Observer counts ranged from 78 percent of our best estimates of true redd numbers in Lion Creek and from 90 to 130 percent Creek. Observers made both errors of omission and errors of false identification, and we modeled this combination using a binomial probability of detection and a Poisson count distribution of false identifications. Redd detection probabilities were high (mean = 83%) and exhibited no significant variation among observers (SD = 8%). We applied this error structure to annual redd counts in the Swan River basin (1982-2004) to correct for observer error and thus derived more accurate estimates of redd numbers and associated confidence intervals. Our results indicate that bias in redd counts may be reduced, if experienced observers are used to conduct annual redd counts. Future studies should assess both sources of observer error to increase the validity of using redd counts to infer true redd numbers in different basins. This information will help fisheries biologists to more precisely monitor population trends, identify recovery and extinction thresholds for conservation and recovery programs, ascertain and predict how management actions influence distribution and abundance, and examine effects of recovery and restoration activities.

Spatiotemporal Variation of Fish Assemblages in Montana Prairie Streams

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Information on the spatiotemporal variation of fish assemblages in Montana prairie streams is needed to better understand the ecosystem and to enable managers to design more efficient sampling regimes. To assess spatial variation in fish assemblages, we sampled fishes from five streams at nine or ten (dependent on access and permission) longitudinal sites per stream arrayed from the confluence to the headwaters during June and July 2005. To assess temporal variation, a downstream, middle, and headwater site was sampled on each of the five streams in June, July, August, and October 2005, and February and April 2006. Species richness generally decreased from downstream to upstream sites, whether assessing all species or only large river guild species. Increases in species richness at downstream sites may be associated with high flow events. Future evaluations will focus on the spatiotemporal variation of species composition and its relationship to longitudinal position, season, watershed size, and habitat variables.

Historical Distribution of Pallid Sturgeon in the Yellowstone River: An Oral Retrospective

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Historical distributions and abundances of pallid sturgeon (*Scaphirhynchus albus*) in the Yellowstone River were unknown; sampling efforts targeting pallid sturgeon did

not occur until the species was listed as endangered in 1990 although factors believed to cause population declines (mainstem diversion dams, impoundment and flow alteration of tributaries) occurred as early as 1905. Recovery efforts are focused on restoring pallid sturgeon to reaches where they historically occurred; however, the only existing information on historical distributions and abundances was in the form of the experiences and photographs of anglers. An accurate account of historical distributions and subsequent declines was needed to better understand restoration potential. Therefore, a timeline of pallid sturgeon encounters was developed by interviewing anglers that captured and photographed pallid sturgeon in the Yellowstone River.

Assessment of Post-Stocking Dispersal of Age-1 Pallid Sturgeon: Implications for Acclimation

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A propagation program for pallid sturgeon (*Scaphirhynchus albus*) in the upper Missouri River was implemented by the U. S. Fish and Wildlife Service in 1997. However, evidence suggested that many hatchery-reared pallid sturgeon were experiencing significant downstream post-stocking dispersal, negatively affecting the population. Therefore, the objective of this study was to evaluate the effects of acclimation to flow and site-specific water conditions on post-stocking dispersal. Fish from three acclimation treatments were radio-tagged, released at two locations, and monitored using passive remote telemetry stations. Treatment 1 fish were acclimated to flow and site specific water conditions for 35 d in tanks on the Marias River, treatment 2 fish were acclimated in cages in the Marias River for 3 d, and treatment 3 fish were reared with no acclimation at the Bozeman Fish Technology Center. Treatment 2 fish experienced 100 percent mortality. Pallid sturgeon from treatment 1 and 3 drifted less in the lower reaches of the study area where more sand substrate is present. Treatment 1 fish drifted less than treatment 3 fish, experienced lower mortality and nearly twice as many remained in suitable pallid sturgeon habitat. These preliminary data suggest that acclimation can reduce post-stocking dispersal.

Multi-Agency Effort to Prioritize Habitat Restoration and Protection Projects for Native Salmonids in Large Management Areas

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Avista Corporation (Avista) has an aquatic protection, mitigation, and enhancement program for the Clark Fork River Hydroelectric Project on the lower Clark Fork River and its tributaries in Montana and Idaho. Avista's aquatic program is implemented cooperatively by an Aquatic Implementation Team (AIT) consisting of Montana Fish, Wildlife and Parks; Idaho Department of Fish and Game; the USDI Fish and Wildlife Service; and Avista. The AIT initiated a project to 1) summarize the existing data on fish populations and habitat

conditions in tributary streams and 2) prioritize watersheds for future habitat protection and restoration. The team developed criteria to prioritize protection/restoration projects for the lower Clark Fork River drainage at multiple spatial scales, based on a philosophy of 'protect the best first.' This project combined professional knowledge and available data to rank current population and habitat conditions in the drainage. This prioritization allows programs to proceed in a logical order. The ability to prioritize future projects is an important tool for all managers attempting to allocate limited funds and receive maximum biological benefits that are consistent with management goals and objectives. This project provides a template for prioritization that could be adapted to other locations with differing resource management objectives.

Chinook Salmon Fish Health Challenges

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Managing Chinook salmon fisheries in the mid-Missouri River reservoirs of Montana, North Dakota and South Dakota presents significant fish health challenges for fisheries managers. Disease considerations associated with Pacific Chinook salmon stocks have prevented fisheries managers from using salmon from the Pacific northwest as a source of salmon for the Missouri River reservoirs. Chinook salmon from the Great Lakes represented less disease risk and were selected for stocking into the Missouri River reservoirs. However, fish pathogens, such as Renibacterium salmoninarum, the bacteria responsible for bacterial kidney disease, are also a concern with the Great Lakes fish, and fisheries managers must evaluate this risk when considering the benefits Chinook salmon bring to the fisheries of these reservoirs. Fish health issues in the Great Lakes in the early 1980s made importation of Chinook salmon into Montana very difficult. Given changes in laws and regulations, importation of salmon into Montana from the Great Lakes would be much more difficult today. Annual spawning, egg distribution and fish stocking operations depend on results of annual health testing conducted during spawning. Fish health inspections have not detected pathogens of concern in Missouri River Chinook salmon populations, indicating these fish are among the most pathogen-free stocks in the United States. However, detection of specific pathogens of concern may hinder future imports of salmon into any of the three states, or into any of the reservoirs.

Biologic Assessment of Rivers and Streams Using Multimetric Indices: Methods and Applications

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The development of multimetric indices using benthic invertebrate organisms as bioassessment tools in Western North America was reviewed. An overview of recommended methods for testing metrics for their usefulness in assessing habitat conditions and water quality was given. I included the current status of these indices and their applications and various study designs and made comparisons between various field sampling techniques employed in the Western U.S.

Effects of Road Culverts on Eastern Montana Prairie Fish Assemblages: Initial Results

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Road culverts can serve as obstacles to fish migrating between seasonal habitats. Development of new roads, as well as repair and upgrade of existing roads has led to research addressing the effects culverts have on fish populations. Much of this research has focused on salmonid species in mountain stream systems, but the total effect road culverts have on species continuity in small, prairie streams remains largely unknown. Because many of the diverse number of fish species found in prairie streams are small bodied, and likely poor swimmers, culverts may act as significant barriers to passage via high outlet drops, high water velocities, and insufficient water depth. Fish passage on several tributaries of the Yellowstone River with a variety of culvert crossings were examined in this study. Passage abilities of prairie fish species were assessed indirectly using software models and directly through the use of mark-recapture experiments. In the first year of this study, we observed diverse fish assemblages with little difference in species composition above and below the culvert crossings studied. Upstream movement through natural reaches as well as culverts was documented for six species of fish. The goal of the study was to identify culvert characteristics that restrict fish passage during the range of flow conditions present in prairie streams from spring to fall and identify species that may be particularly sensitive to fish passage restriction.

Western Native Fishes Database: An Update on the Project

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The Western Native Fishes Database is a project developed by the Native Species Committee of the Western Division of the American Fisheries Society (WDAFS). The goal of the project is to compile accurate information on approximately 300 fish species native to western North America including the Canadian Provinces of British Columbia and Yukon; the Sonoran, Chihuahuan, and Baja California Norte States of Mexico; and the United States that include, or are west of, the continental divide; and Hawaii. Garcia and Associates (GANDA) completed the database design in the summer of 2004, and the data entry for the United States in 2005. The database was distributed for its initial review in early 2006. The database can be queried by species, region, or HUC. The WDAFS envisions the database being used to track regional status of native fishes and to assist agencies and biologists in developing management plans that extend beyond political boundaries. The purpose of this presentation is to show the progress made on the database, describe the data gathering and review processes, and solicit input on how to tailor the final product. We will also present representative data on declining fish populations.

Fort Peck Chinook Salmon

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Success of a Fort Peck Reservoir Chinook program is highly desired by the public due to the potential of catching large salmon. Consistency in egg collection and providing harvestable returns to anglers has been a difficult objective to meet, with only 3 good returns since 1983. Adjustments in stocking numbers, size at time of release, release strategies and management strategies have not improved returns to the creel or egg collection in the last 5 years. Chinook salmon were initially stocked into Fort Peck Reservoir in 1983. Until 1994, stocking relied solely on availability of eggs or fish from North and South Dakota. In 1994 and the seven subsequent years between 1994 and 2005, Montana had only three successful egg takes that produced more than 200,000 green eggs. Both unsuccessful egg collecting and shortfalls in rearing space throughout Montana's hatchery system may be resolved with completion of the new Fort Peck Hatchery. Fort Peck Hatchery will provide rearing space, close proximity to the reservoir, and options to raise larger sizes and numbers of Chinook, resulting in management and stocking alternatives that haven't been available to provide a stockable Chinook that will survive to adult size.

Cutthroat Trout Restoration on Yellowstone's Northern Range

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Growing concern over the status of Yellowstone cutthroat trout within Yellowstone Lake has led park managers to seek the potential for restoration of this subspecies within watersheds of the park outside of the lake basin. These efforts are focused on Yellowstone's Northern Range, including the Yellowstone River and all of its sub-watersheds downstream of the Lower Falls at Canyon. A paucity of data concerning many of the small headwater streams, and a need to centralize the data that do exist, have previously limited our complete understanding of Yellowstone cutthroat trout status on the Northern Range. We aim to improve our understanding by combining historical records with contemporary field surveys from an effort begun in 2005. Each watershed is being classified by multiple factors, including basin size, potential for metapopulation processes, presence of existing instream barriers, trail access and other logistical factors, and the educational/interpretive value that each may provide. Watersheds will be prioritized to identify those that provide the highest probability for restoration success and overall value to the Northern Range initiative. The results will guide Yellowstone cutthroat trout restoration efforts in Yellowstone National Park in future years.

Life History and the Costs of Reproduction in Yellowstone-Sakakawea Paddlefish Stock

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Investigations on the Yellowstone-Sakakawea stock of paddlefish (*Polyodon spathula*) in eastern Montana and western North Dakota conducted during 1991-2004 have provided information on fish size, population age structure, age-at-maturity, longevity, growth rates, reproductive periodicity, fecundity, energy reserves, migration patterns, mortality rates, and senescence to characterize the life history in relation to the costs of reproduction. Life histories of males and females diverge between age-5 and age-10 as males divert energy and production away from somatic growth into sexual maturation. Females of the same brood year grow more rapidly than their male counterparts until age- 13 or age-14, when they begin to divert energy and production away from somatic growth and into sexual maturation. At the time of their first upstream spawning migration, both sexes have mature gonads with attached gonadal fat bodies, which function in energy storage much like a capacitor. Increases in fecundity among young adults of both sexes are concurrent with decreases in the weight of gonadal fat bodies. Males typically spawn every 1 or 2 years and deplete gonadal fat reserves gradually over several spawning cycles. Females typically spawn every 2 or 3 years and deplete fat over two to three spawning cycles, largely exhausting it by age-25. Energetic and migration results conform with the idea that middle-age and older paddlefish are the most effective spawners. The general life history pattern of growth and energy accumulation early in life, followed by maturation, reproduction, energy depletion and senescence appears to exist widely among Chondrostean fishes, and may exist in many other fishes as well.

Watch It He's Angry: Movements of Little, Individual Trout in Response to Electrofishing

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Estimating abundance is fundamental to enlightened management and ecological understanding of stream fishes. Commonly used estimators assume that fish do not leave sample sections; movement would lead to biased measures of abundance. To prevent fish movement, biologists often install block nets at the boundaries of sampling reaches, which is time-consuming, may be logistically impossible, and detracts from effort that could be invested in sampling additional areas. We individually electrofished 124 trout (ca. 125 mm) of three species implanted with radio transmitters in six small, montane streams in western Montana to quantify movement and the influence of habitat. Most fish (60%) remained in a habitat unit when electrofishing commenced, and only 10 percent moved more than two habitat units. Forty-three percent were captured on the first electrofishing pass, and all fish were eventually recaptured. Capture efficiency was lower in the largest stream sampled, but

there were no differences among other streams or species. Habitat variables including water depth, substrate size, and percent cover did not explain fish movement nor capture probability. These data help define the level of bias in estimates of fish abundance produced by fish movement and will help define parameters to monitor fish densities.

Conservation of Westslope Cutthroat Trout by Removal of Brook Trout Using Electrofishing

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From 1995 to 2004 we employed repeated electrofishing to remove nonnative brook trout(Salvelinus confluentus) from approximately 15.2 km in six streams to conserve sympatric, native westslope cutthroat trout. We successfully eradicated brook trout from 10.7 km in four of these streams. In the two other streams we suppressed brook trout, but dense riparian vegetation, beaver dams, and abundant woody debris prevented us from eradicating them. Costs to eradicate nonnative trout using electrofishing were similar to costs estimated for piscicide treatments. Electrofishing eradication may be preferred in locations where native fish are sympatric with nonnative fish because most of the native fish can be saved during removal efforts. We recommend conducting at least six removal treatments of two to three passes per treatment within two to three years, targeting mature adults during the first year, trampling nonnative redds, conducting at least one removal during late fall or early winter period, and eradicating adults first, then focusing on the smaller fish (age-0 and age-1). Fish barriers must be installed at lower boundaries of treatment areas to prevent re-invasion of nonnative fish. Native cutthroat trout populations responded positively to brook trout removal, but this response often took two to three years.

Use of Half Duplex Pit Tags to Assess the Probability of Culvert Passage of Yellowstone Cutthroat Trout and Rainbow Trout

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Culverts at road crossings are known to present possible passage barriers during salmonid migration. Yet existing models used to predict passage have not been sufficiently tested, particularly for non-anadromous species. Most existing evaluations give "yes" or "no" answers to passage questions when an estimate of the probability of passage under a given set of hydraulic conditions may be more useful. We utilized Passive Integrated Transponder (PIT) tags to examine the probability of Yellowstone cutthroat trout and rainbow trout to pass 3 distinct culvert types over a variety of hydraulic conditions. Use of PIT tags eliminates the need for multiple captures thereby reducing stress and biases associated with various

trapping methods. The use half duplex PIT tags instead of the more widely utilized full duplex tags reduces costs, allows for the construction of antennas customized for each location and their large reading range of 60 cm is nearly double that of full duplex tags. In addition to determining whether an individual successfully passes a particular culvert, we will are able to determine the number of attempts made at passage of each culvert, time spent in each culvert and travel time between culverts as well as residence time. Examining the probability of culvert passage over a variety of velocities may give a clearer determination of whether a particular culvert poses a barrier to fish passage.

Aquatic Community Classification for Eastern Montana: Uses in Bioassessment and Conservation

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The Montana Natural Heritage Program developed a hierarchical classification framework defining 38 Aquatic Ecological Systems (AES) within 13 broader lotic ecosystems of the Missouri River Basin of Montana. We used a combination of classification techniques identifying the dominant variables and indicator species structuring river communities from the mountains to the prairies. Twelve macroinvertebrate and 10 significant fish community groups were delineated using taxonomic data from ~1100 sampling sites within the basin. These community groups were related to elevation, geomorphology, stream size and tolerance to anthropogenic impacts. Fish introductions have played a significant role in structuring the transitional river systems, as well as warm-water fish communities. Reference sites for each classification group were determined and the frequency of occurrence of the indicator species calculated. Thus, for each classification type, we developed an "expected" community of fish and macroinvertebrates that can be analyzed against future samples to test the samples similarity to reference condition, and ultimately determine the biointegrity of the system. Our observed versus expected (O/E) analysis of fish/macroinvertebrate samples from the Powder River and Frenchman Creek produced comparable and slightly more robust values than the existing plains IBI. We contend that using O/E values is a truer measure of ecosystem health than traditional multimetric indicies, i.e., IBI, BIBI, especially for Montana's lower-elevation streams that naturally contain species tolerant to environmental and anthropogenic stressors.

Powder River Fish Communities in Montana: Expected and Declining Species Based on Historical Perspectives

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Powder River fish communities in Montana were examined from sampling data going back 30 years to determine an expected native fish community for the purpose of biomonitoring. Four fish species (3 native and 1 introduced) have not been collected in sampling events since 1976. Two introduced species, the plains killifish and the walleye, have been collected in the river since the late 1970s. The total number of reported fish species (19) collected in the river has been stable, but the number of native species has decreased from 17 to 15, and species community composition has changed incrementally over the sampling

period; with noticeable decreases in sturgeon chubs (MT SOC) and increases in sand shiners. Expected fish communities from the upper Powder River (30-220 RM) averaged 7.5 species and were dominated by the typical prairie river species: flathead chubs, longnose dace, plains and western silvery minnows, sand shiners, catfish and river carpsuckers. The lower 30 river miles to the confluence, averaged 8 native fish species with significant species replacements by larger river dominants. We derived frequencies of occurrence for all species collected and compared observed vs. expected communities (O/E) with the existing prairie fish IBI for testing river biointegrity.

Spatial Dynamics of Arctic Grayling in the Gibbon River, Yellowstone National Park

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Fluvial Arctic grayling are presently restricted to less than 5 percent of their native range in the contiguous United States and are listed as Category 3 under the Endangered Species Act. Fluvial grayling are thought to be restricted to a segment of the Big Hole River, Montana, in which abundances are too low to estimate accurately. Although fluvial grayling of the Madison, lower Firehole, and lower Gibbon rivers of Yellowstone National Park were thought to be extirpated by 1935, anglers have reported catching grayling throughout the Gibbon River annually. Our goal was to determine if a viable fluvial grayling population persists in the Gibbon River, or if fish caught in the river are downstream emigrants from lacustrine populations in headwater lakes. Seventeen grayling were sampled from the Gibbon River in 2005 by intensive electrofishing and fly-fishing efforts. In contrast, fry-trapping yielded few to no grayling at reaches throughout the Gibbon River. These preliminary data suggested that few grayling adults and fry inhabit the Gibbon River, implying that a reproducing fluvial population may not exist. Our findings may affect the potential Endangered Species Act listing of fluvial grayling while supplementing their management and conservation within and outside of Yellowstone National Park.

Adult Stonecat Distribution in the Upper Missouri River, Montana

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Stonecats, native to Montana, were sampled in the Missouri River near Craig, Montana, in the late 1800s. Subsequently, stonecats have not been sampled during intense electrofishing efforts throughout the same area over the past 24 years. The objective of this study was to determine adult stonecat distribution within a 142 km reach of the Upper Missouri River in northcentral Montana, between Holter Dam and Black Eagle Dam. The study area was divided into eight 17.8 km sections and baited hoop nets were systematically fished in each section at approximately 2 km intervals on both sides of the river. Since all eight sections were

sampled during March 2005, sampling order was randomly selected. Adult stonecats were only sampled in the most downstream 17.8 km of the study area with mean hoop net catch rates varying from 0 to 33/2-night period. Our initial results indicated that adult stonecats presently occupy only the lower 17.8 km of the study area. Canyon Ferry Reservoir's thermal influences on the Upper Missouri River system might help explain the current distribution of stonecats. Additional sampling will commence in March 2006 with an increased effort aimed at sampling younger age classes.

Vectors for the Spread of Myxobolus Cerebralis, the Causative Agent of Whirling Disease: A Research Update and Review of Management Implications

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Whirling disease, caused by the myxozoan parasite *Myxobolus cerebralis*, has impacted fisheries is several western states and presents a great challenge to fishery managers and biologists. In the mid- 1990s, whirling disease was first implicated in dramatic trout population declines in the American west. Since then, intensive research has increased knowledge about the parasite, its complicated life cycle, and management implications of the disease. Risk analysis has emerged as a top priority for researchers and managers and knowledge about vectors for the spread of *Myxobolus cerebralis* is vital. The transfer of infected fish is thought to be the primary vector for the spread of whirling disease. Other vectors include human activities, such as boating and wading, and transfer by predatory animals. This project will review available information regarding whirling disease vectors with a focus on recent research developments and will address the management implications of this knowledge.

Developments in Whirling Disease Research and Management

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Whirling disease, caused by the myxozoan parasite *Myxobolus cerebralis*, has impacted fisheries is several western states and presents a great challenge to fishery managers and biologists. In the mid- 1990s whirling disease was first implicated in dramatic trout population declines in the American west. Since then, intensive research has increased knowledge about the parasite, its complicated life cycle, and management implications of the disease. Recent developments in risk assessment, gear treatment, parasite and host ecology, parasite detection, and environmental factors have great potential to inform and improve management related to whirling disease. This project summarizes recent developments in whirling disease research and management and describes the current research emphasis of the Whirling Disease Initiative.

Population Characteristics and Status of Smallmouth Bass in the Missouri River, Montana

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Non-native smallmouth bass were first sampled in the Missouri River, Montana downstream of Morony Dam (river km 3386) in 1993. Since then, anecdotal evidence indicated that the smallmouth bass population was expanding; however, an analysis of the population data was lacking. Thus, data from Montana Fish, Wildlife and Parks and diet data from 2004 and 2005 were analyzed to evaluate the population characteristics of smallmouth bass in the Missouri River. Catch per effort varied from 0.5 in 1996 to 19.2 in 2003. Mean relative weight of smallmouth bass varied from 112 to 128. Total annual mortality rate varied from 25 percent in 2001 to 38 percent in 2002. Smallmouth bass most frequently consumed longnose dace and mottled sculpin. These data suggest that the smallmouth bass population has expanded over the last decade and will likely continue given the high relative weight values and low mortality. The expanding smallmouth bass population provides an additional angling opportunity. However, the increase in density of the smallmouth bass population may become problematic given that smallmouth bass may compete for similar resources with native species.

Timber Harvest and Wildfire Effects on Stream Temprature in the Gold Creek Watershed, Montana

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In mid-August 2003, the Mineral-Primm wildfire swept across the Gold Creek watershed. This 18,000- acre fire was initiated by a lightning strike in the Rattlesnake Wilderness and quickly moved eastward burning virtually the entire watershed and streamside corridor of West Fork Gold Creek. At the time of the fire, stream temperature was being monitored by Plum Creek Timber Company on both tributaries as part of a larger study to evaluate the effect of streamside timber harvest (consistent with the Company's Native Fish Habitat Conservation Plan) on maximum summer stream temperatures. This poster reports on the reach-scale effects of timber harvest on stream temperatures in the West and North Forks of Gold Creek prior to the fire, and the subsequent effect of the wildfire on West Fork stream temperatures.

Stream and Road Crossings: Convering Dams with Little Holes to Natural Channels

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Culverts and bridges are commonly used to permit water to flow beneath roads where they cross streams, thereby preventing road erosion and allowing water to follow its natural course. However, if not designed properly, road crossings are more analogous to dam sites for many physical and biological functions. In the past, engineers designed for hydraulic efficiency as the dominating criteria, giving little regard to backwater effects, scour, and other passage considerations such as bedload, debris, fish, and other aquatic organisms. Historically, water has been viewed as a liability in road design that needed to be managed to avoid destroying an investment. Despite standards and guidelines that address the importance of species movement, the number of crossings either partially or fully impeding passage is enormous. As the number and range of many species have declined, the importance of protecting the remaining populations has multiplied. Properly designed culverts provide for stream structure and function, which in turn provides desired species passage. A holistic, interdisciplinary approach creates a win-win scenario for all. Tradeoffs exist, but it is time to consider an economic reality check. Having the least expensive crossing alternatives and still maintaining aquatic species passage, stream function, maximized structure life, and minimized maintenance costs are unrealistic. Integrating crossing structures, streams and species passage is a win- win scenario that ultimately will help lead to more viable aquatic, semi-aquatic, and terrestrial populations, healthier streams, and engineering maintenance budgets that can focus resources elsewhere.

Accuracy Assessment of Aquatic Gap Fish Distribution Models in the Upper Missouri River Basin

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Non-game and native species have become a major focus of conservation and sampling efforts due to limited knowledge of their distribution, abundance, and conservation needs. Thirteen landscape level variables and known fish locations were used to create distribution models for fish species throughout the upper Missouri River Basin to identify areas for aquatic species and habitat conservation. Distribution model accuracy was tested by comparing presence/absence data from 61 sites throughout the Basin and 143 sites in South Dakota targeting species of concern to model predictions. Model performance was quantified using detection probabilities and confusion matrices to calculate weighted and unweighted Cohen's Kappa statistics and correct classification rates. In six drainages sampled throughout the Basin, the mean unweighted Kappa statistic for individual species was 0.12 (range –0.80 to 1.00) indicating slight improvement above chance levels and the mean correct classification rate was 78 percent (range 54-91%). Rare species in South Dakota had weighted Kappa values ranging from 0.32 to 0.61, indicating moderate to substantial model performance above chance agreement levels. Fish distribution models and accuracy statistics will allow managers to quantitatively evaluate model performance for use in directing future nongame and native species sampling and conservation efforts.

Statistical Evaluation of Periphyton Samples from Montana Reference Streams 2

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Periphyton Bioassessment Methods for Montana Streams (Bahls 1993) presents procedural guidelines and numeric biocriteria for using the composition and structure of periphyton communities to assess biological integrity and impairment of aquatic life in Montana streams. This manual was based on the findings of a 1990 Montana reference stream study and follow-up surveys in 1991 (Bahls et al. 1992). Three metrics—sediment index, pollution index, and diversity index–and two sets of biocriteria are provided, one for mountain and foothill streams and one for plains streams. These original metrics have been supplemented by additional metrics adopted by the Montana Department of Environmental Quality (State). These metrics and biocriteria are linked to beneficial use classifications in Montana Surface Water Quality Standards. While generally accepted, Montana's metrics and biocriteria have not been subject to rigorous data analysis protocols. Advances in biological data analysis and the collection of a large amount of periphyton data since 1993 now offer the opportunity to review existing metrics, test new ones, and refine or develop biocriteria for those metrics. Therefore, the purpose of this study is to use generally accepted statistical protocols and recent periphyton data to develop and test an array of candidate metrics and to revise or establish biocriteria as needed. Biocriteria are evaluated for their ability to address two key questions directly relevant to the State's assessment of naturally flowing streams: 1) Do diatom sample results indicate impairment under 303(d) guidelines? 2) If so, do diatom sample results indicate the cause of impairment? Criteria developed within this framework directly support the State's water quality assessments. Of specific interest to the State is the level of impairment where aquatic life use support is partial or none. Criteria address instances where diatom community response is most likely; that is, impairment due to sediment, nutrients, and/or metals. Diatom community response to other causes is expected to be limited, regardless of the level of impairment, and therefore not addressed.

Statistical Evaluation of Periphyton Samples from Montana Reference Streams

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Since 2000, Montana Department of Environmental Quality (MDEQ) has been sampling and analyzing periphyton communities from streams throughout Montana considered representative of natural biological, physical, and chemical integrity of the region. A full discussion of these reference streams and criteria used to screen them can be found in Suplee et al. (2005). Through 2005, over 100 reference streams have been sampled throughout the state, enabling statistical analysis meeting generally accepted power requirements. This talk will address three statistical evaluations performed on these data: 1. Assessment of the similarity of floristic communities among reference samples; 2. Evaluation of the extent of inter- and intra- annual variability on metric values; and, 3. Characterization of the distribution of metric values calculated from these samples. Findings from these analyses directly support use and interpretation of periphyton sample data in conducting water quality investigations in Montana.

Description and Characterization of Pectoral Fin Curl in Pallid Sturgeon

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Softening of the fins, most easily observed as pectoral fin curl, and scutes has been observed in numerous species of sturgeon around the world with an unknown etiology. Pectoral fin curl of hatchery reared pallid sturgeon (*Scaphirhychus albus*) has been observed at the Bozeman Fish Technology Center (BFTC) for four successive years. Other facilities rearing sturgeon of the same genetic lot have not observed pectoral fin curl. Rearing conditions are similar among the hatcheries except for water source. BFTC uses spring water compared to surface water at the other facilities. Comparison of shovelnose sturgeon reared in the wild versus the BFTC indicated large differences in whole-body macro-mineral concentrations. Water source may play a role in the severity and prevalence of fin curl. The relationship between water source/quality and fin quality is not understood. To evaluate this relationship, morphologically normal pallid sturgeon reared in surface water at two different hatcheries were compared to abnormal pallid sturgeon (curled pectoral fins) reared in spring/well water at the BFTC. Comparisons were made by 1) histological analysis to observe fin structure during early development, 2) proximate and mineral analysis to identify possible mineral/compositional differences, and 3) radiographs to compare mineral density and distribution.

Identification of Blood Plasma Factors for Assessment of Stress and Health in Pallid Sturgeon

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Pallid sturgeon recovery efforts require the capture of wild broodstock for hatchery propagation. Capture, transport, handling, assessment of spawning readiness, and spawning are all stressful events and these potentially cumulative stresses can contribute to poor egg quality, reduced spawning success and occasional mortality of wild broodstock. The overall goal of this study was to identify and determine which blood parameters are the most appropriate physiological indicators for the assessment of stress load and health status of pallid sturgeon. Subadult pallid sturgeon (5 yrs old) maintained at the Bozeman Fish Technology Center were subjected to a severe confinement stress with repeated handling for 12 hours (n=17). Blood was collected from the caudal vasculature from each individual at time 0 (at removal from tank), 6, and 12 hours. Blood was collected from control fish (maintained in an undisturbed tank, captured with a net, and blood collected immediately; n=5) at time 0, 6, and 12 hours. Plasma from unstressed and stressed pallid sturgeon was screened using gas chromatographymass spectrometry (glucocorticoid screen), a blood

chemistry analyzer (electrolytes, glucose, lactate, liver enzymes, plasma proteins), and enzyme immunoassay (catecholamines) to identify blood parameters that may serve as indicators of stress in pallid sturgeon.

Quantifying the Effects of Flow Diversion and Channel Geometry on Aquatic Habitat and Implications for Mitigation and Adaptive Managment Strategies

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Flow diversions have significantly different affects on the quantity and quality of aquatic habitat in the Lower White River depending channel geometry, particularly in reaches where the river has been artificially constrained by levees. This study demonstrated that salmonid habitat is not simply determined by discharge, but also the shape of the river. Prior during European colonization the lower White River consisted of an anabranching channel within a forested floodplain. Recruitment of large woody debris introduced flow obstructions that created and sustained perennial and ephemeral side channels.High-resolution topography and hydraulic modeling of the study reach show the presence of numerous abandoned and active side channels that are activated with increasing discharge. The quantity of aquatic habitat (wetted area, channel length, and bank length) increases with discharge. Sensitivity to changes in discharge was found to be greatest within sub-reaches unconstrained by levees. Side-channel activation is particularly sensitive to variations in discharge during low flow conditions when historical water withdrawals were most significant. Discharge-habitat relationships indicate that diversions of 1 m3/s result in a loss of over 500 m of side channel habitat within the 26.9 km middle and upper sub-reaches of the river unconstrained by levees. Variability in channel response to flow between the geomorphically distinct sub-reaches suggested that channel geometry can play as significant role on aquatic habitat as flow regulation. The current regulatory requirement for minimum instream flows does not consider the activation of side-channel habitat. Manipulating geomorphic factors that influence channel migration and alluvial topography such as levee setbacks, reintroduction of large woody debris, and floodplain reforestation offer significant opportunity to mitigate impacts of flow regulation.

Evalutaion of Introductions of Spottatil Shiners and Cisco to Improve Walleye Forage in Tiber Reservoir, Montana

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Tiber Reservoir's walleye (*Sander vitreus*) population, like many introduced walleye fisheries in the Northwest, went through a 'boom and bust' cycle following their introduction into the reservoir in 1971. Walleye quickly became established and expanded, but rapidly

depleted the available forage in the reservoir. Growth and body condition of walleye subsequently declined. Spottail shiners (Notropis hudsonius) were introduced into Tiber in 1984 to provide additional forage in the reservoir. Spottails quickly became the dominant shoreline forage, but no measurable improvements in the walleye population were discerned from this introduction. Further efforts to improve Tiber's forage base led to the introduction of cisco (*Coregonus artedi*) in 1997 and 1998. Cisco quickly established and became a dominant component of Tiber's fishery within two years of their introduction. The development of this population resulted in dramatic changes throughout Tiber's food web, yet no improvements in the walleye population have been realized. Managers are now faced with the question of exploring other management options or taking a 'wait and see' approach. Growing discontent amongst anglers may make future management decisions more political than biological.

Summer Site Fidelity of Cutthroat Trout in a Small Rocky Mountain Watershed

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Research over the last two decades has demonstrated that many trout are mobile at some point during their lives. Nevertheless, salmonids apparently home to natal areas to reproduce, and earlier work implies that at least some individuals home to sites chosen for summer growth. To evaluate whether fish show fidelity to summer growth sites, crews implanted about 4000 Colorado River cutthroat trout with PIT tags from 1996 to 1999 in the North Fork Little Snake River basin in south-central Wyoming, and relocated them from 1997 to 2001. Crews made nearly 1500 recaptures of 650 marked fish (80-230 mm total length) from one to five times. Overall, 45 percent of fish were last relocated within 50 m of where they had been originally found. The remainder were found from 50 to 7835 m away (median distance, 150 m), and > 60 percent of mobile fish moved upstream. However, fish length and the maximum number of years between locations were unrelated to the total distance moved and the probability that fish moved. Summer site fidelity appeard far lower than fidelity to natal areas, but predicting the distance and prevalence of movement remains challenging.