ABSTRACTS

BIOLOGICAL SCIENCES – AQUATIC

ABSTRACTS OF THE 2007 ANNUAL MEETING OF THE THE AMERICAN FISHERIES SOCIETY 40TH ANNUAL MEETING

RETURN TO THE RIVER: REVISITING AND REINVIGORATING THE SOURCE OF OUR PASSION AND PROFESSIONALISM

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RELATING FISH ASSEMBLAGES TO ENVIRONMENTAL PATTERNS AT THREE MULTI-STATE SCALES

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Key challenges to studying and managing riverscapes include understanding how factors measured at various spatial-scales influence aquatic biota and developing accurate predictive models where study data are limited. Currently fish zones, physiographic regions, ecoregions, and river basins are commonly used for classifying fish faunas. All these classifications reduce the apparent variability occurring at a large scale, but also include considerable heterogeneity. We analyzed a 780-site data set obtained from the U.S. Environmental Protection Agency's EMAP western survey. First, we determined fish clusters at three spatial scales in the western U.S., i.e., all 12 conterminous states, all western mountains, Pacific Northwest mountains. We next determined that the predictor variables for those clusters changed with spatial scale. For example, longitude, dams and temperature were the best predictors for all sites, longitude, dams and catchment area were the top predictors for mountain sites, and latitude, turbidity, and canopy density ranked highest for Pacific Northwest mountains. The best three variable models included site, basin, and ecoregion predictor variables. However, basin, ecoregion, state, and abiotic site variables alone only accounted for half of the mean within-group similarity demonstrated by the fish clusters. We conclude that using large quantitative fish assemblage data sets linked with quantitative physical and chemical habitat data and landscape data to predict fish assemblage patterns is preferable to using preexisting landscape classifications.

An Outbreak Of Viral Hemorrhagic Septicemia In The Great Lakes: Montana's Next Whirling Disease?

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Viral Hemorrhagic Septicemia (VHS) is an aquatic rhabdovirus that has the potential to cause significant mortality in fish. It is believed to have originated in Europe where it affects mostly freshwater fish in culture situations. It was first reported in the United States in 1988 and has since become enzootic in the Pacific Northwest in several marine species including pacific herring and several salmon species. In 2005 a variant of the virus was discovered in the Great Lakes Region and has been associated with significant mortality in a variety of freshwater fish species. Although the origin of this Great Lakes genotype of VHS is unclear, it has demonstrated the ability to cause severe mortality among a number of species unaffected by previously isolated strains of the virus, including most game fish found in Montana. Due to this unique characteristic, the outbreak in the Great Lakes generated an unprecedented regulatory response from a variety of state and federal agencies. There is already in place a national framework of regulations at various jurisdictional levels aimed at preventing the spread of destructive pathogens and organisms; however, it is not a perfect system. It is important to remain active and informed at the local level so as to increase our protection even more. Though it has not been found in Montana, this pathogen has significant implications to fisheries managers in Montana. It is important to remain vigilant in our oversight of potential transmission vectors to ensure that this pathogen does not find its way into Montana waters.

Nuisance Alga Didymosphenia Geminata: A Threat To Our Fisheries

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Didymosphenia geminata, a type of freshwater diatom alga, has recently been documented outside its historic northern circumboral range and has resulted in highly visible algal blooms. Additionally, in locations with previous record of *D. geminata* in North America, algal growth has increased in spatial coverage and temporal persistence. The changes in growth habit may negatively impact fisheries and macroinvertebrates. Nuisance benthic growth of *D. geminata* can extend for greater than 1 km, persist for several months of the year, and cover up to 100 percent of substrate with thicknesses > 20 cm. Nuisance growth, characterized by thick mats that cover the stream bed, consists primarily of mucopolysaccaride stalks secreted by single cells of *D. geminata*. The thick mats are resistant to degradation and may influence the ecological properties of the stream, e.g., species diversity, population sizes, nutrient pools, alter the invertebrate food base, and reduce appropriate habitat and spawning sites for fish. The observed nuisance and invasive behavior patterns of *D. geminata* have prompted studies to improve our understanding of and methods to control this species. Research that examines the impact of algal blooms on species composition and diversity is underway. Studies suggest that *D. geminata* may be transported to new locations by recreational activities and equipment. With such limited information available on the basic biology of this species and little understanding of its impacts on fisheries, the best current defense against this alga is to limit its spread to new locations with proper equipment cleaning techniques and effective outreach education.

Fish Assemblages In The Powder And Tongue Rivers In Relation To Coalbed Natural Gas Development

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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. Potential exists for substantial effects on aquatic ecosystems because CBNG development involves production and disposal of large quantities of coalbed ground water that differs from surface waters. We used four different approaches to determine the effects of coalbed natural gas development on fish assemblages in streams of the Powder River Basin in 2005 and 2006. 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. Third, we compared fish assemblages present in 2006 to fish survey data from the mid 1990s in areas with and without CBNG development. Finally, we compared growth and survival of native fish in streams with and without CBNG development. Several fish metrics and an index of biotic integrity were used to compare fish assemblages in relation to the status of development within a drainage area. Streams in drainages with CBNG development on average had lower species richness than those without development.

Spatiotemporal Variation In Prairie Stream Fish Assemblages

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Fisheries biologists must be certain that their samples represent true parameters to make sound management decisions. Thus, assessing the spatiotemporal variation of fish assemblages in Montana prairie streams will allow for a better understanding of these ecosystems and their management. We used stratified random sampling to select five tributaries of the Yellowstone River that represent a gradient of stream sizes. To assess spatial variation, fish were sampled at sites arrayed from the confluence to the headwaters of each stream during June and July 2005 and 2006. To assess temporal variation, downstream, middle, and headwater sites, i.e., drainage position, were sampled on each stream in spring 2005 and summer and fall 2005 and 2006. In general, species richness increased with increasing watershed size from 16 to 26 species. Species richness varied spatially and decreased from downstream to upstream sites. Species richness in the smallest stream varied spatially from 12 to 0 (CV = 86.73) species; likewise, species richness varied from 16 to 2 (CV = 41.63) in the largest stream. The downstream site of the largest stream exhibited the greatest temporal variation in species richness—from 16 to 9 species (CV = 1.03). Overall, species richness did not vary consistently among seasons. Canonical correspondence analysis showed that drainage position and proportion of fine substrate were significant in explaining the most variation in fish assemblage structure. Given logistic and monetary constraints, we suggest that biologists design their surveys to maximize spatial coverage to adequately characterize fish assemblages of prairie streams.

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 USDI Fish and Wildlife Service in 1997. However, evidence suggests that many hatchery-reared pallid sturgeon are experiencing significant downstream post-stocking dispersal, negatively affecting their recruitment. Therefore, the objective of this study was to evaluate the effects of acclimation to flow and site-specific water conditions on post-stocking dispersal of age-1 pallid sturgeon. 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 in tanks along the Marias River. Treatment 2 fish were acclimated to flow in tanks at the Bozeman Fish Technology Center (BFTC), and Treatment 3 fish were reared with no acclimation at the BFTC. In 2005 Treatment 2 experienced 100 percent mortality. Further, Treatment 1 fish drifted less, experienced lower mortality, and nearly twice as many fish remained in suitable pallid sturgeon habitat than Treatment 3 fish. In 2006, drift rates, mortality rates, and fish remaining in suitable habitat were similar among treatments. In both years, all pallid sturgeon drifted less in the lower reaches of the study area where more sand substrate is present. Fin curl was present in nearly all individuals in 2005, and 28 percent of individuals in 2006. These data suggest that acclimation can reduce post-stocking dispersal when fin curl is present.

Population Viability Of Arctic Grayling In The Gibbon River, Yellowstone National Park

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Fluvial Arctic grayling (*Thymallus arcticus*) are presently restricted to < 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 declining abundances have been observed since 1998. Although fluvial grayling of the Madison, lower Firehole, and lower Gibbon Rivers of Yellowstone National Park were thought to be extirpated by 1935, anglers report catching grayling throughout the Gibbon River annually. Our goal was to determine if a viable population of fluvial grayling persists in the Gibbon River, or if fish caught in the river are downstream emigrants from lacustrine populations in headwater lakes. In 2005 and 2006, sixteen and fourteen grayling respectively, were sampled from the Gibbon River by electrofishing and fly-fishing. In both years, fry-trapping yielded no grayling at sites on the Gibbon River below the farthest upstream barrier to headwater lakes (Little Gibbon Falls). Sixteen grayling were caught on

a weir established above Little Gibbon Falls in 2006. Genetic analyses will be performed in 2007 on grayling within and outside of the Gibbon River System. 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 providing valuable data for sound management within and outside of Yellowstone National Park.

Lake Trout Suppression In Lake Pend Oreille Idaho – Will It Work?

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The lake trout population in Lake Pend Oreille, Idaho has been increasing exponentially since about the mid 1990s threatening the collapse of the kokanee population and one of the best adfluvial bull trout populations remaining in the Pacific Northwest. Traditional sport angling has done little to curb lake trout population growth. Deep water trap nets were used to estimate lake trout population abundance and evaluate harvest efficiency. Lake trout abundance was estimated at 6400 fish > 52 cm in 2003 and 10,700 in 2005. The steep sides and extreme depth of Lake Pend Oreille limited harvest efficiency by trap netting to about 12 percent. Based on recaptures in gill nets, the estimated population was 35,800 fish with 15,600 > 52 cm. An aggressive angler incentive program using $110,000 of Avista mitigation funding was used to encourage harvest of rainbow and lake trout to reduce predation on kokanee. A $10/fish bounty was more effective at motivating anglers than rewards based on PIT tags ($100-$2000), lottery tickets, or monthly cash drawings for every fish entered. Anglers harvested 5800 rainbow trout and 10,800 lake trout between May and November. The combined exploitation from netting and angling resulted in a total annual exploitation rate on lake trout of 44 percent and total annual mortality rate of 60 percent. We conclude that lake trout suppression can only be achieved through a combination of netting and angling. Next, we will employ population models to estimate the number of years needed to collapse the lake trout population in Lake Pend Oreille.

Are Anglers Able To Reduce Lake Trout Abundance In Flathead Lake?

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Flathead Lake's native fish fauna have declined in large part from predation by introduced lake trout (*Salvelinus namaycush*). The state and tribal co-managers completed a plan in 2000 to reduce the lake trout population. The primary strategy to accomplish this goal is recreational angling. We improved access and increased bag limits, number of lines, and publicity, but have yet to substantially increase harvest > 40,000 fish. While catch rates are high and increasing, anglers resist keeping large numbers of fish. We addressed this behavior with fishing contests where participants receive lottery tickets for every fish they harvest. The contests are growing rapidly, accounting for > 11,000 fish in 2006. Many have equated the success of these contests with reduction of the lake trout population, but our data contra-

dict this conclusion. We estimated the harvest needed to reduce the population so we could better evaluate which tools were capable of achieving that harvest. We estimated that a total harvest of 60,000 lake trout would result in a mortality rate sufficient to cause the population to decline. With increased angler incentives this harvest may be achievable in two years. However, the degree of compensation that the increased harvest will cause is unknown. We have measured reductions in growth rates and increases in age at maturity of lake trout that indicate a large compensatory reserve that must be overcome. While reaching the 60,000 target by angling appears imminent, it is presently speculative whether the additional compensatory recruitment can be removed by angling alone.

Lake Trout Suppression In Yellowstone Lake: The Reality Of This Battle For Cutthroat Trout Persistence

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Soon after the 1994 discovery of lake trout in Yellowstone Lake, Yellowstone National Park initiated a gillnetting program aimed at suppression of the population. In 2001 our efforts were enhanced by acquisition of a Great Lakes-style gillnetting boat and funding to support additional staff. From 2001 to 2006 we set 105,000 net nights of gillnet (100 m/night) and removed 170,000 lake trout. Despite this effort, lake trout remain abundant. A new spawning site was discovered in 2006, and increasing numbers of smaller, immature lake trout have been removed for the fifth year in a row. Suppression efforts are surely slowing the rate of population growth, but whether or not the program will be able to suppress the lake trout population to an equilibrium that allows cutthroat trout to co-exist is unknown. Recent results are encouraging, in that larger, older lake trout continue to be caught with low frequency, and the mean length of lake trout caught on spawning areas has declined each year (559 mm in 2001 as compared to 505 mm in 2006). Program effectiveness is now being evaluated through collaboration with scientists at Montana State University and USGS Cooperative Fisheries Research Units in Montana and Wyoming. Population models created during the next two years, based on information collected over the past decade, will help to guide our program. As lake trout will never be fully removed from Yellowstone Lake, the development of new, advanced techniques for improving efficiency of suppression efforts is needed for this program to continue long term.

Lake Trout In The Lakes Of Glacier National Park, Montana

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Glacier National Park, Montana, contains a significant portion of natural lake habitat available to adfluvial populations of bull trout (*Salvelinus confluentus*) throughout the United States. Because of the complex landscape in Glacier National Park some bull trout populations are relatively isolated; however, other populations are less isolated and susceptible to deleterious effects of invasion by nonnative species. Of particular concern is the invasion by nonnative lake trout (*Salvelinus namaycush*), which was introduced into the Flathead drainage in the early 1900s. Past research has shown that invasion by lake trout may result in significant declines in bull trout populations. However, little effort has been made to manage the invasion in lakes within Glacier National Park. Using historical and contemporary data we examined the effect of lake trout invasion on bull trout populations in the four largest lakes in Glacier National Park west of the Continental Divide; Bowman Lake, Kintla Lake, Lake McDonald, and Logging Lake. Dramatic declines in bull trout numbers were observed over the last 36 years; these declines were associated with an increase in the numbers of lake trout. In 2005, relative abundance (mean catch/unit effort) of lake trout was 2.85 to 4.06 times higher than that of bull trout among lakes. These data suggested that further invasion by lake trout in this system may have a negative effect on native bull trout populations under a management strategy of "no action."

Lake Trout Populati●n Control In Lake Pend Oreille, Idaho: Reversing Lessons From The Great Lakes

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The lake trout (*Salvelinus namaycush*) is widely distributed throughout the northern half of North America, but is generally thought to be susceptible to recruitment over-fishing because of its long-lived, late-maturing life history. For example, in the Laurentian Great Lakes, the World's largest lake trout populations were nearly extirpated by excessive fishery exploitation and predation by non-native sea lampreys. Experience in the Great Lakes shows that lake trout stocks have been exceedingly slow to recover, largely because fishery exploitation has been excessive. Lake trout stocks have recovered only in Lake Superior and isolated areas of Lake Huron, whereas populations are sustained by hatchery production elsewhere in the basin. Therefore, lake trout populations in western lakes, where the species was introduced in the early 1900s, but is now negatively impacting native species such as bull trout (Salvelinus confluentus), should be relatively easy to control through intentional programs of excessive fishery exploitation. Why then has lake trout population control been elusive in most western lakes? We suspect that fishery exploitation has not been high enough to drive lake trout populations into collapse in most western lakes. In contrast, population modeling suggests that exploitation on the lake trout population in Lake Pend Oreille, Idaho, during 2005–2006 will cause the population to collapse, if maintained for at least several years. If successful, the lake trout population control program on Lake Pend Oreille will provide fishery managers throughout the West with a formula for similar programs elsewhere.

Simple Population Models: What Can They Tell Us About Lake Trout Suppression?

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Simple population model projections and elasticity analyses have been used in evaluating and prioritizing techniques for population conservation. These types of analyses have been particularly effective in comparing the relative impact of different conservation efforts. These same techniques can help us compare potential lake trout population suppression efforts. We built an age-based matrix model for a lake trout population and parameterized it with both unpublished data of lake trout in Flathead Lake and other published demographic studies of lake trout. We then examined multiple model simulations to begin to evaluate potential suppression scenarios for a newly established lake trout population. Overall lake trout adult survival had high elasticity values, implying that a proportional change in demographic rates of this life stage would produce a relatively large impact on population growth rates. Eradication often requires decreased survival of multiple life stages. Techniques that reduce egg survival in addition to decreased adult survival can influence population numbers substantially. Scenarios with adult and egg survival reduced (75 and 50%, respectively), population sizes decreased by one-half after 15 years over reducing adult survival alone. This benefit of increased egg mortality is dependent upon the role of density-dependence in early life history stages. Finally, we examined scenarios associated with delaying suppression a decade as the population continues to increase. As expected, to either maintain the lake trout population at a set reduced level or eradicate the population, delaying suppression efforts results in either more or a longer effort required to achieve a similar end point.

Analyzing Tradeoffs Between The Threat Of Invasion By Nonnative Trout And Effects Of Intentional Isolation For Native Westslope Cutthroat Trout Using A Bayesian Belief Network

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Conservation of inland cutthroat trout can involve either the placement or removal of migration barriers to address threats from invading species and habitat fragmentation, respectively. Such efforts may proceed without a formal mechanism for considering potential tradeoffs from addressing these competing threats. A consistent decision process would include an analysis of when and where intentional isolation or removal of barriers is most appropriate, and we explored the application of a Bayesian belief network (BBN) as a tool for such analyses. We focused on westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) and nonnative brook trout (Salvelinus fontinalis), and current understanding of environmental factors influencing both species, their potential interactions, and the effects of isolation on the persistence of individual cutthroat trout populations. Analysis indicated the tradeoff between isolation and invasion was strongly influenced by the size of the stream network (or cutthroat trout population) to be isolated and existing demographic linkages within and among cutthroat trout populations. Intentional isolation was predicted to benefit demographically isolated cutthroat trout populations facing certain invasion by brook trout. The relative benefits of isolation depended strongly on the size and quality of isolated habitat. Intentional isolation generally reduced the probability of persistence for migratory populations regardless of invasion threat. The BBN does not provide a decision; rather it allows a biologist or manager to explore management options within streams and prioritize conservation actions among streams with a transparent and consistent logic. It can also facilitate discussion that encourages clarification of conservation values, management goals, and biological uncertainties.

Fish Barrier Design In Northcentral Montana

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Genetically unaltered westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) in north central Montana (Missouri River Drainage) currently occupy less than 3% of their historical habitat. Declines in westslope cutthroat trout abundance and range in north central Montana are primarily attributable to hybridization with introduced rainbow trout Oncorhynchus mykiss and competition with introduced brook trout (*Salvelinus fontinalis*). In many instances protection and short term restoration of extant stocks of westslope cutthroat requires immediate suppression of brook trout and construction of fish barriers. Barrier construction has been a process of adapting various designs, which either use height or current velocity to block fish, to site conditions. Construction methods have included blasting and chipping out native bedrock, pouring concrete, anchoring of native materials, use of gabions, and installation of perched culverts. Design and funding considerations will be discussed along with advantages and difficulties associated with each barrier method. Responses of westslope cutthroat populations to blockage and removal of non-native brook trout using electrofishing has been uniformly positive and in some cases dramatic.

Effects Of Road Culverts On Eastern Montana Prairie Fish Assemblages

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Road culverts can restrict passage of fish migrating between seasonal habitats. The development of new roads, as well as the repair and upgrade of existing roads, has led to research addressing the effects culverts have on fish populations. The majority of this research has

focused on salmonid species, and the effect of culverts on movements of small-bodied, weak swimming species is largely unknown. Fish passage within a species-rich assemblage of prairie fishes was examined in two tributaries of the lower Yellowstone River having a variety of culvert types. Passage restriction at culverts was determined using a combination of existing fish passage models, mark-recapture experiments, and patterns of longitudinal fish distribution above and below culverts. Fish movement was not significantly different through culvert versus natural reaches for most species ($P > 0.05$). Additionally, few differences were observed in relative abundance and species richness above and below culvert crossings. A survey of culverts throughout much of eastern Montana showed that the conditions observed in study culverts were typical of many low-gradient, prairie streams. Many culverts had small outlet drops, low gradients, contained natural substrate, and low water velocities similar to those of natural reaches. Our results suggest that in these conditions, culverts may allow for adequate passage of most prairie species. However, more research is needed to determine what thresholds in these variables negatively influence passage of prairie fishes.

Use Of PIT Tag-Detecting Antennas To Assess Culvert Passage Of Yellowstone Cutthroat Trout And Rainbow Trout In Mulherin Creek, A Tributary Of The Yellowstone River

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Road crossing culverts create passage barriers during fish migration and, as a result, there are various tools for predicting passage success. Most tools have not been field-tested and give a "yes" or "no" answer to passage success. However, an estimate of the probability of passage could be more useful given that success is contingent on dynamic interactions of fish size, discharge, water temperature, and hydraulic conditions. We utilized half-duplex PIT (passive integrated transponder) tags to assess the probability of passage of Yellowstone cutthroat trout and rainbow trout in relation to biotic and abiotic factors among three different culvert types on a spawning tributary to the Yellowstone River. Velocities were significantly different between smooth box, baffled box and smooth circular culverts but did not differ significantly between a natural stream reach and one baffled box culvert. There was a positive linear relationship between number of attempts and velocity and a negative linear relationship between number of attempts and drop height, most likely due to culverts with lower velocity having larger drop heights. Time required for passage was inversely related to water velocity. Culverts where velocities were most similar to natural reaches allowed fish to pass multiple times in both directions and some remained in the culvert for up to 22 hr. These results show that culverts that simulate natural conditions are most efficient for allowing fish passage and that PIT tags are an efficient method for determining not only probability of passage success but also can provide measures of passage difficulty.

Fish Passage Planning And Development For Bull Trout At Thompson Falls Dam, Montana

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PPL Montana is the owner of the Thompson Falls Dam (Project), built in 1917 on the Clark Fork River near Thompson Falls, Montana. The listing of the bull trout as a threatened species under the Endangered Species Act prompted the preparation of a biological assessment (BA) to assess the impacts that the Project may be having on bull trout (*Salvelinus confluentus*), and to make recommendations about possible conservation measures to reduce those impacts. That BA concluded that the Project might adversely affect bull trout, in large measure due to a lack of upstream fish passage. An Interagency Technical Advisory Committee was established to help guide PPL Montana in their efforts to conserve bull trout by providing upstream passage. Proper location of a fish collection facility is critical to the success of an effective fish passage solution. In order to find the most effective location for the fishway, trout were radio tagged, and stationary receivers were positioned at key locations to continuously monitor fish movements. Results indicated that trout migrate upstream to the main dam, the upstream most location in the tailrace, during the early spring. Therefore, the main dam was selected as the fishway site. An alternatives analysis assessed three potential fishway configurations at that site. The Interagency Technical Advisory Committee recommended the right bank full height ladder alternative, and PPL Montana concurred. This fishway is currently being designed, and will include fish sampling facilities that will allow maximum operational flexibility for fisheries managers.

Expected Changes To The Distribution, Abundance And Life History Expression Of Fishes Following The Removal Of A Montana Hydroelectric Dam

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Milltown Dam has fragmented the Clark Fork watershed sincel907. Historically, fish used large, connected, ecologically and geographically distinct habitats spanning hundreds of kilometers to express different stages of their life histories. The dam as not allowed upstream fish passage, has limited downstream fish movements and created a reservoir that has fostered a population of exotic northern pike. Recent studies show the dam's continued affect on an enormous geographic scale. Milltown Dam annually impedes migrations of tens of thousands of fish, and data suggest that fish that migrate to the dam do not spawn once their migration is impeded. Native migratory fishes like westslope cutthroat trout and bull trout have been especially affected by the dam but their annual presence at the dam suggests the potential to reestablish fluvial life history forms and enhance local or up-river populations. Milltown Dam will be removed in the next few years and the watershed will once again regain connectivity. Biotic changes from dam removal will range from drastic local changes in species composition, fish densities, and unimpeded fish passage. However, on most scales, the changes will be subtle and offer populations more resilience and better expression of life history tactics.

Restoration Plan For The Clark Fork River And Blackfoot River Near Milltown Dam

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In 2005, a consent decree set forth the terms and conditions for the removal of Milltown Dam near Bonner, Montana. Constructed in 1907 at the confluence of the Blackfoot and Clark Fork rivers, Milltown Dam is a fish passage barrier and impounds ~ 6.6 million cubic yards of contaminated sediments transported to Milltown Reservoir from upstream historical mining in Butte and Anaconda. The State of Montana, in consultation with the Confederated Salish and Kootenai Tribes and the USDI Fish and Wildlife Service, are developing a plan that will restore the Clark Fork and Blackfoot rivers to naturally functioning, free-flowing fluvial systems. Project goals include 1) maintaining water quality, 2) accommodating sediment transport and channel dynamics, 3) providing habitat for native fishes and other trout, 4) creating functional wetlands and riparian communities, 5) enhancing visual and aesthetic values, and 6) providing safe recreational opportunities compatible with other restoration goals. Design approaches are process and form based and include stream classification, regional hydraulic geometry relationships, regime and tractive force equations, and one and two-dimensional flow and sediment transport computations. These approaches are being used to meet both ecological and stability objectives. Preliminary results indicate that the most probable state of the rivers is a slightly entrenched, meandering, gravel-dominated, riffle-pool channel transitioning to a moderately entrenched channel near the confluence with the Blackfoot River. Following restoration activities, fish passage will be restored resulting in the full expression offl uvial life histories for species that include bull trout, westslope cutthroat trout, and large-scale suckers.

Influence Of Migratory Barriers On Genetic Diversity And Similarity Among Bull Trout Populations In Glacier National Park, Montana

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Adfluvial populations of bull trout (*Salvelinus confluentus*) in Glacier National Park, Montana, occupy a complex landscape of interconnected and fragmented lake habitat. Natural barriers, e.g., waterfalls, may limit migration among available habitat and result in fragmentation and isolation of some populations. Polymorphic microsatellite loci were used to examine patterns of genetic diversity and similarity among populations of bull trout in Glacier National Park and to examine differences between populations isolated by migratory barriers and those occupying more interconnected habitat. One hundred ninety-six bull trout, comprising 16 populations, were genotyped at 10 microsatellite loci. Five populations were isolated by migratory barriers, i.e., waterfalls with a vertical drop $\geq$ 1.8 m. Expected heterozygosity (averaged across loci) varied from 0.18 to 0.73 among populations and was lower on average for populations isolated by barriers (0.27 $\pm$ 0.09) compared to those not isolated (0.61 $\pm$ 0.08). Allelic diversity (averaged across loci and adjusted for sample size) varied from 1.47 to 3.45 among populations and was lower on average for populations isolated by barriers (4.53) compared to those not isolated (6.46) based on a hierarchical classification. Pairwise Fst values varied from 0.00 to 0.69 with larger values representative of comparisons between populations isolated by barriers. These data indicated that natural barriers have influenced genetic diversity and similarity among bull trout populations in Glacier National Park.

Big Coulee: An Attempt To Thwart Extinction

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Westslope cutthroat trout (WCT, *Oncorhynchus clarkii lewisi*), in Big Coulee Creek were first surveyed in 1995 after the USDA Forest Service received information from Montana Fish Wildlife and Parks. Other headwater tributaries of Highwood Creek were later inventoried and it was determined that the WCT in Big Coulee were the last extant population in the drainage. Information concerning Big Coulee showed that if action was not taken quickly, this small remnant population of native fish would likely become extinct. To prevent their loss, fishery managers faced many challenges: competition/predation by brook trout, habitat degradation, and illegal angler harvest. Habitat improvement and fishery projects have been implemented to protect these aboriginal westslope cutthroat. At the end of the 2006 field season, brook trout had almost been eradicated and a fish migration barrier was successfully stopping immigration of non-native fish. The WCT population is now rebounding with dramatic increases in juveniles and adults. Due to collaborative efforts of the USDA Forest Service, Montana Fish, Wildlife and Parks, and a number of volunteers there are still WCT in the Highwood Basin.

Barrier Assessment Of The Chadbourne Diversion Dam On The Shields River

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The Shields River supports widely distributed populations of Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) that show little to no evidence of introgression with rainbow trout (*O. mykiss*) or westslope cutthroat trout (*O. c. lewis i*). The Chadbourne diversion dam, approximately 12.5 river miles upstream of the confluence with the Yellowstone River, is suspected to be a partial barrier to upstream passage of large trout. We performed a fish passage assessment of the diversion using a combination of hydraulic modeling under a range of flows combined with fish swimming and leaping abilities of Yellowstone cutthroat, rainbow, brown (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) to characterize its barrier status. We analyzed three potential passage scenarios: (1) the development of a side-channel that bypasses the diversion at high flows, (2) the potential for trout to leap over the structure, and (3) the potential for trout to pass through a keyhole or notch in the structure. Results indicate that a side-channel may form at flows exceeding the 2-year recurrence interval (RI) when the diversion is operating with wooden planks in place and a 10-yr RI when the diversion is operating without wooden planks in place. The analysis also indicated that the leap heights are too

great for all operating scenarios and flows. However, the analysis indicated that large trout of all four species might pass the structure by swimming up the key hole or notch at some flows.

Fish Losses To Irrigation Diversions On Two Tributaries Of The Bitterroot River, Montana

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Withdrawals of surface water for irrigation and stock water leave the mainstem of the Bitterroot River and its tributaries chronically dewatered during the irrigation season. These water withdrawals affect local trout populations by entraining migratory trout in irrigation diversion canals at multiple life stages, and through the loss and degradation of available habitat for aquatic species. Irrigation losses may be responsible in part for the low abundances and restricted distributions of migratory native westslope cutthroat trout (*Oncorhynchus clarkii*) lewisi and bull trout (*Salvelinus confluentus*) in this system. Information about entrainment rates of fish into irrigation diversion canals and the factors that influence these rates is limited. Our goals were to quantify entrainment of fish into seven irrigation diversions on Lost Horse Creek and five irrigation diversions on Tin Cup Creek, two tributaries of the Bitterroot River, and to identify characteristics of these diversions that correlate with rates of entrainment. We sampled fish species by snorkeling, electrofishing, fry trapping, and reconnaissance at the end of the irrigation season at 60 sites in 2005 and 54 sites in 2006. In August, the period of peak abundances of entrained fish, we estimated 5525 fish in 2005 and 3372 fish in 2006 to be present in Lost Horse Creek diversions. We estimated 1904 fish in 2005 and 1158 fish in 2006 to be present in Tin Cup Creek diversions in August. The highest entrainment of fish occurred in canals diverting the greatest amounts of water.

Efficacy Of Fish Screens At Preventing Entrainment Of Westslope Cutthroat Trout Juveniles In Three Irrigation Canals Of Skalkaho Creek, Montana

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Fish screens have been installed to prevent fish loss in many irrigation canals of the western U.S., costing millions of dollars annually. However, few studies have attempted to evaluate the effectiveness of fish screens. Our goal was to determine the efficacy of fish screens installed in three of seven irrigation canals on Skalkaho Creek, a tributary of the Bitterroot River. Fish screen efficacy was quantified using half-duplex PIT tags and PIT tag-detecting antennae located in the headgate opening(s), around the bypass pipes, and in the canal downstream from the fish screens. Throughout the irrigation season, juvenile westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) were captured, PIT-tagged, and introduced into

each screened canal between the headgates and the fish screen. Fish screens in the Highline, Ward, and Hughes canals prevented entrainment of 97.5 percent (116 of 119), 96.7 percent (116 of 120), and 74.2 percent (72 of 97) of the PIT-tagged fish introduced into the canals, respectively. Whereas none of the PIT-tagged fish became entrained beyond the screens, 9.5 percent (32 of 336) remained in the canals upon headgate closure. Seventy-percent (21 of 30) of the PIT-tagged fish introduced into the Hughes Canal two weeks prior to headgate closure remained in the canal because no water was being bypassed and the headgates were not open enough to provide an easy upstream exit. If not rescued, fish remaining in the canal upon headgate closure would have perished. Fish screens are an effective management tool for reducing irrigation canal entrainment but their effectiveness varies among specific installations.

Seasonal And Spawning Movements Of Genetically Pure And Hybridized Westslope Cutthroat Trout In The Fan Creek Drainage, Yellowstone National Park

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Once the dominant salmonid of the Gallatin River, westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) have been reduced to four isolated headwater populations in this river drainage. We used radio telemetry to investigate the seasonal movement of westslope cutthroat trout and hybrids in the Fan Creek drainage, focusing on the North Fork. Fish were tracked for an average of 60 days throughout the summer of 2001 and an average of 262 days throughout the end of 2001 and 2002. Westslope cutthroat trout moved an average of 2143 m in the summer of 2001 and an average of 2990 meters throughout the study period of 2001-2002. The majority of movement for 2001-2002 occurred in the spring and summer months, whereas sedentary behavior was observed in the fall and winter months. R1/R4 inventory data was collected for the North Fork of Fan Creek and personal observation was used for the main stem. Westslope cutthroat trout were relocated in areas of increased instream habitat complexity and a high percentage of cover in the North Fork of Fan Creek. There was no discernable difference found in habitats where fish were relocated and where fish were not located in the North Fork of Fan Creek. In the mainstem, westslope cutthroat trout were relocated in areas where deep bends provided undercut banks and areas with root wads. In summation, fish moved throughout the Fan Creek drainage throughout the study. Adequate habitat appeared to be provided for fish to remain in the North Fork for all seasons.

Movement Of Anglers And Sediment Transport: Implications For Moving Aquatic Nuisance Species

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Movement of anglers among rivers presents a potential pathway for the spread of whirling disease and other aquatic nuisance species (ANS). The objective of this study was to quantify the movement of anglers in southwestern Montana and the quantity of sediment they

carry on angling equipment. Anglers were surveyed at randomly selected high use fishing access sites on six rivers in southwestern Montana. Survey questions focused on locations of angling trips in the past 30 days, planned fishing trips for the next 7 days, equipment cleaning practices, and aquatic nuisance species awareness. In addition to the questionnaire, sediment samples were collected from boots and waders with a pressure sprayer. Mean distance traveled by Montana residents from their home to the survey site was 115 km and 1738 km for non-residents. The median number of fishing access sites used during the previous 30 days by resident and non-resident anglers was three. Non-residents fished in more states in the previous 30 days than residents and traveled further distances to fish in the previous 30 days than residents. Mean quantity of sediment carried on one boot-wader leg was 8.39 g (± 1.5, 95% CI). Combining angler movement data, sediment quantity carried, and fishing license data, anglers in southwestern Montana are potentially moving thousands of kg of soil among fishing access sites every year making transport of ANS highly likely. Control of future ANS infestations will be difficult unless sediment transport is addressed.

Effects Of Water Temperature And Angling On Mortality Of Salmonids In Montana Streams

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Effects of catch-and-release angling on salmonid mortality during periods of elevated (> 20 °C) water temperatures are largely unknown. In addition, few field studies have quantified salmonid mortality associated with angling during varying times of diel temperature cycles. Thus, our objectives were to quantify post-release salmonid mortality during elevated summer water temperatures and cooler fall water temperatures, and quantify mortality from morning and evening angling events. Angling occurred on the Gallatin and Smith rivers. Anglers were allowed to use only fly-fishing gear and techniques, without any other restrictions. Angled fish were transported from the anglers to in-situ holding cages and monitored for 72 hr. Mean rainbow trout (Oncorhynchus mykiss) mortality during summer varied from 7 percent in the Gallatin River to 9 percent in the Smith River, whereas brown trout (Salmo trutta) mortality varied from 0 percent in the Gallatin River to 8 percent in the Smith River. Mountain whitefish (Prosopium williamsoni) mortality varied from 2 percent in the Gallatin River to 21 percent in the Smith River. No mortalities for any species occurred in either river during fall sampling. Rainbow trout (n = 125) and mountain whitefish (n = 114) mortality in the Smith River differed significantly between summer and fall angling events. Different diel water temperature cycles between rivers likely contributed to this difference. No significant differences were detected between morning and evening angling events during the summer in either river. Currently, it appears that mortality associated with catch and release angling during elevated water temperatures (> 20 °C) is relatively low for rainbow trout and brown trout.

Environmental Conditions Affecting The Toxicity Of Piscicides

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The piscicides rotenone and antimycin are important tools in fisheries conservation but their application is inefficient and not always effective. We examined the persistence of both piscicides in the laboratory and field to determine the causes of their detoxification. The effects of sunlight and turbulence were isolated in the laboratory and studied using 96-hr toxicity tests. Sunlight rapidly detoxified both rotenone and antimycin. Turbulence affected antimycin more than rotenone. The interactive effects of combined stream characteristics were measured in streams using a single drip station and sentinel fish at 100-m intervals. Stream characteristics were measured along the entire reach that detoxified rotenone. Environmental characteristics most abundant in the stream section that detoxified rotenone were identified using logistic regression. The abundance of substrates >150-mm diameter, total dissolved solids, and oxidation reduction potential were significantly related to the persistence of rotenone in streams. The predictive ability of models was good using reclassification procedures. However, the predictive ability of the models will need to be tested in streams before they can be used in future piscicide applications. This information will make piscicide use more efficient and effective by reducing the uncertainty associated with its application.

Collection Of Samples To Detect Hybridization: One Of These Things May Not Be Like The Other

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Hybridization is an important factor to consider for the conservation of many native stream fishes. Fisheries biologists often collect samples to test for hybridization where there is ready access to stream habitats or in spatially limited stream reaches. Because stream salmonids are highly mobile animals and rapidly re-assort into mixed stock assemblages, it is often difficult to interpret the meaning of results obtained for hybridization assays at the population level. We have assayed 35 samples (n = 14-35 fish) at five codominant diagnostic microsatellite loci to determine the geographic distribution of hybrids in the Jocko River Basin. Samples were collected in 100-m sections with a backpack electrofisher. We detected hybridized individuals at only 3 of 16 sites in the South Fork Jocko River in preliminary analysis. One of those sites was non-adjacent to the other two indicating the distribution of hybrid fish in that system is variable. To design a robust sampling strategy to determine the hybridization status of a population, we assessed the spatial variability of samples in 47 stream km of the upper Jocko River drainage.

Tracking Fluvial Cutthroat Trout Movements With Stable Isotope Markers In A Stream Network

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Movement between environments is a common phenomenon across taxa because it allows individuals to match their phenotype to the biotic and abiotic conditions that maximize fitness. However, biologists and managers did not consider movement between distinct habitats important for stream-resident fishes until recently because field methods and monitoring favored relocating immobile fish or fish large enough for tags. As a result, little is known about the frequency of movement in stream fishes and the critical locations that fishes move to within a stream network. We used stable isotope analysis to provide precise information about individual movement patterns and frequency for Bonneville cutthroat trout (*Oncorhynchus clarkii utah;* BCT) combined site-specific and trophic level-specific N isotopic signatures of BCT to estimate the frequency of movement to downstream environments, to identify downstream environments that fluvial BCT move into from headwater streams, and to identify important food resources in these habitats.

Montana Arctic Grayling: Status, Concerns, And Antidotes

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Arctic grayling (*Thymallus arcticus*) have a holarctic distribution in northern latitudes of North America and Asia. Montana Arctic grayling represent the most southerly distributed populations of the species. Species existing at the periphery of their range are often more susceptible to extinction due to habitat and environmental changes. Historic distribution and abundance of fluvial (permanently stream dwelling) Arctic grayling has decreased due to a variety of human caused and environmental factors that have imperiled the future existence of the species in Montana. The last remaining fluvial population exists in the Big Hole River representing ~ 4 percent of the native range in Montana. Population abundance and distribution of Arctic grayling in the Big Hole River has declined substantially. Assessing the factors that have contributed to the decline of grayling is essential to focus restoration efforts. This presentation will provide current population abundance, distribution, age structure, and genetic demographics of the Big Hole River grayling population. Habitat limitations, climatic fluctuations, and potential effects of non-native fishes will be evaluated with regards to grayling restoration efforts. This presentation also introduced a basin wide conservation strategy that is essential to ensure persistence of grayling in Montana.

Can Candidate Conservation Agreements Save Montana's Fluvial Arctic Grayling?

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A Candidate Conservation Agreement with Assurances (CCAA) is an agreement between the USDI Fish and Wildlife Service (USFWS) and any non Federal entity whereby non Federal property owners who voluntarily agree to manage their lands or waters to remove threats to species at risk of becoming threatened or endangered receive assurances against additional regulatory requirements should that species be subsequently listed under the Endangered Species Act (ESA). The goal of the Big Hole CCAA is to secure and enhance a population of fluvial Arctic grayling (*Thymallus arcticus*) within the upper reaches of their historic range in the Big Hole River drainage. Under this Agreement, Montana Fish, Wildlife and Parks (MFWP) holds an ESA Enhancement of Survival Permit issued to it by USFWS and will issue Certificates of Inclusion to non Federal property owners within the project area who agree to comply with all of the stipulations of the Agreement and develop an approved site specific plan. Site specific conservation plans will be developed with each landowner by an interdisciplinary technical team made up of individuals representing MFWP, USFWS, USDA Natural Resources Conservation Service, and Montana Department of Natural Resources and Conservation. The conservation guidelines of the Big Hole CCAA will be met by implementing conservation measures that 1) improve streamflows, 2) improve and protect the function of riparian habitats, 3) identify and reduce or eliminate entrainment threats for grayling, and 4) remove barriers to grayling migration. We believe this program represents the best opportunity to conserve the Big Hole River grayling population.

The Restoration Of The Upper Big Hole Watershed's Riparian And Instream Habitat Using Candidate Conservation Agreements

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The Candidate Conservation Agreement with Assurances (CCAA) for fluvial Arctic grayling (*Thymallus arcticus*) in the upper Big Hole watershed presents a unique opportunity to develop and implement comprehensive restoration and conservation projects on private land. During the preliminary sing-up in 2005, 40 landowners enrolled just under 220,000 ac of private land, representing nearly 70 percent of the private land in the project area. Site-specific restoration plans for each property, which addresses everything from instream and riparian restoration, grazing management, irrigation efficiency improvement, off-stream livestock water development, entrainment and fish passage, need to be developed with consideration of the unique physical and hydrologic characteristics of each property, as well as the agricultural goals and objectives of each livestock operation. The cumulative effects of restoration on one property upstream have tremendous ramifications downstream. The scale and complexity of this undertaking, the largest of its kind ever developed in the country, relies upon the dedication and creativity of many valuable partners.

Improving Stream Flows In The Upper Big Hole Using Candidate Conservation Agreements

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Stream flow improvement is a key conservation guideline outlined in the Candidate Conservation Agreement with Assurances (CCAA) presently being implemented for fluvial Arctic grayling (*Thymallus arcticus*) in the Big Hole River drainage. Eight years of drought conditions, over-appropriation of water rights, and dependence on the beneficial use of its water for irrigation, presents a water management challenge for agencies and CCAA enrollees in the upper Big Hole basin. The Montana Department of Natural Resources and Conservation (DNRC) provides technical support to meet this challenge through quantification and assessment of basin hydrology, water use, and water management practices. Data have been collected from an established flow monitoring network, tributary and mainstem synoptic stream flow measurement runs, and water rights compliance checks. These data helped establish flow conditions prior to the implementation of the CCAA and provide the basis for understanding the timing and magnitude of water use and its influence on stream flows. Water savings to be converted to stream flow are anticipated through CCAA-associated activities with landowners such as supplemental flow agreements, infrastructure improvements, irrigation management planning, and water rights compliance. While it will take years to fully implement all facets of the CCAA water management goals, improvements to river flows have already been realized. Between 2003 and 2006, increases in river flows relative to water availability were documented. These increases can be attributed to voluntary flow reductions by irrigators. Irrigator cooperation such as this will need to continue to ensure the success of stream flow improvement using the CCAA.

Understanding Entrainment Dynamics And Potential Implications To The Conservation Of Arctic Grayling In The Big Hole River

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Arctic grayling (*Thymallus arcticus*) in the upper Big Hole River watershed display significant migratory patterns, and as such, are susceptible to becoming entrained in irrigation ditches during their annual migrations. The extent of entrainment and its impact to the population, however, is poorly understood. To gain insight into entrainment dynamics in the Big Hole River watershed, survey and salvage efforts were conducted in 2006. We completed electrofishing surveys on approximately 2 percent (42.5 mi) of the irrigation ditches owned by landowners that have enrolled in the Big Hole Grayling Candidate Conservation Agreement with Assurances (CCAA) Program. One of the CCAA conservation goals is to assess and minimize the effects of entrainment on the grayling population. In 2006, five adult grayling were captured in irrigation ditches. This represents 12 percent of all adult grayling that were captured during annual fall population monitoring efforts by Montana Fish, Wildlife, and Parks in 2006. The implication of these findings and previous efforts are discussed in relation to their potential effects on grayling population abundance and recovery efforts. Strategies to minimize entrainment may include the installation of fish screens, changes to irrigation infrastructure, and voluntary flow reductions. Implications of these actions are also discussed in terms of their potential impact on water rights, pending water rights legislation, and the Big Hole Grayling CCAA.

Grayling Reintroduction In The Ruby River, Montana

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The Arctic Grayling Workgroup designated the Ruby River as a potential restoration site for fluvial arctic grayling (*Thymallus arcticus*) based on an assessment of historic grayling streams in Montana. The Ruby was chosen among candidate streams because of its long sections of unimpeded stream, suitable habitat conditions, and relatively low densities of non-native salmonids. Potential negative characteristics of the Ruby include access to Ruby reservoir, and the presence of non-natives. Reintroduction efforts began in the Ruby in 1997 following the 1995 Grayling Restoration Plan. Grayling derived from the Big Hole River were stocked as age-one and young-of-the-year. Natural reproduction of stocked grayling was documented two different years, indicating suitable habitat was available; however, high over-winter mortality rates illustrated the need for an alternative to stocking. Reintroduction efforts have evolved from stocking, to the use of Remote Site Incubators (RSIs) which emerge grayling fry reared under selective mechanisms of the stream. RSIs have been used since 2003 and have been very successful at introducing grayling to the system. Over-winter survival of grayling from RSIs has been documented 3 yrs in a row. Habitat enhancement projects to increase adult pool, spawning, and rearing habitat for grayling are now complimenting RSI efforts. Future direction of Ruby reintroductions will be determined by current revision and updating of the Grayling Restoration Plan. This plan will revisit restoration goals, provide genetic and brood stock management direction, and create short and long-term goals that address connectivity, habitat, and population goals for grayling in Montana.

Changes In Angler Use Following An Unauthorized Walleye Introduction In Canyon Ferry Reservoir

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Angler use of Canyon Ferry Reservoir has changed following an unauthorized walleye (*Sander vitreus*) introduction. In summer 1986 majority of anglers targeted rainbow trout (*Oncorhynchus mykiss*) (81.9%) and fished from the shoreline (62.9%). It took an average time of 96 min for an angler to catch any species of fish. Following expansion of the walleye population in the late 1990s, the majority of anglers in 2005 target walleye (69.2%) and fish from boats (83.2%). In 2005 it took an average of 399 min to catch any species of fish. Total angler pressure has decreased from 98,768 angler days in 1989 to 80,249 angler days in 2005. Angler origin has changed little since walleye introduction with Lewis and Clark, Gallatin, and Broadwater Counties representing most anglers. Percent of out of state anglers have decreased from a peak of 10.7 percent in 1987 to a low of 2.3 percent in 2004. Walleye contribute little to the winter fishery, however heavy predation of yellow perch (*Perca flavescens*) has led to declines in winter angler pressure. With declines in perch numbers, rainbow trout have become the primary component of the winter fishery. Since the introduction of walleye the Canyon Ferry fishery has become less accessible to general and shoreline anglers. Predation by walleye has reduced numbers of other sport fishes in the reservoir to the point that walleye are currently the only sport fish that meets management goals.

Effects Of Spill On The Kootenai River Below Libby Dam In 2006

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Mismanagement of reservoir elevations in the spring of 2006 caused forced spill to occur from Libby Dam on the Kootenai River from 8 June 2006 to 27 June 2006. Spill discharge reached a maximum of 31,000 ft^3 /sec (cfs), leading to the highest discharge of 55,000 cfs from Libby Dam since regulated flows began in 1974. Spill discharges above approximately 1200 cfs cause gas supersaturation and subsequent violation of the state and federal water quality standards of 110 percent. Gas levels reached a maximum of 133.5 percent and the 110 percent saturation level was exceeded for 18.5 consecutive days (446 hrs) below the Dam. Initially, higher percentages of fishes exhibited gas bubble trauma symptoms on the left bank when compared to the right bank, but after 14 days of spill, 93.0 percent of rainbow trout, 82.0 percent of mountain whitefish, and 100.0 percent of bull trout exhibited symptoms of gas bubble trauma. No mass mortality of fishes was seen in the river below the Dam, with the exception of kokanee that passed over the spillway. The long term effects on fishes below the dam are unknown at this time, but monitoring will continue in the spring of 2007 for rainbow and bull trout populations, downstream displacement of PIT tagged fishes, and genetic analysis of the bull trout population using pre and post spill genetic analyses.

Correct Implementation Of Variable Flow Flood Control (VARQ) At Libby Dam During 2006 Could Have Avoided Spill And Prevented Impacts To Kootenai River Fish

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The variable flow flood control strategy (VARQ) was designed to improve conditions for resident fish species including the endangered Kootenai white sturgeon (*Acipenser transmontanus*) and threatened bull trout (*Salvelinus confluentus*) while dam operations are modified to recover ESA-listed anadromous fish species in the lower Columbia River. Failure to follow VARQ at Libby Dam during 2006 caused an uncontrolled spill and flooding in the Kootenai River. As much as 31,000 ft^3 /sec (cfs) was released through the spillway, exceeding Montana's water quality standard of 110 percent gas supersaturation for 19 days. Gas levels reached a maximum of 133.5 percent causing gas bubble trauma in Kootenai River fish. Flood stage at Bonners Ferry, Idaho, was exceeded, causing some stakeholders in the U.S. and Canada to doubt the effectiveness of this flood control strategy. The U.S. Army Corps of Engineers considered abandoning VARQ and reinstating standard flood control practices. Analysis of the event revealed that the Corps' discharge protocol had not been implemented as designed. Dam discharge during April and early May was therefore insufficient to control the slightly-above-normal inflow. Spill, flooding and gas bubble trauma in Kootenai River fish could have been avoided if VARQ had been implemented as designed.

Investigations Into Rapid Temperature Decreases In The Upper Madison River Downstream From Quake Lake, Montana

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During the review of temperature data collected from the Madison River downstream from Quake Lake, we noticed two cases of short term, very sharp temperature decreases. On 23 June 2001, river temperature decreased 8.1 °F over 7.5 hours and on 28 July 2001, river temperature decreased 15.2 °F over 9.5 hrs. Water temperature remained low for ~ 30 min to 1 hr and then rebounded quickly to typically normal levels. We believe that the cause for these anomalies may be a wind driven disturbance tilting the Quake Lake thermocline allowing cool hypolimnetic water to spill out of the Quake Lake outlet. We support this hypothesis with a presentation of the geographical orientation of the Lake, wind data from a nearby weather station, and temperature profile data taken from Quake Lake. Other cases of this phenomenon at this site are identified.

Estimation Of Fish Age Using Otolith Relative Mass

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Otolith and body growth rates are non proportional, resulting in fast growing fish with relatively small otoliths at a given body size and vice versa. Thus use of otolith mass alone to estimate fish age will be biased when body growth rates vary from those in the established age versus otolith mass relationship. By accounting for the otolith mass at a given body size (defined as otolith relative mass) it should be possible to improve age models particularly when growth rates are variable. Herein I compared two multiple regression models incorporating otolith relative mass to predict Flathead Lake lake trout (*Salvelinus namaycush*) annuli with a conventional otolith mass regression. I found that the models incorporating otolith relative mass were less prone to growth bias, and produced growth curves that better mimicked the empirical relationship. The best performing otolith relative mass model was applied to archived otoliths, revealing a pattern of sharply declining growth from 1986-1991 to 1998, and a smaller decline from 1998 to 2005. Coherent with these temporal growth declines I observed increases in otolith mass at a given body length, suggesting that the otolith mass vs. body length relationship can be used to monitor growth rates.

A New Biochemical Genetic Technique To Examine Hybridization Among Westslope Cutthroat, Yellowstone Cutthroat, And Rainbow Trout

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Hybridization is a large threat to the continued existence of native cutthroat trout (*Oncorhynchus clarkii*). Considerable effort has been spent identifying and attempting to conserve non-hybridized native cutthroat trout populations. Previously, Montana Fish, Wildlife, and Parks used a procedure examining fragments of nuclear DNA located between transposable elements (PINE analysis) to determine whether or not populations were hybridized and to what extent. A problem with this technique was that the markers used were inherited in a dominant/recessive fashion making identification of all genotypes not possible which from a statistical aspect weakens the power of the data. We developed a procedure that examines codominant insertion/deletion (indel) events as well as microsatellite markers that distinguish among westslope cutthroat (*O. c. lewisi*), Yellowstone cutthroat (*O. c. bouvieri*), and rainbow trout (*O. mykiss*). The codominant nature of these markers allows for the direct determination of all genotypes and estimates of allele frequencies in samples which greatly increases the power of the data. Furthermore, the new procedure requires only two independent polymerase chain reactions which reduces the amount of effort required to collect the data. This technique, therefore, is far superior to the previously used PINE analysis.

Evaluation Of Stocking As A Means Of Replacing Introduced Trout Populations In Lakes With Westslope Cutthroat Trout

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Conservation and restoration plans often call for the elimination and replacement of non-native fish populations. Elimination in lakes has generally been successful only by poisoning. Poisoning is becoming increasingly problematic, however, because of legal and permit issues and potential social and political opposition. As an alternative to poisoning, we investigated the effectiveness of stocking as a means of replacing nonnative lake populations of trout. Among six lakes in the South Fork Flathead River drainage, Montana, genetic analysis indicated after stocking began that the proportion of westslope cutthroat trout (*Onchorhynchus clarkii lewisi*), alleles had progressively increased from zero, or near zero, to 0.75 up to 0.99. Some of this increase was due to hybridization and introgression with the stocked fish. Examination of individuals, however, indicated that most of the change was due to the replacement of fish in the lake with westslope cutthroat trout. The results suggest that in small headwater lakes with limited spawning and juvenile rearing habitats stocking juveniles can be an effective means of replacing introduced nonnative trout populations or hybrid swarms with westslope cutthroat trout.

Who's Yer Daddy? Photo Documentation Of Bull Trout And Brook Trout Hybridization

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Field survey and genetic sampling of fish in Goat and Lion Creeks, two tributaries of the Swan River in northwest Montana, indicated hybridization between bull trout (*Salvelinus confluentus*) and brook trout (*S. fontinalis*). In 2006 I used an easily-constructed Plexiglas streamside solarium and a digital camera to individually photograph each of 336 Salvelinus specimens that were randomly captured by electrofishing crews at five sites in the two drainages. Finclip samples from each fish were analyzed, using a set of 13 microsatellite loci previously identified as being useful to distinguish between bull trout, brook trout, and hybrid individuals. Preliminary results of the genetic analysis determined that about 53 percent of sampled fish were bull trout, 38 percent were brook trout, and 9 percent were hybrids. Field identification matched closely with these proportions and well-trained observers adequately identified hybrid specimens. However, nine field misidentifications that were detected by genetic analysis were correlated to hybrids; some due to inability to recognize larger fish (> 200 mm) as hybrids, and several due to smaller brook trout (< 100 mm) that were improperly identified as hybrids. Additional evaluation of the genetic attributes of hybrid individuals will determine more about individual ancestry and spatial and temporal patterns of hybridization. The unique archive of broadside digital photos of which most provide good or excellent representation of phenotypic characteristics, will allow us to use "visual virtual recall" to re-examine phenotypic characters of each fish, e.g., coloration and spotting patterns, and may be useful as future training aids.

Considering Natural Vegetation Development Processes In Streambank Stabilization Design

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Stabilizing eroding streambanks is a common component of stream and river restoration projects and is addressed by various disciplines using a wide range of techniques. A native species revegetation approach to streambank stabilization has numerous benefits and is being used with increasing success in western Montana. The most successful streambank stabilization efforts combine techniques from the tool boxes of different disciplines, such as incorporating soil bioengineering techniques with natural channel design structures like log vanes and engineered log jams. In addition to improving channel function and stability, including native species revegetation as part of streambank stabilization accounts for ecological processes necessary for long-term self-maintenance of restoration projects. Ecological processes that influence vegetation development along streams include alluvial bar deposition, plant community succession and related soil development, surface water/groundwater connection, and wildlife influences such as deer browse and beaver dams. Considering different vegetation development pathways in the context of these processes will result in streambank stabilization efforts that are self-sustaining and support objectives for instream habitat, riparian revegetation, and dynamic stability at the reach scale.

Dual-Frequency Identification Sonar (DIDSON) For Fisheries Applications: Cool Tool Or Expensive Toy?

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The Dual-Frequency Identification Sonar (DIDSON) camera was developed for inspection and identification of objects underwater in highly turbid environments, using acoustic lenses and sonar technology to deliver near video-quality images. Although developed primarily for the Navy to image underwater structures, such as mines and ship hulls, the DIDSON is now available to the public and is being used for other applications. Reclamation has been exploring the technology to determine if it can provide a useful tool for fisheries management. The DIDSON camera operates using sound frequencies and allows observations of fish behavior in large, turbid rivers where video camera observations are impossible, and is also useful in identification of substrates and observation of other underwater structures. Reclamation has captured images of razorback sucker (*Xyrauchen texanus*) spawning behavior in the Colorado River and is currently using the technology on the Yellowstone and Missouri Rivers in hopes of documenting behavior of the endangered pallid sturgeon (Scaphirynchus albus) and other native fish. Preliminary results are promising. We found that the best image quality is obtained by deploying the camera on a remote controlled underwater tripod. The most effective methods are either using the camera in conjunction with radio telemetry to locate a known target or by setting the camera in favorable habitat and waiting for fish. Though there are some limitations, DIDSON technology may provide a useful tool for fisheries applications.

Spawning Abundance Of Bull Trout In Relation To Geomorphology, Temperature And Roads In Tributaries Of Rock Creek Basin (Missoula And Granite Counties), Montana

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Land management is a pervasive influence on imperiled native aquatic species, but its effects are often difficult to tease from those of natural environmental variation. To discriminate these effects, we first indexed bull trout (*Salvelinus confluentus*) spawner abundance from redd survey counts made in 19 tributaries of Rock Creek—Upper Clark Fork Basin, Montana (Missoula and Granite Counties). We compared response metrics of spawner abundance against a large suite of environmental variables, including measures of geomorphology, summer stream temperature and land management. We iterated multivariate analyses to compare effects of alternate aggregation and stratification methods for both response and environmental variables. Significance tests revealed several robust results: spawner abundance increased with channel or sub-basin slope, declined with maximum stream temperature, increased with proportion of sub-basin in wilderness and roadless area, and increased with extent of bounded alluvial valley geomorphology. Catchment road density did not correlate with bull trout spawning, but the range of road density among Rock Creek sites was one order of magnitude lower than in a previously published analysis for Swan River tributaries (Baxter et al. 1999). The two studies showed highly consistent associations with catchment and stream hydrogeomorphic features. We hypothesize that proportional roadless area, a variable that reflects

the dispersion of road disturbance within the catchment, is an important factor at low road density, but at moderate and higher road densities prevailing across the bull trout's range, total road density tends to saturate or override the effect of spatial distribution of roads within the catchment.

Eustache Creek Mine Site And Stream Channel Reclamation-Planning, Monitoring, And Implementation

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Mining for gold in middle and headwater tributary streams of the Ninemile Creek watershed, a middle Clark Fork River tributary, has left numerous physical and biological legacies slow to heal. These legacies include unstable channel and floodplain habitats, an inhibited riparian community, increased water temperatures, reduced stream channel complexity, disconnected surface flow and altered fish assemblages. Large-scale fire and landscape scale evaluations in Ninemile watershed provided the planning backdrop for prioritization, partnership, and implementation of the Eustache Creek project, a 1-mi reclamation project in the headwaters of Ninemile Creek. Reclamation objectives include: provide bedload transport through the reach by facilitating deposition and scour without excessive aggradation or degradation, increase channel complexity (wood, pools, substrate), re-watering dewatered channel segments, and improving the ability of floodplain surfaces to support primary and secondary succession of native vegetation. We used a geomorphic design approach to establish stream channel and floodplain configurations in an attempt to achieve these objectives. Restoration techniques included collection and propagation of native riparian seed for transplant back to reclaimed surfaces, use of shallow groundwater retention sills, rootwad composites and wood vane structures to assist with initial channel stability and complexity, and organic amendments to mine spoils. No large rock was imported to fix the channel in place. Pre- and post-project monitoring includes longitudinal and cross-section profiles, fish abundance and movement estimates, aquatic invertebrate metrics, water temperature monitoring, instream habitat metrics, and photo points in both the reconstructed and a reference tributary similar to Eustache Creek. Preliminary findings were discussed.

Hebgen Reservoir Activities Update: Still Looking At Factors That Could Potentially Be Limiting Wild Rainbow Trout Recruitment To The Hebgen Fishery

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Seldom does a lake or reservoir environment contain sufficient spawning and rearing habitat to support a self-sustaining fishery and maintenance of the sport fishery is achieved through stocking. Hebgen Reservoir, however, is rare among reservoir systems. Numerous tributaries with in the Hebgen system provide high quality spawning and rearing habitat. Brown trout Salmo trutta have been self-sustaining since 1956, and spawning runs of wild rainbow trout (*Oncorhynchus mykiss*) occur in nine Hebgen tributaries. In 2002 a graduate research project investigated tributary potential for recruitment of wild rainbow trout. Results of the study suggested that quantity and quality of spawning and rearing habitat was not likely limiting wild rainbow trout production, but other factors in the tributaries and reservoir may be affecting recruitment to the adult population. Therefore, upon recommendations of the 2002 study, Montana Fish, Wildlife and Parks in conjunction with the Gallatin National Forest initiated investigations to identify other factors within tributaries and the reservoir that may be influencing wild rainbow trout survival and recruitment to the adult population in the Hebgen Basin.

Population Structure And Seasonal Habitat Use Of The Northern Pike Population Of Cabinet Gorge Reservoir, Montana

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Northern pike (*Esox lucius*) have been shown to impact salmonid communities in many areas where this predatory species has become established. The potential for such impacts to limit the effectiveness of native salmonid management and mitigation programs for Cabinet Gorge Reservoir and its tributaries provided the impetus for this study. This study employed active and passive capture techniques to characterize the northern pike population and to provide fish for radio-tagging. A total of 51 northern pike were radio-tagged and tracked over the course of this study (Apr 2003-Jul 2005) to ascertain habitat use and possible overlap with native salmonids. Telemetry depicted northern pike closely associated with shallower habitats characterized by abundant aquatic vegetation. Hard part aging found most northern pike captured were between 4 and 6 yrs of age. Proportional stock density and relative weight indices averaged 85 and 141, respectively. Opportunistic angler surveys portrayed a northern pike-based recreational fishery of increasing popularity. Extensive efforts to document reproduction suggested that water level fluctuations negated successful spawning. Although no bull trout Salvelinus confluentus or westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) were found in 66 stomachs sampled or 19 instances when gastric lavage was performed, the preponderance of northern pike detections in Bull River Bay represented a significant opportunity for predation of migratory native salmonids from this important nursery tributary. Based on the history of impacts northern pike have had on native salmonids in other systems, possible corrective fisheries management measures may be warranted.