Biological Sciences – Aquatic

Rural Stakeholders and Arctic Grayling Management in the Big Hole River Watershed, Montana, USA

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In order to counteract Arctic grayling (*Thymallus arcticus*) population declines in the Big Hole River, rural stakeholders have partnered with natural resource managers on Candidate Conservation Agreements with Assurances (CCAA) activities. Surveys designed to assess attitudes towards grayling management practices were sent to 300 watershed residents in February 2008. We received 83 responses, mostly from men ≥ 50 years who identified their occupation as farming, ranching, government or retired. Respondents indicated grayling numbers had declined (31%) or stayed about the same (25%) in the last 10 yrs, and that it would be favorable for grayling numbers to increase (60%). Respondents chose drought, habitat loss and birds as factors strongly associated with declining grayling numbers. Activities listed as strongly associated with increasing grayling numbers varied, but often included drought management. Demographic trends among area residents match those typical of rural western communities; 62 percent are 45 years or older, 17 percent live below the poverty line, and 76 percent lack a college degree. The benefit of CCAA activities to the local "restoration" economy included an influx of nearly $2 million since 2006. CCAA activities could be linked to future federal infrastructure, education and workforce training programs, with substantial benefits to the local populace.

Diversion Dams and Fish Passage – Don't Give Up the Fight!

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The Tongue River, in southeastern Montana, is a major tributary to the Yellowstone River. Numerous Yellowstone River fish species utilize the Tongue River for spawning. However, diversion dams have limited fish migrations up this system. Through persistent efforts, measured in careers not years, fish passage around these diversion dams and complete removal of other dams is occurring. T&Y Diversion dam, constructed in the 1880s, is the first dam migrating fish encounter, and it is a complete fish barrier. During fall 2007, a fish bypass (named Muggli Bypass) was completed to allow fish passage around T&Y Diversion Dam. Fish sampling was conducted in 2008 to evaluate the success of this structure. A fyke net was utilized to sample fish that successfully navigated the complete length of the bypass channel. Electrofishing was conducted upstream and downstream of the diversion dam to compare relative abundances of fish in the river to those collected in the bypass. Nineteen fish species were successful in passing through the bypass during the sampling period and four additional species were collected in the bypass channel when it was block netted and drained. Comparatively, 29 fish species were collected downstream of the diversion dam. Electrofishing upstream of T&Y Dam found four species (freshwater drum, goldeye, smallmouth buffalo and western silvery minnow) which have never been documented upstream of the dam. In summary, the Muggli Bypass is a noteworthy success story.

Competition as a Factor in Displacement of Native Cutthroat Trout by Nonnative Rainbow and Hybrid Trout

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Native salmonid fishes have been displaced worldwide by nonnatives through competition and hybridization, but dynamics of these factors are poorly understood. We apply a Lotka-Volterra population model to displacement of cutthroat trout (*Oncorhynchus clarkii*) by rainbow (*Oncorhynchus mykiss*)/hybrid trout in the Snake River, USA. Cutthroat trout are susceptible to hybridization in the river but are reproductively isolated in tributaries via removal of migratory rainbow/hybrid spawners at weirs. Hybridization is the primary mechanism for initial growth of the rainbow/hybrid trout population, but a model with hybridization alone does not explain observed trends. Two models, in which competition occurs 1) among river-spawned fish only and 2) among all fish, explain observed trends, but are indistinguishable from one another based on fit to data. When tributary-spawned cutthroat trout out-migrate as fry, competition with rainbow/hybrid trout results in extinction of cutthroat trout, even though reproductive segregation is maintained.

Perspectives on Not Listing the Fluvial Arctic Grayling

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I summarize views held by the Big Hole River Foundation and provide insights into potential positive and negative outcomes of listing the fluvial Arctic grayling (*Thymallus arcticus*) under the Endangered Species Act. The perception that listing would lead to recovery of the grayling was evaluated based on past recovery of listed species. Currently, 1,925 species are on the Endangered Species List as either Threatened or Endangered. The number of species listed increased during the 1990s, but has decreased in recent years. To date, 48 species have been removed from the list; 22 have been "recovered," 17 have been reclassified due to data errors, and nine have gone extinct. For species in the contiguous U.S., 15 have been recovered, seven have gone extinct, and 15 have been removed due to data errors. The rate of recovery is estimated at 1.1 percent for North American species, and no fish species have been recovered to date. A common perception that a listing would increase funding was evaluated and showed that relatively little funds are available for species recovery under Section 6 of the ESA, when compared to other federal funding sources. Although the Foundation thinks evidence suggests a listing is warranted, they are supporting the CCAA is an appropriate means of addressing species recovery in the Big Hole.

Toxicity of Rotenone to Larval Amphibians

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Piscicide use in fisheries management is becoming increasingly common. Rotenone, specifically, is being used to remove non-native fish species from aquatic systems. While

the effects of this chemical on fish are well-studied, the impacts of rotenone on non-target species, such as amphibians, are not well known. This study was conducted to determine the toxicity of rotenone on two native species of tadpoles in Montana – *Rana luteiventris* and *Bufo boreas* – under laboratory conditions. For each species, tadpoles at three developmental stages were exposed to either a control or CFT Legumine (5% active rotenone) at one of four doses (0.1 mg/L, 0.5 mg/L, 1 mg/L, 2 mg/L). Total exposure time was 96 hours. Parameters measured included mortality at 96 hrs post treatment, and in the survivors, weight, Snout-Urostyle Length, and time to metamorphosis. In addition to the rotenone exposure trials, a recovery trial was conducted with early stage spotted frog tadpoles to determine survivability of tadpoles exposed to rotenone at 1 mg/L and then placed in clean water. Spotted frog tadpoles exposed to rotenone at 1mg/L – typical field application dose– experienced significantly greater mortality than control tadpoles. Although all stages of frog tadpoles exposed to rotenone were negatively affected by the chemical, the effect was worse at earlier life stages. Early stage toad tadpoles were significantly more resistant to rotenone exposure at 1 mg/L than early stage spotted frog tadpoles; however they were still negatively affected by the chemical. Sub-lethal effects, though statistically different between control and exposed survivors in two instances, were not consistent and therefore thought not to be biologically significant. Spotted frog tadpoles exposed to rotenone and then transferred to clean water experienced significantly lower mortality than those exposed for the full 96 hrs. Overall, rotenone exposure was found to be lethal to tadpoles of both species at all three developmental stages though mortality was not uniform across dosages or age groups.

Bull Trout Monitoring; Look Deep and Wide

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In most of the Bitterroot drainage fluvial westslope cutthroat (*Oncorhynchus clarkii lewisi*) trout are fairly common and fluvial bull trout (*Salvelinus confluentus*) are rare. Monitoring the fluvial cutthroats is not difficult because mainstem population estimates are possible. However, due to the small number of fluvial bull trout, population estimates are not obtainable and redd counts are inconclusive. Monitoring of juvenile and resident populations also presents challenges. Population estimates (intensive) of bull trout that have the potential of providing quantitative data can be difficult to collect and basin-wide distribution (extensive) generally does not provide quantitative information. On the Bitterroot National Forest we have monitored bull trout and westslope cutthroat trout using mark-recapture population estimates for nearly 20 years. While these data allow us to follow trends within the reaches of a stream where populations are densest, it is not designed to identify trends in distribution. We have collected more extensive data but not in a systematic manner. We propose formalizing the collection of single pass electrofishing on short reaches throughout selected streams to augment the monitoring reaches established many years ago.

Population Characteristics of Lake Trout in Swan Lake, MT

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The recent establishment of lake trout (*Salvelinus namaycush*) in Swan Lake, Montana threatens one of the most productive bull trout (*Salvelinus confluentus*) fisheries remaining in the USA. Management of invasive lake trout in other systems has been focused on suppression often without establishing a thorough baseline from which to evaluate the impacts of suppression efforts. Describing the population dynamics of lake trout in Swan Lake prior to suppression efforts will provide a baseline for evaluating the effects of exploitation in the future. In 2007 and 2008 extensive gill net sampling provided data to estimate size structure, density, condition, maturity, fecundity, age structure and mortality of lake trout. Size structure indices in 2007 and 2008 were low with proportional size distributions (PSD) values of 7 and 8 respectively. Lake trout density was estimated at 8800 (7300-10,500 95% CI) fish > 160 mm. Condition of lake trout in Swan Lake is among the highest recorded for populations in the northwestern USA. Relative weight (W_r) values varied from 92 for fish between 300 and 499 mm to > 120 for fish between 800 and 999 mm. Fifty percent of male lake trout mature at 584 mm and 50 percent of females at 726 mm. Fishing mortality was estimated between 36 percent and 52 percent based on the population estimate in 2008 and those fish removed. The thorough baseline established by this study provides managers with a reference point for evaluating the effects of exploitation on the lake trout population in Swan Lake, Montana.

Cutthroat Trout Struggle for Persistence in the Face of an Expanding Lake Trout Population in Yellowstone Lake

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Lake trout *Salvelinuus namaycush* were discovered in Yellowstone Lake in 1994. The ecological threat of this non-native fish was immediately recognized and efforts to control lake trout were initiated the following year. The objective of the removal program is to reduce lake trout to the point where their effect on native Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) is minimized. Lake trout capture techniques have focused on mechanical methods, mostly gill netting, and more recently electrofishing. Despite removal of almost 350,000 lake trout since 1995, with 76,140 removed in 2008 alone, all indicators point toward continued population growth. Catch per effort of juvenile lake trout has steadily increased since 2002 with 2008 being the highest on record (5.0 lake trout/100 m gill net set per night) since 1998. However, cutthroat trout have not shown a positive response to lake trout removal efforts. Numbers of spawning cutthroat trout in Clear Creek, a tributary to Yellowstone Lake, are at the lowest levels ever recorded and the lakewide cutthroat trout assessment catches are averaging 40 percent fewer cutthroat trout over the past 5 yrs when compared to pre-lake trout years. In 2008 a panel of experts convened to assess the current status of cutthroat trout and review lake trout removal efforts in Yellowstone Lake. The panel concluded that while current

levels of suppression have slowed lake trout population growth, more is required if a healthy cutthroat trout population is expected to persist in Yellowstone Lake. They concluded it was imperative that we immediately increase suppression efforts, and develop/implement lake trout monitoring.

Estimating Lake Survival of Juvenile Bull Trout in Trestle Creek, Idaho in the Presence of Changing Fish Communities, Land Use, and Fish Management

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A total of 921 age-1 and older juvenile bull trout (*Salvelinus confluentus*) were marked emigrating from Trestle Creek, Idaho, from 2000 through 2002. Individual juvenile bull trout were marked with abdominally implanted PIT tags, and adult returns were monitored at an automated PIT tag detection weir, as well as at fish traps through 2008. All marked juveniles returned as adults by the end of the 2007 field season. Minimum estimates of survival from outmigrating juvenile to returning adult were similar across study years, and ranged from 8.9 percent to 15.5 percent. Short-term tag retention and survival of marked juveniles was high, but long-term tag loss estimated by examination of double-marked returning adult bull trout indicated substantial tag loss over time. Generally, outmigrating juveniles reared in the lake environment for between 3 and 5 growing seasons before returning as adults, with most spending four growing seasons in the lake (not including their "return year" as a year at-large in the lake). In general, return rates for larger outmigrants were higher than those for smaller outmigrants. Additional studies quantifying lake/river survival of migratory bull trout in other systems are needed to put these results into an appropriate ecological context, and to better understand the complex and likely interacting effects of non-native fish, land use, and fish management on bull trout recruitment.

Bull Trout Entrainment at Libby Dam in the Kootenai River, Montana

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Montana Fish, Wildlife and Parks has used nighttime jetboat electrofishing to conduct annual mark-recapture population estimates of adult bull trout (*Salvelinus confluentus*) in the Libby Dam tailrace since 2004. Estimates are conducted during April or May within this 3.5-mi section of the Kootenai River, and have ranged from 176 bull trout in 2006 to 1079 bull trout in 2005. We collected tissue and scale samples from all bull trout we handled, and marked all fish with PIT tags, which allowed us to obtain capture histories across years for many fish. We recaptured 53 bull trout that were previously marked ranging between 285 to 1469 days prior. The recaptured bull trout grew an average of 101.4 mm (0.2 mm/day), and gained an average of 1869 g (3.1 g/day). Juvenile bull trout were collected from 15 tributaries within the Kootenai River Basin in British Columbia and Montana to develop a genetic methodology using microsatellite loci to assess whether fish originated above or below Libby Dam. Results indicated that there is a high degree of genetic variation among different bull trout populations within the Kootenai River basin. Jackknife analysis of our baseline data

set indicated that we had a high degree of power (> 95%) to correctly assign unknown fish captured in the Kootenai River as originating either upstream or downstream of Libby Dam. We applied this methodology to the tissue and scale samples collected each year below Libby Dam during the population estimates to predict origin, and estimated that the proportion of the fish originating above Libby Dam ranged from 49.1 percent in 2004 to 62.7 percent in 2006. The majority of the adults assigned to populations above the dam were assigned to the Wigwam River, British Columbia, which represented the tributary with the highest number of bull trout redds in recent years.

Patterns Of Trout Survival and Movement Before and After Logging on Industrial Forest Lands

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Clear-cut timber harvest continues to be a common practice that frequently results in a patchwork of disturbance across the landscape. Although harvest techniques have greatly improved over the past half-century, effects of contemporary harvest methods on adjacent (point) and downstream (cumulative) portions of the aquatic network are not well documented. Therefore, we sought to quantify spatial and temporal patterns of survival and movement of coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) in two, experimentally-paired watersheds in the Cascade Mountains of Oregon, before and recently after logging. All harvest units were located along non-fish bearing channels upstream from the end of fish distribution. A total of 4406 trout (>100 mm, fork length) were implanted with half-duplex passive integrated transponder (PIT) tags and monitored seasonally during a 5-yr period (3 yrs before and 2 after harvest) using a combination of electrofishing and mobile and stationary PIT-tag antennas. Apparent survival varied widely among seasons and years, and variation among subcatchments was small in comparison. Seasonal apparent survival, regardless of year or subcatchment, was always lowest during the fall (Sep 15-Dec 15). There was no significant effect of this logging treatment on survival of coastal cutthroat trout in this headwater stream network, and although there was some increase in the probability for movement following logging, it remained low. In general, these data suggest that contemporary forest harvest practices regulations provided adequate short-term protection for coastal cutthroat trout from potentially negative consequences of timber harvest in the non-fish bearing portions of the Hinkle Creek drainage.

Avian Piscivores Vector in the Greater Yellowstone Ecosystem

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Although often blamed on movement of trout, the dispersal vector of *Myxobolus cerebralis* among aquatic habitats often remains unknown. Occurrence of whirling disease in native Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) within the highly protected environment of Yellowstone Lake is one example. Given their local abundances, we sought to clarify the potential role of highly mobile piscivorous birds in the dissemination of *M. cerebralis* to otherwise isolated habitats. Six each of American White Pelicans (*Pelicanus erythrorhynchos*), Double-crested Cormorants (*Phalacrocorax auritus*), and Great Blue Herons (*Ardea herodius*) were held in an aviary and fed known-infected or uninfected rainbow trout (*O. c. mykiss*). Fecal material produced during 10-day periods before and after feeding was collected to determine if M. cerebralis could be detected and, if so, remained viable after passage through the gastrointestinal tract of these birds. Fecal samples from all (100%) of the nine birds fed known-infected trout and collected during days 1-4 following feeding tested positive for the presence of *M. cerebralis* by PCR. In addition, *Tubifex tubifex* fed fecal material from known-infected herons produced triactinomyxons in laboratory cultures, confirming the persistent viability of the parasite. Given the infection prevalence of cutthroat trout within Yellowstone Lake, pelicans, cormorants, and herons can move an estimated 1.27 billion *M. cerebralis* myxospores in the ecosystem during a 100-day breeding season each year. Piscivorous birds have the potential to concentrate and release *M. cerebralis* myxospores with fecal material into habitats highly suitable for *T. tubifex*, forming the basis of a positive feedback loop where the proliferation of *M. cerebralis* is supported.

Landscape Conservation and the Big Hole CCAA Program

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Beyond the tangible results across riparian and aquatic habitats of the upper Big Hole basin, the CCAA restoration program creates new opportunities for an array of landscape-scale conservation activities. The public and private partnerships forged through the CCAA program and the local watershed groups provide a valuable system for advancing collaboration conservation including: private land conservation, invasive species management, wetland restoration, bird and plant monitoring, fire management, and preservation of other species of concern or federally listed species. Proposed and on-going projects in the Big Hole, as well as lessons that can be applied to other biologically important landscapes, will be presented.

Reduced Genetic Variation in Upper Missouri River Drainage Westslope Cutthroat Trout Populations Appears to be Due to Historical and Contemporary Factors

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The number of westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) local populations has decreased over the past 100 years. In Montana, this decrease has been most severe in the upper Missouri River drainage. The remaining populations in the drainage tend to be small and confined to headwater streams isolated above man made or natural barriers. Data from 14 nuclear loci indicate that mean average expected heterozygosity (Columbia = 0.155, Missouri = 0.064), mean proportion of polymorphic loci (0.321, 0.179), and mean average number of alleles per locus (2.040, 1.313) were all significantly smaller within 16 Missouri populations than within 34 upper Columbia River populations. Total heterozygosity among the Missouri populations (0.106) was only about half of that observed among 16 randomly chosen Columbia populations (0.194). The average number of alleles per locus was also lower among the Missouri (2.714) than Columbia (3.643) populations. These latter two observations suggest that the reduced genetic variation in the Missouri populations is partially the result of a significant founder effect when the fish colonized the drainage. The relative amount of genetic divergence among the Missouri populations (F_{ST} = 39.4%) was about twice that observed among the Columbia populations (20.5%) suggesting that subsequent to colonization the former have experienced more genetic drift and isolation than the latter. Because of their reduced genetic variation, genetic rescue is more likely to be required in Missouri than Columbia populations. Furthermore, the reduced genetic variation in the Missouri populations may retard their response to other conservation actions.

A Fish Hatchery's Role in a Changing Montana

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Demographic change is sweeping across Montana like a racing wild fire, rapidly changing the mix of rural and urban dwellers and the face of Montana politics. A good percentage of these new residents have relocated to Montana specifically to partake in the time honored Montana traditions of hunting and fishing. Interest in fish and wildlife is at an all time high. As the natural resources of our state are pursued more intensely by residents and nonresidents, as well as consumptive and non-consumptive users, the management of these resources must adjust in order to protect fragile native populations. How will fish managers respond to this growth? What role should fish hatcheries play in Montana today? Are fish managers utilizing this conservation tool in the right manner? How much effort should be put into restoring threatened native populations? What attempts should be made trying to increase recreational opportunities throughout the state? The Creston NFH has served a unique role in Montana fish production, constantly changing and evolving, for over seventy years. Creston

has played a support role in several restoration and recreational fishery projects. Some of these have failed and some have created world class fisheries. This talk will focus on the lessons we have learned and how we can put those lessons to use in playing a future role in conserving, protecting, and enhancing Montana's fishery resource.

Hybridization Rapidly Reduces Fitness of Native Cutthroat Trout in the Wild

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Human-mediated hybridization between native and invasive species is a leading cause of biodiversity loss worldwide. How hybridization affects fitness and what level of hybridization is permissible pose difficult conservation questions with little supportive empirical information to inform policy and management. This is particularly true for salmonids, where widespread introgression among nonnative and native taxa often create hybrid swarms over extensive geographic areas, threatening natives with genomic extinction. Here, we used parentage analysis with multilocus microsatellite markers to measure how varying levels of genetic introgression with nonnative rainbow trout (*Oncorhynchus mykiss*) affect reproductive success (number of offspring per adult) of native westslope cutthroat trout (*O. clarkii lewisi*) in the wild. Small amounts of hybridization markedly reduced reproductive success of male and female trout, with fitness sharply declining by ~50 percent with only 20 percent nonnative admixture. Despite heavy fitness costs, our data suggest that hybridization may spread due to relatively high fitness of first-generation hybrids and inordinately high reproductive success of a few males with high levels of nonnative admixture. This outbreeding depression suggests that even low levels of nonnative genetic admixture may have negative effects on reproductive success in the wild and that policies protecting hybridized populations may need reconsideration.

Effects of Large Wood Placement on Channel Morphology and Aquatic Habitat Hallowat Creek, North Fork Flathead River Drainage, Montana

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Montana Fish, Wildlife and Parks (MFWP) documented a substantial reduction in bull trout (*Salvelinus confluentus*), spawning redds in Hallowat Creek, a tributary to Big Creek of the North Fork Flathead River. The Big Creek watershed is an important spawning tributary for fluvial bull trout, a federally-listed threatened species (USDI Fish and Wildlife Service 1998). USDA Forest Service fire suppression efforts undertaken during the 2001 Moose Creek

Fire influenced channel hydraulics and spawning habitat distribution in Hallowat Creek. Fire suppression activities included cutting large woody debris within the active channel and riparian zone. Stable large wood loss resulted in a more simplified channel characterized by coarse substrate, few pools, and infrequent large woody debris. In 2005, River Design Group, Inc. (RDG), MFWP and FNF implemented an in-channel treatment plan for Hallowat Creek. Large wood was imported to the active channel and arranged in stable wood complexes to promote pool development. Reach-specific treatments were developed to either meet or exceed large woody debris counts that were enumerated in a pre-fire, 1998 R1R4 survey conducted by the FNF. Channel monitoring surveys and annual bull trout redd counts were completed in 2005, 2006 and 2008 to assess spawning and geomorphic response to the structures. Results suggest augmenting existing stable large wood structures with additional wood, and building structures that are anchored to stable floodplain features provide the best opportunity for increasing complex pool habitat in Hallowat Creek. This presentation summarizes the monitoring data and provides recommendations to practitioners engaged in similar habitat restoration projects in forested, mountain streams.

Creating Wildlife Habitat and Expanding Fisheries with BioHaven® Floating Treatment Wetlands

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BioHaven® floating islands are an environmentally low impact and economical way to create new wetland, while augmenting the vitality and biodiversity of a waterway. They are made using non-toxic recycled materials and are hands off and non-mechanical. The biomimetic design gives our fish, wildlife and waters the least carbon footprint and the most natural support for the systems they depend upon for healthy and productive lifecycles. The benefits are many: habitat creation and restoration for a myriad of fauna, from microbiological systems to aquatic and wetland wildlife; reduced turbidity and pollution mitigation (with resource recovery of nutrients such as nitrate and phosphate); and aesthetic and unique living water features of any size or shape for any water body. Floating Islands used in landscaped water features and pools offer a chemical free approach to managing water quality. Placed in a stream or pond, BioHavens and their suspended root complex give secure habitat for fish, offering shade and protection from currents and predators. The living islands attract a range of insects that also become a food source for fish and wildlife and further promote biodiversity. Unique configurations can be designed for nesting sites, spawning platforms and load bearing hanging banks to increase protective fish habitat. Several projects have developed successful, protective bird habitat specifically for Duck, Loon and Swan and a 22,000 sf Caspian Tern Habitat Island.

An Overview of the Candidate Conservation Agreement with Assurances Program, with Special Reference to the Big Hole River, Montana

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In 1999 the Candidate Conservation Agreement with Assurances (CCAA) program was initiated by the USDI Fish and Wildlife Service to engage private landowners in species conservation before a potential listing under the Endangered Species Act (ESA). For their

participation, private landowners receive assurances that they will not be subjected to additional regulatory burden should the species be listed. Hundreds or thousands of species are potentially eligible for this program, but only a few dozen CCAA's have been completed and the scope and complexity varies widely among individual agreements. Because the program is relatively new, there are little data to evaluate the biological effectiveness of CCAAs. However a few agreements can be considered a success in terms of landowner participation. Issuing permits under the ESA has led to litigation for other conservation programs like Habitat Conservation Plans (HCPs), but the validity of the CCAA policy and individual CCAA agreements have not yet been subjected to formal legal challenge. I briefly summarize the basic premise of the CCAA program, the different organizational frameworks to structure these agreements, and some of the institutional and social challenges to effective implementation, highlighting the example of the CCAA for fluvial Arctic grayling in the upper Big Hole River, Montana.

Genetic Variation, Ancestry and Population Structure in Native Arctic Grayling in the Upper Missouri River

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Arctic grayling (*Thymallus arcticus*) were thought to be historically widespread in the Missouri River system in Montana and Wyoming, but have been reduced to a handful of remnant populations since Euro-American colonization. Conservation efforts have focused primarily on protecting the fluvial population in the Big Hole River, and re-establishing fluvial populations elsewhere. Widespread historical stocking of exogenous grayling has created some uncertainty about the origin of extant populations and the composition of native gene pools. Additionally, declines in native populations may have reduced the genetic template for adaptation and recovery. Effective conservation would benefit from a better understanding of genetic ancestries, and whether bottlenecks have substantially altered genetic diversity of remnant populations. Consequently, we conducted a population-level genetic analysis of native and introduced grayling from 18 locations. We genotyped 730 grayling at 10 microsatellite loci and used these data to identify population groupings, genetic variation within and among groups, and evaluate evidence for population bottlenecks. We found significant divergence among native populations from the Big Hole River, Madison River, and Red Rock lakes. The Big Hole population had greater heterozygosity and allelic diversity than the Madison and Red Rock populations, both of which showed some evidence of recent bottlenecks. Most introduced populations traced their ancestry to the adfluvial Red Rock lakes population, and we did not find strong evidence that stocking of hatchery grayling homogenized native gene pools. Geographic patterns of genetic variation among native Missouri River grayling were consistent with differentiated local populations historically connected by occasional gene flow.

The East Fork Specimen Creek Westslope Cutthroat Trout Restoration Project: the Good, the Bad, and the Smokey

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Initiation of the East Fork Specimen Creek (EFSC) westslope cutthroat trout (*Oncorhynchus clarkii lewisi*; WCT) restoration project in 2005 marked the beginning of a renewed effort to actively restore native fish in Yellowstone National Park. That summer an interdisciplinary team was assembled to begin a NEPA compliance process and within 12 months an EA and FONSI were complete. Project implementation began immediately with chemical removal of nonnative fish in High Lake, a 7-ac isolated headwater lake, in August 2006. Unfortunately, the construction of a fish barrier on EFSC, planned for completion in 2007, was delayed by a natural wildfire that destroyed all previous work and left an unsafe worksite. Rotenone treatment of High Lake was successful and we began efforts to restock the lake with genetically-pure WCT (from multiple sources) that year. In 2008 we again stocked High Lake with WCT and undertook a vigorous effort to complete the EFSC fish barrier. Because of its remoteness, 93 mule loads and five helicopter sling loads were required to move supplies and tools to the site. Contracted log crafting specialists, Montana Conservation Corps crews, and park staff collaborated to bring the barrier to successful completion. Immediately afterwards two piscicide treatments were conducted on EFSC from High Lake downstream to the fish barrier (12 km). Additional treatments of this reach are planned for 2009 and WCT reintroduction efforts will begin as soon as complete removal of non-native fish is verified.

Climate Change Mediates the Spatial Partitioning of Sculpin and Longnose Dace Leading to Trophic Cascades in Riverine Ecosystems of Western Montana

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Sculpin (*Cottus spp.*) and longnose dace (*Rhinichthys cataractae*), perform diverse roles in trophic interactions. Both are abundant inhabitants of the benthos, and longnose dace are present in nearly every Montana drainage. The ecological importance of both genera arises, in part, from their tendency to occur in high abundances, often dominating fish assemblages in number and biomass. Although both are numerous, small-bodied, and largely confined to the benthos, they occupy different trophic positions, express different life history tactics, and perform different ecological roles. Over the last few decades, west-central Montana rivers have warmed affecting the distribution of, among other species, longnose dace, and sculpin. Both species have undergone dramatic shifts in occupancy of habitats leading to ecotonal shifts on a broad geographical scale and this change has occurred rapidly and quietly. In general, as waters have warmed, longnose dace have replaced sculpin leading to the retreat and isolation of many sculpin metapopulations. Both species are sympatric with endangered species like the bull trout (*Salvelinus confluentus*), whose populations are targets for

protection, mitigation, and enhancement. It is unclear the effects of the replacement of sculpin by longnose dace, though they are likely large and measurable, and since they represent the basis of the food chain for higher trophic order organisms, this change could ultimately could affect the restorative potential of the systems for target species. Furthermore, warming and species replacement may lead to a further homogenization or regional distinctive ecotones and fauna.

Watershed-Scale Approach to Assessing Colorado River Cutthroat Trout Abundance and Habitat in the Upper Colorado River Headwaters

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Information concerning the effects of physical habitat on the distribution, abundance, and population structure of salmonid fishes has been routinely gathered at the site and reach scales, but data collected at these scales has provided little insight into spatial and temporal structure of fish assemblages within the stream network. This is especially relevant where periodic disturbances across the landscape are extensive, and effects are not uniform (spatially or temporally). To gain new insight into the relationships between trout abundance and population structure and the physical habitat at multiple spatial scales, we surveyed six watersheds in the upper Colorado River basin and assessed Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) abundance and habitat variables continuously throughout the stream network. The watersheds were selected randomly from a sampling frame based on presence of Colorado River cutthroat trout populations, percent beetle infestation of the watershed area, and erosion potential of the upslope geology. Although similar physical habitat conditions existed within and among several watersheds, fish distribution was patchy at the channel-unit scale, and physical habitat was not strongly related to distribution. However, at the reach scale, patterns of fish distribution explained a substantial amount of the variation in abundance. Further refining of these relationships will provide critical information necessary to assess future changes related to restoration activities, wildfire, and climate change.

Recovery Of Westslope Cutthroat Trout Populations Following Removal Of Nonnative Brook Trout

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We investigated whether 75-mm and longer westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) and brook trout (*Salvelinus fontinalis*) occupied similar niches by comparing biomasses, population densities, and condition factors prior to and following total removal of brook trout in 2.3- to 3.0-km reaches of three headwater streams in Montana. Biomasses and their associated errors were estimated using depletion estimators. Total trout biomass did not

change significantly after brook trout removal indicating that these two species have similar niches in these streams. Densities of juvenile westslope cutthroat trout were significantly and negatively affected by densities of juvenile brook trout and positively related to densities of adult westslope cutthroat trout ($R^2 = 0.482$; F-ratio = 15.415; $P < 0.001$). Including densities of westslope cutthroat trout or brook trout from the previous year did not measurably improved model performance. Densities of juvenile brook trout were negatively associated with body condition of juvenile westslope cutthroat trout. We found evidence for size-asymmetric competition in one stream, but not in the other where it was assessed. Interspecific competition between brook trout and westslope cutthroat trout was nearly as strong as intraspecific competition within westslope cutthroat trout, especially among juveniles, providing insight into one mechanism by which brook trout displace westslope cutthroat trout.

Spatial and Temporal Fish Entrainment from Hauser Reservoir, Montana

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Management sport fish populations of Hauser Reservoir, Montana, is hindered by undesirable and unpredictable downstream entrainment of fish through Hauser Dam. We quantified fish entrainment through Hauser Dam using hydroacoustic technology at turbine intakes from July 2007 to November 2008 and over the spillway from 21 May to 18 July 2008. Species composition of entrainment was characterized using multiple netting gears. Annual estimated turbine entrainment was higher in 2007 ($N = 99,148 \pm 5582$) than in 2008 ($N = 53,456 \pm 5,118$). Spillway entrainment ($N = 29,931 \pm 3173$) was 36 percent of total annual entrainment in 2008. Entrainment was higher in fall than in summer in both years, likely in response to fall turnover and the annual release of hatchery rainbow trout. Most entrained fish (~ 60%) were < 220 mm total length in both turbine discharge and spill. The most common fish captured were rainbow trout (43%), white sucker (27%), and walleye (15%). The least common were common carp and yellow perch. We applied species composition by size to the hydroacoustic data to identify fish species entrained, but most fish ($N = 74,062 \pm 4834$) could not be reliably assigned to a species because concurrent net catches did not include individuals of similar size. Most identified entrained fish were rainbow trout ($N = 33,472 \pm 3014$) and walleye ($N = 35,439 \pm 2953$). Identification of patterns in spatial and temporal fish losses affords fishery managers the ability to make more informed decisions about operation of this dam.

Mercury Contamination in the Fishes of Glacier National Park

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We investigated mercury contamination in fishes from four lakes in Glacier National Park. Three of these lakes (Bowman, Harrison, McDonald) are on the west side of the park, and one is on the east side (St Marys). We focused our sampling on lake trout (*Salvelinus namaycush*) but also collected lake whitefish (*Coregonus clupeaformis*), burbot (*Lota lota*), and incidentally killed bull trout (*Salvelinus confluentus*). Mercury contamination generally increased with fish size but not always. Lake trout and burbot were the most contaminated species and levels exceeding 0.5 ppm Hg wet occurred in the larger fish. We found that lake whitefish and bull trout generally had lower mercury levels than lake trout on a size normalized basis. Examination of the lake trout and lake whitefish data revealed that males and females had similar levels of mercury. Mercury levels in lake trout from the west side lakes showed similar trends with fish size, and were comparable to other lake trout populations in the region.

Adjusting Lake Trout Ages Versus Otolith Mass Relationships for Variable Growth

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Otolith weight holds considerable promise for increasing speed and consistency of age estimates relative to otolith thin sections, especially for species such as lake trout (*Salvelinus namaycush*) where age and otolith weight are highly related. Using known age lake trout from Lake Michigan we demonstrate that the age versus otolith mass relationship is dependent body growth rate, reducing the utility of otolith mass alone for estimating age when growth rates vary between samples. To compensate for this growth bias we developed a correction procedure. This procedure uses otolith weight versus total length relationships to estimate the body growth rate difference between samples, and then estimates the bias in the age versus otolith mass relationship. Using the correction procedure we successfully adjusted the Lake Michigan age versus otolith mass relationship to the more slowly growing Flathead Lake fish, revealing a pattern of declining body growth rates through time in the Flathead Lake population.

Are Lake Trout in Flathead Lake Morphologically and Genetically Segregated by Depth?

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We compared muscle lipid content, muscle stable isotope ratios, body morphology, and microsatellite allele frequencies between shallow (0-25 m) and deep caught (>50 m) lake trout (*Salvelinus namaycush*) from Flathead Lake, Montana. We found that lipid content was similar between depth groups. Stable isotopes of N and C varied between depth groups, demonstrating that individual fish exhibit long term depth preferences. Depth groups varied in their morphology. Relative to shallow fish, deep fish had a head more in line with the rest of the body, bigger eye, deeper body, wider skull, longer pectoral fin, and a deeper and shorter caudal peduncle. Microsatellite allele frequencies were similar between depth groups, strongly suggesting gene flow between shallow and deep fish.

Western Pearlshell Mussel Distribution & Status in Montana: Two Years Later, It's Worse Than We Thought!

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Montana's only trout stream mussel, the western pearlshell (*Margaritifera falcata*), has disappeared from many of our watersheds in relatively recent times. During 2006 and 2007, we reviewed western pearlshell occurrence records and systematically resurveyed sites of current and historic occupation in watersheds throughout the state. Twenty-five of the original 40 site records proved to be either absent or had non-viable mussel populations; only seven of the 15 viable populations documented in 2007 were classified as having excellent integrity. Extensive field surveys and biologist training workshops continued in 2008, but only four additional viable populations were reported. Of the ~820 stream reaches (avg. length ~150 m) surveyed over the course of 3 yrs, western pearlshell populations were absent from 660 (76 %) of the reaches and non-viable to severely declining from another 139 sites (16%). Sites with excellent population viability (9) were rare and represented disjunct metapopulations with little ability to colonize other stream reaches in the watershed. Because of this fact, the evaluation of current vs. previously occupied river miles and the severity of the decline, we officially placed this species on the Species of Concern list in November ranked an S2 (vulnerable to extirpation in the state). Introduction of non-native fishes, reduction of westslope cutthroat populations, reduced in-stream flows and warmer water temperatures have all been implicated in the decline of populations of the western pearlshell. Reintroduction of western pearlshells into westslope cutthroat trout restored stream reaches is currently being investigated.

Proposed Coal Mining and Coal-Bed Methane Development Threaten Aquatic Resources in the Transboundary Flathead Ecosystem

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The Transboundary Flathead River basin in Montana (USA) and British Columbia (Canada) hosts one of the most diverse and unique aquatic ecosystems throughout North America. Migratory bull trout (*Salvelinus confluentus*) and non-hybridized westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) migrate from Flathead Lake upstream to the Canadian headwaters to spawn and rear, representing some of the last remaining strongholds in the basin. However, proposed open-pit coal mining and coalbed methane (CBM) drilling in the Canadian headwaters threaten water quality, invertebrate communities, and migratory fish populations downstream to Glacier National Park (GNP) and Flathead Lake. In response to these threats, a multi-agency, long-term research and monitoring program was initiated in 2005 to examine water and sediment chemistry, contaminant levels, aquatic habitat, and the distribution and genetic diversity of native fishes. Comparative data collected in the neighboring Elk River drainage, a system impacted by coal mining and CBM development, show increased nutrients and heavy metal concentrations in the water and lower invertebrate species richness than the Flathead. In 2008, basin-wide fisheries surveys were initiated and data were collected at 119 sites in Canada and GNP. Native fishes were found throughout much of the system, including proposed mining locations. Additionally, the highest quantity of bull trout redds in the system was detected immediately downstream of proposed mine sites. Continuation of these collaborative investigations will provide necessary baseline data to inform conservation and management decisions impacting this diverse and sensitive transboundary system.

Analysis Of Population Metrics to Assess the Efficacy of Lake Trout Suppression in Yellowstone Lake, Yellowstone National Park

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Introduced lake trout (*Salvelinus namaycush*) threaten to extirpate native Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* from Yellowstone Lake, Yellowstone National Park. The USDI National Park Service removed nearly 280,000 lake trout from Yellowstone Lake between 1997 and 2007. Lake trout population size has not been estimated; therefore, it is difficult to determine what proportion has been removed. We evaluated several population metrics to determine if the removal program caused the lake trout population to exhibit characteristics typical of overharvested populations. Biomass of lake trout harvested has

increased through the duration of the suppression program and was 0.74 kg/ha in 2007. Catch-per-unit-effort of lake trout has increased in both targeted-removal and survey netting. Mean length at age declined from 2000 through 2006 for lake trout older than 8 years. Total annual mortality in 2007 was 37 percent for lake trout of ages 3 through 5 and 12 percent for lake trout over age-5. Population metrics do not indicate that lake trout suppression has been effective at reducing abundance in Yellowstone Lake, however, the quality of existing data limit the certainty of conclusions. Yield-per-recruit modeling indicates that growth overfishing may begin to occur when conditional fishing mortality exceeds 10 percent for lake trout of all ages. Spawning potential ratio computed with rates of mortality from 2007 was 0.14, and could be reduced to 0.04 with a conditional fishing mortality rate of 20 percent for lake trout over age-5. An increase in fishing mortality of lake trout over age-5 may increase effectiveness of lake trout suppression.

Determining Morphological and Biochemical Parameters Associated with Early Ovarian Follicular Atresia in White Sturgeon Females

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In order to improve quality and yield of caviar in farmed white sturgeon (*Acipenser transmontanus*), it is essential to correctly assess stage of ovarian maturity and avoid harvesting females with atretic ovarian follicles. To detect atresia by changes in blood plasma parameters, individual females ($N = 11$) in the late phase of oogenesis were repeatedly bled and their ovaries biopsied before and after onset of ovarian atresia. Follicular atresia was induced by transferring females at Sterling Caviar, LLC, California from cold (10–13 °C) to warm water (20 °C). Follicle diameter increased and oocyte polarization indices decreased over time. Plasma testosterone and estradiol concentrations in fish with normal follicles were higher, compared to fish exhibiting early histological signs of follicular atresia, such as structural changes in the egg coat. Total plasma protein and calcium concentrations did not differ between fish with normal and regressing ovaries. In the future, our study may benefit sturgeon conservation propagation programs in Montana by improving techniques for detection of ovarian atresia in the late phase of oogenesis.

Distribution, Abundance, and Age Structure of Juvenile Bull Trout in a Tributary to Quartz Lake, Glacier National Park, Montana

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Lacustrine-adfluvial bull trout (*Salvelinus confluentus*) occupy lakes west of the Continental Divide in Glacier National Park (GNP), Montana. Research in GNP has focused primarily on the relative abundance of bull trout within lakes, patterns of connectivity among bull trout populations, and interactions between adult bull trout and nonnative lake trout (*S. namaycush*). Consequently, there is little known about the ecology, abundance, and distribution of juvenile bull trout within headwater drainages in GNP. The expanding distribution and potential negative effects of lake trout on bull trout within GNP has made understanding the ecology of juvenile bull trout a high priority. This study documented the distribution, relative abundance, and age structure of juvenile bull trout in the Quartz Drainage upstream of Quartz Lake. The study area included Quartz Creek and Rainbow Creek; a tributary that enters Quartz Creek about 1.25 km upstream of Quartz Lake. Juvenile bull trout were sampled using a backpack electrofishing unit; bull trout were enumerated and measured for length. Juvenile bull trout were distributed throughout the study area. Relative abundance of juvenile bull trout was greater downstream of the confluence of Quartz and Rainbow creeks than upstream. A bimodal length-frequency distribution suggested that the bull trout present were age-1 and age-2+. These data provide baseline information needed for future recovery efforts aimed at mitigating potential negative effects associated with lake trout colonization.

Montana Unauthorized Fish Introductions

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Montana Fish, Wildlife and Parks has maintained an unauthorized fish introduction database for more than 15 years that documents unwanted fish introductions across the state that have persisted long enough to be detected. The database currently covers 49 species of fish in 536 introductions in 298 waterbodies. Unauthorized introductions cover every drainage in the state and have caused impacts on native and recreationally important fish species, increased management costs, decreased recreational opportunity, and spread disease. Types and spread of introductions are discussed. The motivations behind illegal introductions are examined and linked to possible means of prevention and control.

Lifetime Movement Patterns of Cutthroat Trout in a Stream Network

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Although recent research has emphasized the ubiquity of movements in freshwater fish life histories, the timing, prevalence, and extent of these movements remain contentious. I used juvenile-adult distributions, PIT tagging, and turnover rates of unmarked fish to assess lifetime movement patterns of Colorado River cutthroat trout throughout the 40-km North

Fork Little Snake River watershed in southern Wyoming from 1996 to 2001. Turnover rates indicated that about 30 percent of fish moved an average of at least 100 m annually. Juvenile and adult fish exhibited little spatial overlap in about half of the stream segments in this basin, and length-frequency discrepancies between tributary and main-stem fish imbied widespread movement of fish age-2 and younger. About 40 percent of recaptured PIT-tagged fish were mobile. The probability of movement was related to the length of time between first and last capture and to specific growth rate, but not to fish length or condition. Fish marked in tributaries were less likely to move and moved shorter distances than did fish marked in the main stem, but fish from both sources were most likely to move upstream between captures. Median movement was 300 m and many fish moved several kilometers and between tributaries and the main stem, but migration barriers appeared to influence movement in some areas. These complex movement patterns support the conclusion that even slow-growing salmonids in small streams regularly alter their positions to feed, grow, reproduce, and seek refuge from unfavorable environments.

Aquatic Poster Session

Response of Non-Target Organisms from Rotenone Treatments Within the East Fork Specimen Creek Drainage, Yellowstone National Park

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Fish removal by rotenone applications is a highly effective fish management tool. However, rotenone is nondiscriminatory and can have negative impacts on non-target aquatic organisms. In 2004 Yellowstone National Park staff began planning a native fish restoration project within East Fork Specimen Creek. We conducted pre- and post- treatment monitoring on invertebrate communities throughout the drainage and on amphibian populations in the vicinity of High Lake, a 7-ac headwater lake where initial rotenone treatments took place. In August 2006 fish in High Lake were chemically removed using rotenone (CFT-Legumine). CFT Legumine is a relatively new formulation of rotenone in the United States that doesn't contain petroleum hydrocarbon solvents that are used in traditional rotenone formulas. As a result, CFT Legumine is likely less harmful to the environment but affects on non-target organisms, such as invertebrates and amphibians, are poorly understood. Among invertebrate populations, both pre- and post- treatment studies indicated that midge larvae were the most common invertebrate groups in the stream and lake benthos with increasing densities after rotenone treatment. Results from the stream invertebrate samples indicate that mayfly, stonefly, and caddisfly larvae were most susceptible to rotenone with some taxa experiencing 100-percent mortality. One year after treatment, however, most taxa had recovered with densities exceeding pre-treatment conditions. Higher invertebrate densities could be a result of the absence of fish predation the year following treatment. Similarly, larval amphibians appeared to experience 100-percent mortality from the initial rotenone application but tadpoles were observed in greater numbers 1 yr post-treatment.

Impacts of Two Small Dams on Migratory Bull Trout in the Clearwater River, Montana

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Dams are well known for their negative impacts on fish populations, and dam removal decisions are becoming increasingly common. In collaboration with Montana Fish, Wildlife and Parks and the USDA Forest Service, we used radio telemetry to explore the impacts of the small Emily-A and Rainy Dams on movement of migratory bull trout (*Salvelinus confluentus*) throughout the Clearwater River Drainage. We captured a total of 88 adfluvial bull trout or bull trout/brook trout (*S. fontinalis*) hybrids below the two small dams, primarily by angling. We implanted radio tags in 31 fish and released them above the dams, passing a total of 75 fish in 2007-2008. We monitored their movements and those of 27 other bull trout tagged in the surrounding lakes. The Emily-A is a complete upstream migration barrier, whereas Rainy is a partial barrier. Ninety-seven percent of the radio tagged fish we moved over the dams swam into one of three previously unknown spawning tributaries and presumably spawned. Although we passed a relatively large number of bull trout, redd counts were low, and we estimated only 13 percent detection probability at the dams. In one tributary, approximately 40-47 percent of the spawning adults were fish we passed over the Emily-A Dam. Post-spawning mortality rates were high and attributed primarily to predation. Our data suggests that the dams have large impacts on population sustainability, and will contribute to the decision-making process involving dam modifications or removal to balance the benefits of upstream passage for native fish with the risk of expansion by undesirable non-native fish.

Management of Anthropogenically Derived Hybrid Populations: Explicit Recognition Of Assumptions

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Hybridization and introgression between native and introduced species is one of the most challenging issues currently facing fisheries managers. While recognizing we are simplifying arguments, we suggest two hybrid management paradigms have emerged. The first posits that as long as introgression is at moderate to low level, and the resulting hybrids are morphologically and ecologically similar to the native taxon, they should be considered a member of the parental species. The alternative view suggests that conservation efforts should be focused on pure native genomes that have evolved in response to localized selective pressures and hybridized populations are a conservation threat. We suggest that both management approaches are based on a few key assumptions about the nature and ultimate outcome of hybrid fitness and ecology. Although these assumptions are implicit in the arguments presented by both sides of the debate, neither the assumptions nor the management

implications of violations of those assumptions are consistently clarified and discussed. In our poster, we present a framework that addresses various assumptions surrounding hybridization in cutthroat trout (*Oncorhnchus clarkii*) populations by introduced rainbow trout (*O. mykiss*) and the ecological outcomes each assumption would predict. We further suggest hybridization management actions should have clearly defined goals and be explicit about their assumptions. Finally, we provide an example of our framework applied to a common management action used to manage hybrid invasions: the use of barriers.

Identifying Lake Trout Spawning Locations in Swan Lake, Montana

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Knowledge of spawning locations is critical to the management of invasive lake trout (*Salvelinus namaycush*) populations by providing areas to efficiently target sexually mature fish. In Swan Lake, Montana spawning locations were identified using acoustic telemetry, short-set gill nets, and in-situ egg nets. Telemetry locations were recorded manually after dark with a directional hydrophone from mid-October to mid-November in 2007 and 2008. Two primary sites were identified as potential spawning areas based on kernel-density analysis of 2007 telemetry locations. In 2008, 30 in-situ egg nets were buried by SCUBA divers at each of the 2007 locations to confirm egg deposition. One gill net (274.2 m long X 2.4 m deep with 5.08-cm bar mesh) was set at each primary spawning location once weekly through the tracking period in 2008 to confirm the presence of ripe lake trout and to explore the efficacy of targeting adult lake trout for removal at these locations. Kernel-density analysis of telemetry data identified the same primary spawning locations in 2008. Catch per unit effort of adult lake trout was > 4 times greater at these locations versus lake-wide gill netting. Egg density varied from 38 eggs/m^2 to 114 eggs/m^2 at the two spawning locations. Lake trout spawning locations were confirmed in Swan Lake, Montana. We recommend targeting these areas as an effective option for removing adult fish from the population.

Lake Trout Removal Efforts Continue in Yellowstone Lake

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Lake trout (*Salvelinus namaycush*) removal efforts in Yellowstone lake began in 1995, the year following documentation of this non-native fish in Yellowstone Lake. The objective of the removal program was to reduce lake trout to the point where they have a negligible effect on native Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*). Lake trout capture techniques have focused on mechanical, mostly gill netting, and more recently electrical methods. The lake trout infestation in Yellowstone Lake continues while fishery managers remove greater numbers of lake trout every year, 76,140 lake trout were removed in 2008, and 348,794 have been removed since 1995. Amount of gill net effort has increased every year with the exception of 2008, total effort is mainly dependent on ice-off dates, and seasonal crew staffing and experience. Removal strategies target both adult and juvenile components of the population. Catch per effort of juvenile lake trout has steadily increased since 2002

with 2008 being the highest on record (5.0 lake trout/100 m gill net set/night) since 1998. However, cutthroat trout have not shown a positive response to lake trout removal efforts. Numbers of spawning cutthroat trout in Clear Creek, a tributary to Yellowstone Lake, are at the lowest levels ever recorded with just 538 counted. Yellowstone cutthroat trout gill net assessment, which averaged over 15 fish/net in 1994, has averaged ~ 9 fish/net over the past 5 yrs. Continued suppression of lake trout is imperative for there to be a healthy Yellowstone Cutthroat trout population in Yellowstone Lake.

Restoring the Balance: The Fish & Wildlife Programs at the Creston Fish & Wildlife Center

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The Creston Fish and Wildlife Center is a USDI Fish and Wildlife Service facility located in Creston, Montana. There are three FWS programs working from the Center; the Creston National Fish Hatchery, Ecological Services and Partners for Fish and Wildlife. These programs work with partners and stakeholders to protect and conserve wildlife habitat, and to restore and enhance the fish and wildlife species who occupy these healthy habitats. This poster provides an introduction to the programs at the Center and a sampling of the species they strive to preserve.

Arctic Grayling Emergence and Development in Odell Creek, Red Rock Lakes National Wildlife Refuge, Montana

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Red Rock Lakes National Wildlife Refuge in southwest Montana supports the last endemic population of adfluvial Arctic grayling (*Thymallus arcticus*) in the contiguous United States. The population has been declining for the last several decades and there is concern about its persistence on the Refuge. The goal of this study was to understand how Odell Creek is contributing to the maintenance of this critical population by investigating its use as a spawning stream and rearing ground for grayling fry as well as inventorying overall habitat. Surveys were conducted in 2006 and 2007 to determine the timing of spawning and emergence, to track fry movement in the creek and to make determinations about fry habitat selection. In 2006, 1868 fry were observed throughout the survey period with fry showing apparent movement downstream. During the same period in 2007 only 311 fry were observed. The majority were concentrated at the creek mouth. An a priori suite of models determined that there was little correlation between fry abundance and habitat. The most important parameter for fry abundance in 2006 was water velocity. Fry >30 mm were rarely observed; at this life stage they have improved swimming ability and are able to select different habitat types. Odell Creek's habitat was surveyed and determined to be a suitable grayling stream. The difference in fry abundance between years appears attributable to timing and intensity of

spring runoff which affects spawning and incubation periods. This indicated the importance of climate as a factor affecting this population.

Are Reservoirs Ecological Sinks for Recruitment of Pallid Sturgeon?

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Natural recruitment of pallid sturgeon (*Scaphirhynchus albus*) in the Missouri River upstream of Fort Peck Reservoir has been nonexistent for at least four decades. Deviations from the natural river morphology are likely driving the lack of natural recruitment. An obligate riverine species, pallid sturgeon require large drift distances (> 245 km) before transitioning to benthic habitats. Insufficient lotic habitat downstream from hatch locations because of river impoundment is one hypothesis for the lack of pallid sturgeon recruitment. During 2008, we sampled the aquatic habitat in the headwaters of Fort Peck Reservoir. The headwaters were described as separate habitat units based on visible characteristics, i.e., "river," "transition zone," "side channel," "lake," and "reference." Velocity decreased longitudinally through the headwaters of Fort Peck Reservoir suggesting that there is insufficient drift distance for pallid sturgeon to transition through the larval stage. Water-quality data examined at the diel scale indicated abrupt changes in temperature, dissolved oxygen, and pH that may negatively influence larval pallid sturgeon. These diel fluctuations in water quality parameters correlate with an increase in discharge from Canyon Ferry Reservoir. Further research includes spatial analysis of larval drift dynamics, evaluating larval sturgeon survival under fluctuating water-quality conditions, and experimentally evaluating larval pallid sturgeon survival in the headwaters environment.

Movement and Spawning Locations of Shovelnose Sturgeon and Pallid Sturgeon in the Missouri River Above Fort Peck Reservoir

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The lack of recruitment by pallid sturgeon (*Scaphirhynchus albus*) over that last 40 yrs in the Missouri River above Fort Peck Reservoir has caused their abundance to decrease to less than 150 individuals. Interestingly, shovelnose sturgeon (Scaphirhynchus platyrhynchus) exhibit recruitment in the same area and their abundance is higher than most other rivers in the U.S. Understanding the dichotomy between the two species with respect to recruitment is

receiving much attention throughout the Mississippi River basin. The objectives of this study are to identify spawning locations and the effects of varying discharge on spawning locations and spawning movements for pallid sturgeon and shovelnose sturgeon. Two pallid sturgeon and 39 shovelnose sturgeon were radio tagged and tracked from 1 May 2008 to 5 July 2008. Unfortunately, no data is available for pallid sturgeon movement due to small sample size and loss of one of the radio-tagged fish mid-study. Seventy-four percent of the shovelnose sturgeon moved downstream during the spawning period. Of those that moved downstream the average movement was 39 km. One fish moved 123 km downstream and this was the largest movement of any fish tracked. Only 26 percent of the shovelnose sturgeon moved upstream and their average movement was 51.5 km. Shovelnose sturgeon concentrated in two areas during the spawning period; river kilometer 3090 to 3190 and 3235 to 3270. These data will provide a greater understanding of sturgeon (*Scaphirhynchus* spp). spawning movements and spawning locations in the upper Missouri River and will help guide management decisions aimed at recovery of pallid sturgeon.

Large Woody Debris Depletion Rates in Western Montana Streams

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Maintenance of in-stream habitat diversity through recruitment of large woody debris (LWD) is a principal goal of Plum Creek Timber Company's Native Fish Habitat Conservation Plan (NFHCP). Because LWD loads are governed by long-term processes such as riparian tree growth and mortality, direct measurement of LWD to judge effectiveness of management actions is unlikely to provide timely feedback for adaptive management. Instead, trends must be forecast using models. For the NFHCP, the Riparian Aquatic Interaction Simulator (RAIS, Welty et al. 2002) was used to support development of riparian management options. To help validate this model, several key assumptions are being field-tested as part of the NFHCP's adaptive management program. This study examines the effects of channel size and gradient on annual in-stream LWD depletion rates. Thirty-one sample sites were randomly selected from among a pool of stream segments that represent combinations of channel types and sizes for perennial streams on Plum Creek lands. At each 100-m site, all pieces of LWD with minimum qualifying dimensions of 10-cm diameter and 2-m length in zones 1-3 (Robison and Beschta 1990) were tallied and marked with numbered aluminum tags. Resurveys of these sites were completed in 2007. This poster summarizes five-year LWD depletion rates, and the factors most associated with LWD movement.

Montana Unauthorized Fish Introductions

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Poster display will consist of a map of Montana with illegal fish introduction locations marked by symbols. Display would include a list of species and distribution by region. A copy of the database would be available with an invitation for fisheries personnel to review their area and report any fish introductions not yet documented. Report forms would be available.