ABSTRACTS

Barriers to prevent nonnative fish movement: a review.

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Barriers to non-native fish movement are important tools in the conservation of native fish species. Natural and manmade barriers provide protection to some of the last populations of native fish, and barriers are frequently used to help restore a species to a larger portion of its native range. We surveyed barriers being used to prevent non-native fish movement in an effort to make a wide variety of barrier designs available to managers and researchers. Barrier design, longevity, cost, and functionality vary, and there is some indication that those designing barriers lack the information necessary to build the best barrier to meet their management needs. A wide variety of materials are used to build barriers and each has associated advantages and disadvantages. We review the major types of barrier construction, as well as noteworthy innovative designs, and discuss the advantages and disadvantages of each. The falls barrier was found to be the most common type of barrier currently used to exclude non-native fish. Results of this survey have provided an array of barrier designs and have helped to highlight gaps in the knowledge base necessary to construct effective barriers. Other types of barriers included mesh, perched culverts and velocity barriers. Knowledge gaps in the design of barriers include, the jumping performance of wild fish, knowledge of proper barrier siting, and barrier designs that can accommodate both high and low discharge. A comprehensive manual on barrier design and an understanding of the jumping ability of wild fish are necessary before barrier designers can be expected to build effective barriers.

Basis of Design for a Fish Barrier in German Gulch near Anaconda, MT

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German Gulch supports a population of genetically pure Westslope Cutthroat trout (*Oncorhynchus clarki lewisi*), physically isolated from rainbow trout (*Oncorhynchus*

mykiss) due to historic mining activities near Butte, Montana. The ongoing restoration of Silver Bow Creek, into which German Gulch flows, will eventually remove this isolation. This project involved the development of design criteria and the design of a fish barrier. Design criteria included components to prevent conditions that would allow fish to swim or leap over the barrier. Due to a lack of published data on rainbow trout, the swimming and leaping capabilities for pink and chum salmon (*O. gorbuscha* and *O. keta*) were used. The barrier design consisted of rock configured to create a weir and downstream apron in a reach of channel confined by generally vertical exposed bedrock. A hydraulic model of a stylized barrier was used to determine water velocities and depths and the location and configuration of the hydraulic jump. Four different barrier heights were evaluated (4 to 7 feet). A 6-foot high structure was selected as it satisfied the swim and leap criteria at the 2-year through 100-year flows. As swimming over the structure at lower flows was also a consideration, the model was run at flows of 10 cfs (considered baseflow), 20 cfs, 40 cfs and 80 cfs. While water velocities at these lower flows did not satisfy the swim impedance criterion, it was felt the shallow water and a compound weir surface would nonetheless limit fish passage at low flows.

Efficacy of Fish Screens on Irrigation Diversion Canals at Skalkaho Creek, Montana.

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Post-spawn adult and downstream migrant juvenile westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are entrained, become trapped, and die in the seven irrigation canals on Skalkaho Creek, a tributary of the Bitterroot River. We quantified entrainment rates into the canals using telemetry and trapping before (2003) and after (2004) installation of fish screens at three of the canals (Highline, Ward, and Hughes). No telemetered adults were entrained in 2003, because most were residents and did not migrate past the canals. Fifteen telemetered adults were entrained in 2004; three were entrained, bypassed, and entrained again further downstream. Nine telemetered adults were entrained at screened canals and all nine were successfully bypassed. Five telemetered age-1 juveniles were entrained at the Highline ditch in 2003; three were entrained there in 2004, but only one was bypassed. We estimated that 33,722 age-0 westslope cutthroat trout (95 % CI, 12,044-161,799) moved downstream from 16 July to 20 September in 2003; 8,964 (95 % CI, 2,840-72,141) or about 27 % were entrained at the Highline ditch. In 2004, 7,840 fish were bypassed by all three screens, and of those 6,041 were westslope cutthroat trout. The fish screens effectively precluded entrainment and effectively bypassed adult, age-1 juvenile, and age-0 westslope cutthroat trout. Fish screens were an effective management tool to eliminate entrainment of westslope cutthroat trout at Skalkaho Creek.

Utilizing Stream Simulation Concepts in Designing Fish Passage

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No Abstract Submitted

Stream Simulation Culvert Design and Installation on the Clearwater National Forest

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The Clearwater National Forest, in partnership with the Nez Perce Tribe, has been aggressive at identifying and replacing culverts that are migration barriers to fish and other aquatic species. We have embraced the concept of designing replacement structures to mimic stream conditions. Since 2000, in we have replaced 23 barrier

culverts and opened 64 miles of habitat to steelhead, bull trout, chinook salmon, and westslope cutthroat trout. The majority (83%) of the replacement structures have been embedded pipe arches. A pipe arch can be a cost effective alternative for stream simulation for streams with a bankfull width of less than approximately 12 feet and with fill depths of less than approximately 20 feet. The drawback may be a difficulty in holding substrate in the culvert for the full length of the culvert to the desired depth.

Removing Roads to Restore Watersheds on the Clearwater National Forest
A Nez Perce Tribe – Clearwater National Forest Partnership

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Over the last 8 years, the Nez Perce Tribe and the Clearwater National Forest have worked in partnership to protect and restore watersheds. Restoration projects follow aquatic resource priorities. The Lochsa River Drainage, an important fishery, has been a focal point for restoration projects, especially road removal. The Lochsa River and its tributaries provide critical habitat to populations of spring chinook salmon (*Oncorhynchus tshawytscha*), ESA listed Snake River steelhead (*Oncorhynchus mykiss*), ESA listed bull trout (*Salvelinus confluentes*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and rainbow trout (*Oncorhynchus clarki*) (Clearwater Biostudies various years). In addition to providing critical fisheries habitat, the Lochsa has been an important part of the Clearwater National Forest's timber production program. Among the legacies of intensive timber harvest are roads. Over the last 50 years management priorities and harvest systems changed, leaving many of the roads in the Lochsa redundant to management needs. These abandoned roads on the steep, failure prone slopes of the Lochsa have proved deleterious to aquatic resources. The Nez Perce Tribe and Clearwater National Forest have successfully removed over 400 miles of failing roads. Over the years we have learned many lessons about how to effectively implement road removal projects (road removal is referred to as road decommissioning and/or road obliteration) to restore watershed function and protect aquatic resources. Successful road removal projects involve multiple steps including planning, public outreach, mapping, earthwork, erosion control, and monitoring.

Assessment of road decommissioning on stream habitat in the Flathead National Forest

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The Flathead National Forest has almost 4,000 miles of roads and a mandate to decommission nearly a quarter of the road infrastructure for grizzly bear security. In addition to this area being valuable for grizzlies, it is important for bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Although there are multiple studies demonstrating negative impacts of roads on fish populations (including bull trout), there is relatively little research examining which technique (e.g., gating, berming and revegetating) and what degree of decommissioning is necessary to improve stream habitat. The Flathead National Forest has decommissioned over 300 miles of roads, but has few watersheds where the entire area was decommissioned. We sampled 12 streams in the Hungry Horse and Spotted Bear Ranger Districts with four different watershed types (1) wilderness, (2) roads in use, (3) exclusively decommissioned roads, and (4) a mix of decommissioning (gated, decommissioned spurs, very little road use). Our goal was to address 2 questions. First, do forest roads have measurable impacts on stream habitat in our study site? If so, do streams with watersheds containing decommissioned roads demonstrate recovery and how important is decommissioning at the watershed scale? We performed habitat surveys, Wolman pebble counts, visual embeddedness estimates, and substrate coring in the summer and fall of 2004. There was high variability across streams regardless of treatment. We found no differences in habitat measures (temperature, pool size and number, and LWD) between treatments, but there were differences in sedimentation.

Fire Suppression and Post-Fire Rehabilitation on the Bitterroot National Forest – What Did and Didn't Work for Aquatics

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Over 320,000 acres of Bitterroot National Forest burned in 2000 and 2003. The protection of aquatic resources was monitored by resource advisors during suppression and post-fire rehabilitation activities. Forest fisheries biologists, hydrologists, and other specialists served as resource advisors and worked closely with the fire and burned area emergency recovery teams. During suppression, resource advisors provided guidance to fire leadership, monitored compliance with standards, communicated their findings to the fire teams, and developed rehabilitation plans. Following suppression, resource advisors supervised the recontouring of dozer lines (165 miles) and contour felling (1000 acres). Biologists and hydrologists were instrumental in the replacement of fish barrier culverts (21) and road obliteration (35 miles). The most effective post-fire rehabilitation actions for aquatic resources were replacing fish culvert barriers, upgrading undersized culverts, obliterating roads, and recontouring dozer lines. The effectiveness of other actions such as contour felling, aerial seeding, and straw mulching was limited. During fire, biologists and hydrologists are most effective in protecting aquatic resources if they participate at several levels. Ideally, they should be involved in the development of resource protection standards, know the inner working of the fire bureaucracy, be in the field near equipment and crews during the operational period, and stay with the same fire until rehabilitation is finished. This level of participation provides consistency to limit damage during suppression, irreplaceable knowledge of the site, and efficient follow through on complex rehabilitation plans.

Comparison and Use of Streambank Alteration Assessment Methods

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The potential impacts of livestock grazing on streambanks and riparian areas have received considerable attention in recent years. The percent of the streambank trampled is

one tool used by range managers as a “trigger” to determine when livestock should be moved. Over the last two years the Forest Service has been developing a standardized sampling method for Region 1. As part of this process, we have compared different streambank alteration assessment methods used on federal lands in the Western US. Our objectives were to 1) define observer variability for each method, 2) determine whether the methods yield similar estimates and 3) determine importance of training and 4) discuss recommendations for improving methods. We summarize the results from these studies, implications for using alteration as a grazing management tool, and current Forest Service direction for sampling alteration.

Challenges in developing and implementing ecological standards for aquatic restoration projects: a practitioner view

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While the stated or implied goal of most aquatic restoration projects is to be ecologically effective, many in the restoration community question if these goals are being consistently achieved. In response, some in the academic community (Palmer et al, 2005, J. Applied Ecology, *in press*) have proposed the establishment of ecological standards to evaluate projects. In this presentation, these standards are introduced and placed in context to the subset of restoration projects that principally involve the alteration of existing channel geomorphology. From the lessons of practice it is argued that a number of cultural and institutional factors impede ecologically effective restoration including: (1) misuse of the term “restoration”, (2) failure to create sound, ecologically-based guiding images at project inception and the related phenomenon of *image drift* (3) a lack of risk tolerance leading to unnatural project hardening, (4) practitioner/sponsor inexperience and inflexibility and (5) lack of commitment to monitoring. It is also suggested that more interaction needs to take place between practitioners and the academic community so that the lessons of practice are communicated and integrated into the emerging science of restoration. While this interaction will advance the common goal of implementing more ecologically effective projects, it is noted that project participants outside the scientific community must also appreciate the challenges a project faces meeting higher standards. These challenges are not insignificant and include convincing project sponsors, practitioners and regulators of the need for standards in project generation, implementation, and monitoring on a project by project basis.

Jocko River Floodplain Restoration Planning Using Suitability Analysis.

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The Confederated Salish and Kootenai Tribes are restoring the Jocko River watershed, located on the Flathead Indian Reservation in western Montana. Restoration efforts are focused on restoring the watershed for bull trout. Restoration goals focus on restoring the ecological processes that have been impacted along the river corridor. To support these restoration efforts we identified areas with high potential for restoring native riparian and wetland plant communities along the lower main-stem Jocko River floodplain using a suitability analysis approach. This analysis used a GIS system to combine variables (layers) according to a set of decision rules to ultimately determine restoration categories for revegetation potential along the river. Four main geographic variables were used to determine suitability classes for native plant community restoration: soil texture in the surface layer; hydric soil status, presence of woody vegetation in 1937 and HGM (hydrogeomorphic) cover type. These variables were selected as the best available information for predicting restoration potential across the entire ecological floodplain area. Fine-resolution topographic data will be used as it becomes available, to refine the analysis to include elevation classes relative to known hydrologic features. Based on this analysis, three combinations of variables (suitability classes) were identified that indicate high restoration potential for restoring native plant communities along the Jocko River. This type of analysis is a useful tool that should be incorporated into watershed restoration planning to increase the success of restoration efforts of rivers, floodplain, wetlands and ultimately native fisheries.

A watershed-based approach to restoring wetland-riparian resources and bull trout on the Flathead Indian Reservation.

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The Confederated Salish and Kootenai Tribes (CS&KT) are undertaking a comprehensive watershed restoration effort on the Flathead Indian Reservation. In 1998, as part of a legal settlement, the Atlantic Richfield Company agreed to pay the CS&KT for mining-related damages to treaty-protected resources in the Upper Clark Fork River Basin. Under the terms of the settlement, the CS&KT were to replace, restore, and/or acquire the equivalent of the injured resources, which included wetland-riparian resources and bull trout. Rather than using a piece-meal approach to mitigation, the CS&KT decided to commit to a more holistic resource management approach in one focus area, the Jocko Watershed. The basic goal of the restoration is to maintain or reestablish natural processes to the greatest degree possible, while recognizing limitations

imposed by past and ongoing watershed disturbances. The watershed restoration process the CS&KT chose involved four key actions: 1) assessment to determine environmental history and identify restoration potential; 2) protection to identify and maintain the best remaining habitats; 3) passive restoration to modify activities that are disturbing or preventing recovery; and, 4) active restoration to reestablish functions where the ecosystem would otherwise remain degraded indefinitely. In this talk we will present a broad overview of the settlement and of the planning and implementation of the watershed restoration effort.

Native Species Habitat Restoration in the Upper Klamath Basin, OR

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Aquatic ecosystems in the Upper Klamath Basin have been significantly altered by historical and contemporary land use practices. Modified watershed hydrology, riparian communities, channel morphology, and aquatic habitat conditions have profoundly impacted the native fish community in the Upper Klamath Basin, including bull trout, Lost River and shortnose suckers, and Klamath redband trout. Preliminary efforts to restore riparian and stream habitats in the Sprague River watershed near Beatty, Oregon, offer promising opportunities to rehabilitate considerably degraded aquatic environments. Target project streams including multiple spring creeks and the mainstem Sprague and Sycan rivers, were prioritized in the *Master Plan for the Restoration of the Sycan and Sprague Rivers near Beatty, Oregon*, a guidance document for focusing restoration efforts in the middle Sprague River watershed. River Design Group is collaborating with local agencies and landowners to identify and achieve multiple land management and endangered species recovery goals through the application of passive and active restoration techniques. Restoration projects completed in 2004 included one spring creek and two off-channel pond complexes that provide important spawning and rearing habitat for the focus species. Techniques included channel reconstruction and passive techniques including artificial beaver dam construction for channel grade control. Final restoration design plans were completed in 2004 for a two mile section of the main Sprague River, which is scheduled for construction in 2005. Once completed, the reconstructed streams and off-channel habitats are expected to provide cold water refugia and improved spawning, rearing, and migratory corridor conditions for the focus sucker species, Klamath redband trout, and bull trout.

Build It and They Will Come: Early Monitoring Results from the Nevada Spring Creek Restoration Project

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Nevada Spring Creek is a tributary to Nevada Creek, an impaired tributary of the Blackfoot River. Nevada Spring Creek has been the focus of several restoration projects from 1990-2004. The goal of restoration work was to restore habitat conditions suitable for native trout, specifically westslope cutthroat trout (*Oncoryhnchus clarki lewisi*) and to improve downstream water quality and reduce thermal stress in Nevada Creek and the Blackfoot River. Restoration of four miles of Nevada Spring Creek took place in several stages, and utilized a variety of methods including complete channel reconstruction, instream wood placement, gravel addition, shrub plantings, sod mat stacking, and riparian grazing management changes. Pre- and post-project monitoring indicates that original project objectives are being met. Temperatures have been moderated throughout the entire length of the spring creek (decreased 10-15^{o} F), to provide the preferred range for trout. Initial fisheries surveys indicate community shifts in the upper and lower portions of the spring creek. Surveys in the upper section, a section previously dominated by brown trout, have found continued increased densities of brown trout and early signs of increased westslope cutthroat trout densities. A dramatic community shift was also detected in the lower spring creek as species diversity increased from three to six species, and a pre-project non-salmonid community shifted completely to an assemblage dominated by 85% salmonids (brown trout, westslope cutthroat and whitefish). In addition, a single bull trout was also collected, the first documented bull trout in the Nevada Creek watershed in the last 15 years.

Rainbow Trout and Brown Trout Populations Before and After a Stream Restoration Project on Big Spring Creek, Montana

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A high profile stream restoration project was completed on a 2600-foot reach of Big Spring Creek at the Brewery Flats Fishing Access Site from 1998 – 2001. This project replaced an entrenched reach with a meandering riffle pool stream channel and floodplain. Stream length was increased by 1400-feet. Initial findings indicate the project was successful. The restored reach successfully passed a flood event in 2003 and trout numbers appear to have increased. Big Spring Creek is a 100 cfs (base flow) trout stream that originates from a 52˚ F spring south of Lewistown, MT. Population data was collected with mobile electrofishing on the restored section and 2 other reaches of Big Spring Creek from 1995 – 2004. Mean numbers of combined rainbow trout (*Oncorhynchus mykiss)* and brown trout *(Salmo trutta)* (≥ 10 inches) ranged from 500 – 2200 per mile depending on the section. Total trout per mile (≥ 10 inches) averaged 36% higher during the four years immediately after the project in the restored section, compared to increases of 22% and 0.9% in the other 2 sections. The 1400-foot increase in length at Brewery Flats meant trout numbers (≥ 10 inches) in the section increased by 90% after restoration. From 2002 – 2004 Brewery Flats showed a 66% increase in trout per mile compared to declines of 36% and 23% in the other 2 sections. Small rainbow trout declined to 33% of the pre-project numbers at Brewery Flats but were 42% of the pre-project average at the section 3 miles upstream.

Responses of Yellowstone Cutthroat Trout Populations in the Upper Yellowstone River to In-stream Flow Restoration

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Yellowstone cutthroat trout (Oncorhynchus clarki bouvieri) (YCT) in the upper Yellowstone River rely on quality spawning habitat in tributaries for most of their reproduction. For over twenty years, research and conservation efforts for this mixed-stock of pure and hybridized YCT focused on restoring minimum flows and habitat in spawning tributaries. FWP leased irrigation water in six tributaries of the Yellowstone River since the mid-1990's. Intermittent monitoring of water leases demonstrated localized benefits such as increases in fry production and spawner and redd counts, but the efficacy of these efforts relative to the greater Yellowstone River population is not clear. YCT population estimates dating back to the 1970's provide a means of analyzing population trends relative to limiting factors. Earlier researchers documented a relationship between mid-summer streamflows and YCT reproductive success. In the Corwin Springs section, Age 2 YCT abundance is correlated to mean September flow at the Livingston gage. In low flow years, year class strength is weak. However, since water leases were implemented, year classes have been strong, even during record drought years. The YCT population has been well above long-term median since leases have been in place. In the Springdale Section, YCT populations continue to fluctuate around the long-term median. The only lease affecting this reach was implemented in 2002, so no response is expected for a few years. It appears that water leases and habitat restoration efforts are successfully mitigating a primary factor limiting recruitment of YCT to the Yellowstone River.

The Cherry Creek Native Fish Introduction Project: Successes and Problems After Two Years of Piscicide Treatment

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The Cherry Creek Native Fish Introduction Project is a cooperative effort between Montana Fish, Wildlife, & Parks, the Gallatin National Forest, and Turner Enterprises Inc Biodiversity Fund to establish westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in a large (>50 connected stream miles) tributary of the Madison River, as prescribed in the 1999 Memorandum of Understanding & Conservation Agreement for Westslope Cutthroat Trout in Montana. The project was initiation in 2003 after four years of delay by administrative and legal challenges. *In situ* bioassays were conducted to determine travel time and lethal concentration of Fintrol (a.i. antimycin). To remove non-native fish, Fintrol was applied to Cherry Lake (105 acre-feet, 35-foot max depth) from a raft, and to 11 miles of stream in two forks of upper Cherry Creek using constant flow stations at specific points along the stream. Backpack sprayers were used to treat shallow lake margins and off channel areas. A total of 11.3 gallons of Fintrol was used in 2003 and 2004. Exposed fish succumbed readily to Fintrol, but fish persist in the lake. Gillnets are being used to continue removal from the lake. Natural waterfall barriers on each of the forks prevent fish from invading treated areas, and an existing irrigation weir was dammed to isolate the next portion of the drainage scheduled for treatment in 2005 and 2006.

Selective electrofishing removal strategies for nonnative brook trout to facilitate persistence of native cutthroat trout

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Inland cutthroat trout (*Oncorhynchus clarki* spp.) presently occupy a fraction of their historic ranges, and existing populations are often found as isolates in small headwater streams. Displacement by nonnative brook trout (*Salvelinus fontinalis*) is among the greatest threats to existing populations. Cutthroat trout restoration projects often utilize electrofishing to suppress brook trout, but these operations are labor intensive and costly. Information on the effectiveness of different removal electrofishing scenarios would help managers prioritize restoration efforts given limited resources. To address this, we constructed matrix population models for Colorado River cutthroat trout (*O. c. pleuriticus*) and brook trout using demographic data from a field experiment whereby we modeled survival of juvenile (ages 0 and 1) cutthroat trout as a function of brook trout density. Population responses to brook trout suppression were modeled as a function of electrofishing effort, defined by the number of visits over 50 years, the temporal distribution of those visits and the number of passes per visit. Stochastic simulations suggested an increased probability of cutthroat trout persistence with increasing electrofishing effort. However for a given effort level, persistence was strongly affected by the temporal distribution of visits. Model scenarios with three years of consecutive brook trout suppression repeated at regular intervals provided the greatest benefits to cutthroat trout by providing the periodic infusion of a strong cohort into the population. Model results may inform managers as they prioritize efforts to sustain existing cutthroat trout populations where complete brook trout eradication and/or isolation of cutthroat trout is not feasible.

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

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We removed and relocated nonnative brook trout, *Salvelinus fontinalis*, from approximately 14 km of total stream length in Cottonwood, Craver, Muskrat, Spring, and Staubach creeks to conserve sympatric populations of native westslope cutthroat trout, *Oncorhynchus clarki lewisi*. From 2001 to 2003 we successfully eliminated brook trout from treatment reaches covering almost 8 km of stream in Cottonwood, Muskrat, and Staubach creeks. Electrofishing removal treatments in Muskrat and Staubach creeks began earlier than 2001. In Spring and Craver creeks we suppressed brook trout, but dense riparian vegetation, beaver dams, and abundant woody debris in the channels prevented us from eradicating brook trout using electrofishing. We believe brook trout can be eradicated from the treatment reach in Spring Creek using electrofishing as long as enough riparian vegetation and in-channel woody debris are removed to allow electrofishing crews access to the stream. However, we do not believe it will be possible to remove brook trout from Craver Creek via electrofishing due to the extensive portion of the drainage inundated by beaver dams. We estimated that electrofishing eradication of nonnative brook trout cost about $3,000 to $4,000 ($US in 2002 using Montana state rates) per kilometer where no riparian vegetation or woody debris clearing was necessary, but cost about $8,000 to $9,000 per kilometer where clearing was needed. These costs did not include costs to install barriers at the lower boundary of treatment areas or to prepare environmental assessments. Cost per kilometer that required no channel clearing was similar to estimated costs of two antimycin piscicide treatments, but slightly more than estimated costs for two rotenone treatments. However, electrofishing eradication would be preferred in locations where native fish are in sympatry with nonnative fish because more native fish can be saved during removal efforts. We found that it took at least six removal treatments of two to three passes per treatment to effectively eliminate brook trout from most treatment reaches. We recommend the following strategies for conducting more efficient electrofishing removals: 1) concentrate removal treatments within two to three years by conducting several removal treatments each year; 2) initially conduct at least one, and preferably two, removal treatments prior to the first spawning by nonnative fish and concentrate on removing mature adults during these initial removal efforts; 3) make at least one removal treatment during spawning and focus on eliminating mature adults and trampling nonnative fish redds during this treatment; 4) conduct some

removal treatments in the late fall or early winter to take advantage of winter concentrations of nonnative fish in pools and better electrofishing efficiency associated with cold water temperatures; 5) remove nonnative fish from sections that are long enough that crews can cover one section with one pass each day and conduct repeat removals on subsequent days; and 6) realize that smaller, younger nonnative fish (age-0 and age-1) will be more difficult to capture and plan on eradicating these fish after adults have been eliminated, so no additional recruitment occurs, and these smaller fish have had time to grow to a size where they are more vulnerable to electrofishing, but are still immature. Our data, and other studies, have shown that native cutthroat trout populations will respond positively to removal of nonnative brook trout. This response may take two to three years and appears related to elimination of competition and/or predation that occurs when cutthroat trout are age-0 to age-1.

Predicting Cutthroat Trout Abundance in High-Elevation Streams: Revisiting a Model of Translocation Success

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Assessing viability of stream populations of cutthroat trout and identifying streams suitable for establishing populations are priorities in the U.S. central Rocky Mountains. We reevaluated a model of translocation success developed for cutthroat trout by examining the relation between electrofishing-based abundance estimates ($N = 31$) and mean July water temperature, pool bankfull width, counts of deep pools, and occupied stream length. The preferred model was √(population size) = 0.00508(stream length, in m) + 5.148 ($R^2_a = 0.81$; $P < 0.001$). An independently developed model based on visual counts broadly supported this finding. Additional habitat coupled with increased habitat

complexity may account for the abundance-stream length relation because abundance lacked a consistent longitudinal trend within streams. Model-derived estimates and prediction intervals imply that many Rocky Mountain populations of cutthroat trout fail to meet thresholds associated with reduced risk of extinction. We believe that this model can reduce uncertainty about projected population sizes when selecting streams for reintroductions of cutthroat trout or evaluating unsampled streams.

Behavior and characteristics of anglers in bull trout recovery areas within the upper Clark Fork watershed

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Recent radio-telemetry studies in the upper Clark Fork Basin (1999-2004) indicate up to 10-15% annual angler-caused mortality for adult fluvial bull trout (*Salvelinus confluentus*). Because of extremely low population abundance (1-5 adults/river mile), increasing fishing pressure, concentration of fishing pressure in key bull trout habitats, vulnerability of bull trout to angling, etc., angling is still suspected to be a significant source of mortality. With this in mind, we interviewed 544 anglers (June-October 2004) in 33 known bull trout staging and spawning areas to assess regulation compliance, fish identification skills, angling methods and angler demographics. Anglers surveyed were primarily unguided bank anglers, although guided anglers (13%) and float anglers (25%) were represented in our sample of Montana residents (47%) and nonresidents (53%). Angling methods included fishing with flies (75%), bait (9%), hardware (10%) or some combination of these (6%). Most anglers (79%) were aware of special regulations for bull trout and overall regulation compliance was very high (>99%). However, trout identification skills were poor and the angler group that we were most concerned about (those intending to keep fish) was particularly deficient. Anglers planning to keep fish exhibited lower regulation compliance (94%) and success in identifying the five common trout species (15%) relative to catch and release anglers (46% success). These data do not provide conclusive answers to the question of angling impacts on depressed bull trout populations, but do suggest the need for education targeting specific angler groups and concerted river recreation planning efforts in order for native fish recovery to be successful.

Ground-Water Pumping and Streamflow Depletion in Montana

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Stream dewatering poses a major threat to aquatic ecosystems in Montana. To prevent further dewatering in overappropriated basins, the Montana legislature and the Department of Natural Resources and Conservation have closed the upper Clark Fork, Musselshell, upper Missouri, Milk, and Teton Rivers and their tributaries to new water rights. The closures, however, do not apply to new ground-water appropriations. In response to the closures and prompted by the recent drought, agricultural water users have turned increasingly to ground-water wells and sprinkler systems as more reliable and efficient irrigation methods than traditional flood irrigation from surface-water diversions. The increased crop production made possible by these changes increases water consumption from the basins. New residential and commercial water users likewise may withdraw additional ground water from aquifers in the basins. Because ground water naturally discharges into stream channels, this increased consumption of ground water ultimately decreases streamflow. Conjunctive stream-aquifer models can help planners maximize ground-water withdrawals while minimizing streamflow depletion at critical times of the year. Water-right transfers provide an alternative means to develop new water projects without increasing overall water consumption. Concurrent enforcement of the basin closures for all water, whether from surface or subsurface sources, would prevent further stream dewatering and protect existing water rights.

Trammel Net Efficiency for Sturgeon Sampled in the Missouri River: Implications for Sampling Design

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To accurately document the continued decline or recovery of sturgeon (*Scaphirhynchus* spp.), the efficiency of sampling these species needs to be evaluated. Drifted trammel nets are considered an important tool for sampling sturgeon in lotic systems. Thus, our objectives were to evaluate the efficiency of drifting trammel nets for sampling juvenile sturgeon [pallid sturgeon (*Scaphirhynchus albus*) and shovelnose sturgeon (*Scaphirhynchus platorynchus*)] using known fish locations, and to determine the abiotic factors that influence whether a sturgeon is sampled or not sampled. During the summers of 2003 and 2004, we attempted to recapture radio-tagged juvenile pallid sturgeon and shovelnose sturgeon at 69 locations in the Missouri River above Fort Peck Reservoir, Montana. Drifting trammel net efficiency was 32%, and first drift efficiency was 36%. Sixty-nine percent of the sampled sturgeon were captured on the first drift and subsequent drifts were less efficient and often unsuccessful. Multiple analysis of variance was not significant and all pairwise comparisons for abiotic variables between successful and unsuccessful captures were non-significant. Stepwise logistic regression was used to model the probability that a drift would not capture a sturgeon. However, none of the abiotic variables we measured were useful in the model. These results suggest that drifted trammel nets are a moderately effective sampling gear for juvenile sturgeon in lotic systems. When considering sampling design, our results suggest that it is most efficient to conduct single drifts at multiple sampling locations, rather than drifting multiple times at one location, if a large sample size is the objective.

Habitat Use, Diet, and Growth of Hatchery-Reared Juvenile Pallid Sturgeon and Indigenous Juvenile Shovelnose Sturgeon in the Missouri River above Fort Peck Reservoir

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Natural recruitment of pallid sturgeon (*Scaphirhynchus albus*) has not been observed in the Missouri River above Fort Peck Reservoir, Montana, for at least 30 years. In an effort to recover the species, 736 hatchery-reared juvenile pallid sturgeon (HRJPS) were

released as yearlings in 1998. Evaluation of these HRJPS is necessary to determine their performance in a natural lotic environment. A set of habitat variables was measured at each location for 29 HRJPS and 22 indigenous juvenile shovelnose sturgeon (JSNS) (*Scaphirhynchus platorynchus*) implanted with radio transmitters during the spring, summer, and autumn in 2003 and 2004. Significant interactions among species, season, and year existed for mean relative depth, column velocity, and bottom velocity. However, no significant interactions existed for mean fish depth, which was significantly higher for HRJPS than JSNS. Hatchery-reared juvenile pallid sturgeon frequently used lotic habitat created by receding reservoir water levels, indicating that Fort Peck Reservoir influences the amount of available habitat for juvenile pallid sturgeon. We also examined the diets of all HRJPS and JSNS sampled. Fish composed the majority of the diet of HRJPS, while JSNS primarily consumed aquatic invertebrates. There was no significant difference in relative growth rate between recaptured HRJPS and JSNS from May – October in 2003 and 2004. This study indicates that HRJPS in the Missouri River above Fort Peck Reservoir are capable of living in a natural lotic environment. Therefore, we believe that stocking HRJPS can successfully augment wild pallid sturgeon populations, which is crucial to the long-term recovery of the species.

Distribution and Status of Montana Prairie Stream Fishes

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During 1999-2004, we took 820 samples for fish in 561 prairie streams in Montana. The streams ranged in size from the Powder River down to ephemeral headwater streams. Of the 820 samples, 480 (56 %) were from sites with fish present, whereas fish were absent at 340 (44 %) of sites. We captured over 176,000 individual fish representing 48 species and 11 families. Thirty of the fish species and 89 % of individuals captured were native to Montana, whereas 18 species and 11 % of individuals were introduced species. At sites with fish present, native species richness averaged 4.5 and ranged from 1 to 14 species per sample, whereas introduced species richness averaged 1.9 and ranged from 1 to 8. Only two species, fathead minnow and white sucker were captured at more than 50

% of sites with fish present. Twelve native and 3 introduced species were captured in 10 % to 50 % of samples with fish present, and 15 native species and 16 introduced species were captured in less than 10% of samples with fish present. Of the 30 native species, 13 species were found in close proximity to large rivers or in larger streams, 13 species were found primarily in smaller streams, and 4 species were in coolwater streams in proximity to higher elevations. We documented the distribution of four species of special concern and 6 potential species of concern.

Spatial partitioning of two sculpin species in west central Montana

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Although sculpin (*Cottus* spp.) are often important components of fish communities in coldwater streams, their ecology, movements and population structure are poorly understood. To understand how sculpin are distributed within the upper Clark Fork drainage of Montana, we investigated phylogenic relationships, species differentiation and movement patterns of sculpin in eight tributaries. We determined phylogenetic relationships and identified patterns of genetic differentiation using morphometric measurements, meristic element counts and genetic sequence data from the mitochondrial control region. In each stream, we collected sculpin from two locations; typically from one site as far upstream as they were distributed and another site close to the mouth. In three streams, anthropogenic barriers limited movements between sample sites. Morphometric measurements, meristic counts, and genetic analyses confirmed the presence of two sculpin species in each stream (*C. cognatus* and, the previously undocumented, *C. sp. cf. bairdi*). Furthermore, sculpin were distributed similarly among streams regardless of passage barriers. In general, we found only *C. cognatus* in the

upper sites and *C. sp. cf. bairdi* in the lower sites. Movement studies revealed that *C. sp. cf. bairdi* was highly mobile (moving frequently, and up to 200 m) whereas *C. cognatus* was immobile during the five week study, despite similar densities of sculpin in both sites. These data suggest that two allopatric species of sculpin are apparently widely distributed in the upper Clark Fork watershed and that behavioral mechanisms, e.g., life history tactics, may be responsible for isolating these two species.

Prairie Fish Community Assessments: Scientific Uses with Implications for Conservation

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Aquatic ecosystems of Montana's prairie region have only recently been intensively inventoried for fish and macroinvertebrate communities. Recent surveys from FW&P, BLM, MSU, MTNHP have identified Montana SOC fish species within these communities, as well as "species on review" that need additional information. Since comprehensive data on these prairie aquatic communities remains limited, the Montana Natural Heritage's goal is to compile reliable information on the distribution and diversity of these assemblages with the ultimate goal of tracking unique communities across watersheds and predicting additional locations of these communities containing SOC fish and other aquatic organisms.
We began by documenting the stream types where the characteristic aquatic community clusters w/ indicator species occur in the landscape, and overlay these on TNC's Stream Classification System to determine if they consistently and predicatively align with similar classified stream reaches. Eight statistically valid prairie fish community groups were identified from the data. These were linked on NHD reach codes in a GIS to produce maps of occurrences and potential reach habitat for the fish community types considered potential conservation targets or priorities.

Environmental and Biological Factors Contributing to *Salmincola sp.* Infections in Missouri River Rainbow Trout *Oncorhynchus mykiss*

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During the summer and late fall of 2002, Montana Fish, Wildlife & Parks personnel received reports of Missouri River rainbow trout *Oncorhynchus mykiss* infected with *Salmincola sp.* gill parasites. During June and July of 2003 and 2004, sampling was conducted to determine the extent and severity of the parasite in Missouri River rainbow trout. Rainbow trout were sampled by nighttime electrofishing in two sections of the Missouri River. Length and weight were recorded on all sampled fish, and all fish were examined for the presence of the parasite. Infected fish were classified into 3 categories: 1 (mild), 2 (moderate), and 3 (severe) infections. In 2003, 79.3% (n=63) and 31.8% (n=66) of sampled rainbow trout were infected with the parasite in the Craig and Pelican Point sections, respectively. Most (78%) of the infections observed in the Craig area were classified as grade 1 or 2; however, 22% were severely (grade 3) infected. In the Pelican Point area, all infected rainbow trout had mild infections. In 2004, 52% (n=50) and 9% (n=64) of sampled rainbow trout were infected with the parasite in the Craig and Pelican Point sections, respectively; however, all infected fish had mild infections. The infection rates observed throughout this study are considerably higher than those reported in literature for wild fish. We hypothesize that the severity of the infection was related to environmental conditions (low flows and high water temperatures) coupled with a rainbow trout population with an abnormally high proportion of large (and old) fish.

Using an Index of Biotic Integrity as a Surrogate Indicator in the TMDL process for Prairie Streams

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The State of Montana is determining total maximum daily loads (TMDLs) for pollutants in streams, rivers, and lakes identified as water quality impaired. Common impairments listed for eastern Montana prairie streams include sediment loads, salinity, and temperature. However, numeric water quality standards either have not been developed for these imparIments, or criteria have been based on data from western Montana streams. As part of the TMDL process Garcia and Associates (GANDA) sampled fish populations at 11 sites on three streams within the Flatwillow and Box Elder watersheds near Winnett. We then analyzed the results from each site using an index of biotic integrity (IBI) for prairie fish communities developed by Dr. Robert Bramblett. The IBI ratings were used to support water quality information collected, and to determine level of impairment for sites on each stream. We are applying a similar approach to the

Redwater River planning area near Circle. No new fish collections have been made, but existing collections made by Montana Fish, Wildlife and Parks and Dr. Bramblett were used to calculate IBI scores. We then used the IBI scores to assess whether total suspended solids (TSS) and salinity levels negatively impact native fish communities. TSS and salinity levels from less impaired reaches are also being used to support "background levels" of these parameters in eastern Montana streams. The goal is to develop fish-based monitoring plans to assess whether water quality restoration plans are effective within prairie streams.

Monitoring the Biological, Physical, and Chemical Integrity of the Powder River: Implications for the Sustainable Development of Coalbed Natural Gas

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Coalbed natural gas (CBNG) is an emerging energy source with significant development slated for the Powder River basin in Montana and Wyoming. Water is the principal by-product of CBNG extraction and wastewater disposal strategies have an unknown effect on fish and aquatic life. The objective of this investigation was to document the existing biological, chemical, and physical integrity of the Powder River in Wyoming, upstream and downstream of areas with CBNG development. The investigation included assessments of fish, periphyton, macroinvertebrates, water chemistry, riparian vegetation, and instream habitat. Comparing results with existing data provided a means to evaluate temporal trends associated with current levels of CBNG development. Factors influencing macroinvertebrate and periphyton results included the difficulties related to sampling this sand bed river. Fish populations reflected habitat availability and emphasized the importance of large woody debris in forming pools. The scarcity of sturgeon chub (*Macrhybopsis gelida*), especially compared to its distribution in the early 1990s, emerged as major concern, although the cause of the decline is unknown. Water samples collected downstream of CBNG wastewater discharges had anomalously high concentrations of salts. Invasion of salt cedar (*Tamarisk* sp.) and the potential for increased salt loading from CBNG to give this nonnative species a competitive advantage over cottonwood (*Populus deltoides*) may have long-term implications for fish habitat. Recommendations for sustainable development of CBNG included incorporation of the river's ability to assimilate wastewater given its unique hydrology and integration life history strategies and movements of native fishes.

Toxicity of Coalbed Methane Discharge Water to Prairie Stream Fishes.

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Acute (96 hr) and chronic (60-day) toxicity tests were conducted on various fish species in order to better understand the sensitivities to major ions in surface waters, particularly those present in Coalbed Methane discharge water of the Powder and Tongue River basins. Discharge water in portions of the basins is high in $NaHCO_3$, which when combined with reconstituted Tongue or Powder River water can be toxic to fish at environmentally relevant levels. A general discussion of the sensitivity of different lifestages and the mechanisms of toxicity is also provided.

Whirling Disease, the Whirling Disease Initiative, and Whirling Disease Outreach

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This will be an informational talk on whirling disease, the background of the Whirling Disease Initiative, and the new outreach program. The newest outreach products will be highlighted. Whirling disease is caused by *Myxobolus cerebralis*. *Myxobolus cerebralis* is a parasite that infiltrates the head and spinal cartilage of fingerling trout where it multiplies rapidly, causing the fish to swim erratically and, in severe cases, die. When an infected fish dies, millions of tiny indestructible Myxobolus cerebralis spores (each about the size of a red blood cell) are released into the water. The spores can survive in a somewhat "dormant" form for up to 30 years. When the spores are ingested by *Tubifex tubifex* worms, the spore changes inside the worm and are released in a highly infective form, the *Triactinomyxon* (TAM). TAMs free-float in the water until they infect trout, causing spinal deformities and decreased abilities for feeding. Whirling disease is most infective to rainbow and cutthroat trout, but can infect all salmonid species. The National Partnership for the Management of Wild and Native Coldwater Fisheries is a consortium of public agencies and non-governmental organizations with an interest in sustaining the health of coldwater fisheries in the U.S. The Partnership exercises oversight over the Whirling Disease Research Initiative and evaluates other fisheries-health problems as potential subjects for integrated national research initiatives. Detailed scientific direction of the Whirling Disease Initiative is provided by the Whirling Disease Steering Committee. The Montana Water Center manages the Initiative, and funding comes from the US Fish & Wildlife Service. The Whirling Disease Initiative was established by Act of Congress in 1997. Its purpose is to conduct research that develops practical management solutions to maintain viable, self-sustaining wild trout fisheries in the presence of the whirling disease parasite. The Initiative's ultimate clients are state, tribal, and federal fisheries-management agencies, and the constituencies they serve.

Conducting outreach activities has been an ongoing, yet somewhat limited, effort since the inception of the Whirling Disease Initiative in 1997. Now, as we enter the final phase of the Initiative, a concerted effort to increase accessibility and availability of whirling disease information is warranted. The primary audience to be served through the outreach program is technical professionals—fishery managers and administrators, hatchery operators and fish health professionals, researchers and agency land managers. The secondary audience comprises fishery I&E professionals, both within the agencies and in private organizations such as the Whirling Disease Foundation, Trout Unlimited and the Federation of Fly Fishermen. These technology transfer professionals in turn will serve and educate anglers and the general public. The new outreach program activities and products are: compile audience lists; develop and distribute printed and multi-media materials explaining the biology and spread of the disease and techniques for mitigating its spread and severity; make formal presentations at regional or national fisheries meetings; make targeted visits to fishery managers at their workplaces; respond to requests for information from biologists, agency personnel and land managers; expand the Whirling Disease Initiative web site with detailed project results and management guidance; assess the current situation for whirling disease, including pertinent state laws and the true geographical scope and severity of the disease; develop annual updates for key stakeholders to keep them apprised of the situation and to combat apathy; further develop the RAW risk assessment methodology and make it into a useful product for fishery managers; compile status-and-trend information and mount it on the web site; compile state-by-state information on policies and regulations and mount a compendium on the web site; create and promote the authoritative whirling disease electronic resource that is both customized by audience and an easy-to-use central information repository; develop and distribute a periodic newsletter; collaborate with the Whirling Disease Foundation on outreach activities; build strategic alliances to leverage resources; maintain communication links with researchers, project partners, technical advisors, fishery managers, the media, and the general public.

Consulting 101: A View From Both Sides of the Fence

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This presentation will address the role of consultants in the fishery profession from two perspectives. It will provide information for people who may want to become consultants, and for people who may want to hire consultants. I will discuss what consultants can do, when to hire them, how to hire them, and the big question – why do they cost so much. I will also give some insights into what a career in consulting is like for people who might be considering a career change.

Risk-Based Viable Population Monitoring

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We describe risk-based viable population monitoring in which the monitoring indicator is a yearly prediction of the probability that, within a given timeframe, the population abundance will decline below a pre-specified level. Common abundance-based monitoring strategies usually have low power to detect declines in threatened and endangered species and are largely reactive to declines. Comparisons of the population's estimated risk of decline over time will help determine status in a more defensible manner than current monitoring methods. Monitoring risk is a more proactive approach; critical changes in the population's status are more likely to be demonstrated before a devastating decline than with abundance-based monitoring methods. In this framework, recovery is defined not as a single evaluation of long-term viability, but as maintaining low risk of decline for the next several generations. Effects of errors in risk prediction techniques are mitigated through shorter prediction intervals, setting threshold abundances near current abundance, and explicitly incorporating uncertainty in risk estimates. Viable population monitoring also intrinsically adjusts monitoring effort relative to the population's true status and exhibits considerable robustness to model misspecification. We present simulations showing risk predictions made with a simple exponential growth model can be effective monitoring indicators for population dynamics ranging from random walk to density dependence with stable, decreasing, or increasing equilibrium. In analyses of time-series data for five species, risk-based monitoring warned of future declines and demonstrated secure status more effectively than statistical tests for trend. We present more detailed risk-analyses for Flathead bull trout populations.

Trophic Position, Habitat Use, and Mercury in Flathead Lake Fish: Insights From Stable Isotopes

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We measured $\delta^{13}C$ and $\delta^{15}N$ in lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), and their major prey items to quantify foraging depth and trophic position of individual fish in Flathead Lake, Montana. We subsequently applied our isotopic quantification of foraging depth and trophic position to investigate mercury contamination at the individual fish level. $\delta^{15}N$ of chironomids increased with site depth, and $\delta^{13}C$ generally declined. In contrast, *Mysis relicta* showed no relationship between its isotope ratios and site depth. The isotope ratios in the pooled fish sample were related to fish capture depth, growth rate, and total length. We found no relationship between mercury contamination and our isotopic assessment of foraging depth in the fish. A significant relationship between existed between fish mercury contamination and our isotopic assessment of trophic position, suggesting that fish that feed deeper and/or higher up the food web are more contaminated.

Seasonal Movement and Habitat Use by Subadult Bull Trout in the Upper Flathead River System, Montana

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Despite the importance of large-scale habitat connectivity to the threatened bull trout *Salvelinus confluentus*, little is known about the life history characteristics and processes

influencing natural dispersal of migratory populations. We used radiotelemetry to investigate the seasonal movements and habitat use by subadult bull trout (e.g., fish that emigrated from natal streams to the river system) tracked for varying periods from 1999 to 2002 in the upper Flathead River system in northwestern Montana. Telemetry data revealed migratory (N = 32 fish) and nonmigratory (N = 35) behavior, indicating variable movement patterns in the subadult phase of their life history. Most migrating subadults (84%) made rapid or incremental downriver movements (mean distance, 33 km; range, 6-129 km) to lower portions of the river system and to Flathead Lake during high spring flows and as temperatures declined in the fall (to below 12°C) and winter (to below 4°C). Conversely, some migrants (16%) moved upriver (mean distance, 22 km; range, 6-46 km) as flows subsided following spring runoff and as mean daily temperatures gradually rose above 7°C. Bull trout subadults used complex daytime habitat throughout the upper river system, including deep runs that contained unembedded boulder and cobble substrates, pools with large woody debris, and deep lake-influenced areas of the lower river. Our data indicate that bull trout exhibit variable movement patterns in the subadult phase of their life history, and that movement appears to be influenced by water temperature and river discharge. Results elucidate the importance of maintaining natural connections and a diversity of complex habitats over a large spatial scale to conserve the full expression of life history traits and processes influencing natural dispersal of bull trout populations. Managers should seek to restore and enhance critical river corridor habitat and remove migration barriers, where possible, for recovery and management programs.

Age and growth of bull trout in the Lower Clark Fork River system and factors affecting the relative abundance of migratory and resident life history forms

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Bull trout (Salvelinus confluentus) exhibit resident, fluvial, and adfluvial forms, sometimes in sympatry. The mechanisms driving bull trout life history variation are poorly understood but important to management of this threatened species. In this study, we characterize the age structure of 17 bull trout populations, including age at outmigration and age at maturity. We compare age structures and growth rates between and among resident and migratory populations and discuss patterns across the study area. We examine relationships among life history form, age characteristics, and environmental variables including temperature, productivity, stream size, fish densities, population structure, species composition, and presence of migratory barriers. These findings will enable managers to better determine whether life history variation in bull trout populations can be directed to favor production of resident or migratory forms.

Adult Bull Trout Response to being Released above a Dam on the Clark Fork River, Montana

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Electofishing and a fish ladder/trap were used to capture 129 adult bull trout *Salvelinus confluentus* in the Clark Fork River downstream of Cabinet Gorge Dam, Idaho, from 2001 through 2004. A portion of these fish were presumed to have migrated downstream as juveniles from Montana tributaries through or over the dam and reared in Lake Pend Orielle, Idaho (16 kilometers downstream of Cabinet Gorge Dam). Captured adult bull trout were surgically implanted with radio transmitters, transported upstream by fish tank truck, and released at two sites in Cabinet Gorge Reservoir, Montana (13 and 20 kilometers upstream of the dam). Of the 129 bull trout successfully released in Montana, 78 were detected in tributaries to Cabinet Gorge Reservoir during the spawning season, September and October. A total of 26 bull trout transported from Idaho were recaptured in spawning tributaries, transported downstream, and released in the Clark Fork River, Idaho. Another 37 bull trout were documented to have volitionally passed downstream through turbines or over Cabinet Gorge Dam, a minimum of 23 of those likely survived turbine passage. Genetic assignments to tributaries of origin were accomplished for most fish captured over the 4 year study period. Of the 112 viable genetic samples collected below Cabinet Gorge Dam, 90% were assigned to upstream tributaries. Radio receivers at Noxon Rapids Dam (31 kilometers upstream from Cabinet Gorge Dam) detected 40 of the 129 bull trout in the dam tailrace area, 70% of these fish originated upstream of the second dam on the Clark Fork River. In 2004, a "Rapid Response Genetic Analysis" was employed to determine natal tributary of origin of captured fish prior to transport above Cabinet Gorge Dam.

Thermal Requirements of Westslope Cutthroat Trout

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Westslope cutthroat trout *Oncorhynchus clarki lewisi*, have declined throughout their native range in the Northern Rockies and were considered for listing under the federal Endangered Species Act. Water temperature is widely regarded as playing a key role in determining their persistence, but specific thermal optima and lethal levels for this cutthroat trout subspecies have not been precisely defined. This laboratory study used the acclimated chronic exposure method to determine thermal optima and tolerances for westslope cutthroat trout and for rainbow trout *Oncorhynchus mykiss*, a potential nonnative competitor now occupying much of the former range of westslope cutthroat trout. Optimum growth temperature for westslope cutthroat trout (13.6°C; 95% CI, 10.3 - 17.0°C) over the 60-d test period was, unexpectedly, similar to that of rainbow trout (13.1°C; 95% CI, 6.8 - 18.2°C). However, rainbow trout grew significantly better at temperatures below 6.8°C and above 20.8°C. Increased growth by rainbow trout at these temperatures could be the mechanism by which rainbow trout are out-competing westslope cutthroat trout. In addition, the ultimate upper incipient lethal temperature (temperature at which 50% of the population can survive for 60-d) for rainbow trout (24.2°C; 95% CI, 22.9 – 25.4°C) was 4°C higher than that for westslope cutthroat trout (19.7°C; 95% CI, 19.1 - 20.3°C). The higher upper temperature tolerance of rainbow trout may account for its increased occurrence at lower elevations than cutthroat trout. The thermal requirements established in this study can help guide protection and restoration efforts for this unique cutthroat trout subspecies.

Status of Burbot in Montana

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In Montana, burbot (*Lota lota*) are native to the Kootenai, Missouri, and Saskatchewan drainages. To assess the distribution and status of burbot in Montana, we requested population characteristic data (e.g., length-weight data, catch per effort, population estimates) from fisheries biologists throughout the state. In addition, we surveyed biologists regarding their opinions about the status of burbot in their area. We were able to obtain and analyze trend data from several populations throughout Montana, but most of these data were from incidental catches while biologists were sampling for other species. Thus, low sample size was a common problem with these data and made any conclusions regarding population trends relatively unreliable. Fisheries biologists throughout the state also agreed that data was limiting to make any recommendations regarding the status of burbot in Montana. Where standardized long-term data sets existed, burbot population abundance was highly variable and likely related to discharge. We recommend that standardized sampling be incorporated for monitoring burbot populations and that sampling for burbot be specifically targeted in areas that are identified as potential spawning and rearing habitat. Despite that burbot are native to much of Montana, little is known about their overall status, usefulness as an indicator species, and function in fish assemblages.

Seasonal and Diel Distribution of Lake Trout in Lake McDonald, Glacier National Park

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Bull trout *Salvelinus confluentus* have suffered a dramatic population decline since the establishment of nonnative lake trout *Salvelinus namaycush* in Lake McDonald, Glacier National Park (GNP). In an attempt to prevent further decline of this population, GNP is considering implementing a lake trout suppression program. We used ultrasonic telemetry to examine the spatial and temporal distribution of lake trout, thus providing information critical to developing a successful suppression program. We relocated 36 lake trout 1,137 times from June through November 2003 and March through November 2004. Tracking was conducted at all times during a 24-h period. Lake trout total length varied from 508-859 mm and averaged 629 mm (SE = 13.1). Mean depth of lake trout was shallowest (14.0 m, SE = 2.2) in May and deepest (25.2 m, SE = 1.03) in September. Mean depth increased from May through September as thermal stratification became more pronounced. During stratification, lake trout occupied depths in the thermocline and upper hypolimnion where temperatures varied from 6-12˚ C and dissolved oxygen levels were approximately 9-12 mg/L. Additionally, lake trout were found in the pelagic zone more frequently during stratification than in spring and autumn. Spawning commenced in late-October (water temperature <11˚ C), and lake trout aggregated in shoreline habitats with clean cobble and rubble substrates. Mean fish depth during spawning was 16.1 m (SE = 1.4). These data illustrate patterns in the spatial and temporal distribution of lake trout and will be useful for developing methods to reduce lake trout abundance in Lake McDonald.

A Spatially Explicit Approach for Evaluating Relationships among Coastal Cutthroat Trout, Habitat, and Disturbance in Headwater Streams

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Headwater stream systems are complex networks that form a physicochemical template governing the persistence of aquatic species such as coastal cutthroat trout. Individual portions of the network can function as conduits or receptacles for sediments, wood, and nutrients from terrestrial areas. Temporal and spatial changes in the delivery of these constituents can substantially alter the habitat template and its ability to support this native fish. Our study of 40 mid-sized watersheds (500 - 1,500 hectares) in western Oregon is providing new insights into the factors affecting the distribution of coastal cutthroat trout within, and among, headwater stream networks. For example, data suggest that coastal cutthroat trout move throughout the accessible portions of headwater streams for reproductive, feeding, and refuge purposes. Fish congregate in these areas and form local populations that may exhibit unique phenotypic and genetic attributes. At times, coastal cutthroat trout move into larger downstream portions of the network where they may contribute to the persistence and genetic character of anadromous or local potamodromous assemblages. Variation in distribution patterns among watersheds reflect diverse environments and selective factors, such as geology, geomorphology, climate, and land-management history. According to our research findings, human activities that impede movement among suitable habitat patches can have lasting consequences for local assemblages of coastal cutthroat trout and may ultimately affect persistence.

Genetic Structure of Mountain Whitefish (*Prosopium williamsoni*) in Montana and a Comparison to Other Salmonids

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No Abstract Submitted