

WILD FISH HABITAT INITIATIVE

SEMI-ANNUAL REPORT

Reporting period:
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(Covers Phase V of the Initiative)

Submitted by:
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Submitted to:
**Division of Fish and Wildlife Management Assistance and
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INTRODUCTION

Wild Fish Habitat Initiative Background

Habitat degradation is one of the principal reasons for the listing of wild fish as “threatened” or “endangered” under the Federal Endangered Species Act. Habitat degradation can exacerbate detrimental effects of fish predators, exotic competitors, and diseases such as whirling disease. In addition, land values are diminished by habitat degradation and the subsequent loss of wild fish populations. Private landowners forego economic opportunities when land uses are restricted and resources are directed toward fish restoration. In recent years, many techniques of fish habitat enhancement have been implemented, but their long-term efficacy is not well understood because little or no evaluation and monitoring have been conducted.

Established in 2002, the Wild Fish Habitat Initiative is a cooperative effort between the US Fish and Wildlife Service, Partners for Fish and Wildlife Program and the Montana Water Center (housed on the campus of Montana State University-Bozeman). Research conducted through the Wild Fish Habitat Initiative (Initiative or WFHI) is being carried out by Water Center staff and Montana State University biologists in collaboration with private landowners and private and public-agency biologists.

The Partners for Fish and Wildlife Program, administered by the USFWS, is a critical national effort to restore important fish and wildlife habitat. This voluntary program provides financial and technical assistance to private landowners wanting to restore habitat on their lands.

Purpose—The purpose of the WFHI is to augment the success of the Partners Program and other fish habitat restoration programs by conducting targeted research related to native fish habitat restoration techniques, and by implementing a technology transfer program to provide technical information to landowners and project managers. Progress on each of the efforts conducted for the Initiative is described in detail in later sections of this report.



Focus on Native Fish Populations—Wild fish can be either native or introduced exotic species that reproduce and are self-sustaining in the wild. Non-native fish can have significant recreational and economic value; however, in some instances (locations), non-native fish may not be appropriate where conservation of native fish is a goal. The WFHI gives special consideration to habitat restoration projects targeted for native fish populations. We do consider projects for exotic fish if such techniques are useful in benefiting native fish.

Defining Restoration—Stream restoration has become a multi-billion-dollar industry, and a diversity of techniques have been developed and practiced. Various perceptions exist as to what is meant by the term “restoration.” Wohl et al. (2005) emphasized that these perceptions reflect the wide range of stakeholder interests, scientific knowledge, scales of interest, and system constraints encountered in practice. In recent years, river managers and scientists have proposed the term “restoration” be used only for projects with the objective of assisting in the establishment of improved hydrologic, geomorphic, and ecological processes in a degraded watershed system and replacing lost, damaged, or compromised elements of the natural system (Wohl et al. 2005; Kauffman et al. 1997; Palmer et al. 2005; and Roni et al. 2002). Recently, Palmer et al. (2005) proposed standards for measuring and guiding restoration success, with emphasis on a watershed-scale, ecological approach. These standards were endorsed by an international group of river scientists (Jansson et al. 2005) and practitioners (Gillilan et al. 2005). Until consensus is reached and specific standards for ecological restoration criteria are adopted, the WFHI will hereafter use the term restoration to address any river or stream projects aimed to improve fish habitat.

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PROGRAM ADMINISTRATION

Wild Fish Habitat Initiative Program Administration

Principal Investigators

Dr. Alexander V. Zale, Montana Cooperative Fishery Research Unit Leader and Professor, Department of Ecology, Montana State University

Kristin Keith, Wild Fish Habitat Initiative Program Director, Montana Water Center, Montana State University

Goals and Objectives

The overall goals of Initiative program administration are to meet the needs of the USFWS Project Officer regarding the Initiative, and to support the research teams in carrying out wild fish habitat research projects (described in the *Research Projects* section of this report). Specific administrative objectives are:

- To assure that fiscal transfers are timely, clear, and appropriate,
- To keep the USFWS well-informed about the progress and results of the program,
- To identify and enter into formal relationships with additional project partners, as appropriate, and
- To publicize Initiative projects, research results, and program deliverables to interested parties.

Overview

Montana Water Center administrative personnel have managed the USFWS contract and all research subcontracts; processed invoices and tracked the fiscal status of each project; submitted progress reports to the USFWS; responded to USFWS requests for information or assistance; and supported the research teams in acquiring information, supplies and facilities, in contractual or hiring matters, and in other ways as needed.

All administrative duties are the responsibility of Montana Water Center personnel. Major duties during this reporting period involved soliciting feedback from and maintaining communication with the USFWS and MSU Office of Sponsored Programs personnel, and submitting a detailed report on all research components of the Initiative.

Deliverables

Deliverables for program administration as a whole are regular communication and updates to Division Chief, Hannibal Bolton, and MSU Office of Sponsored Programs personnel; two program progress reports per year; regular invoices to the USFWS; and financial reports.

TECHNOLOGY TRANSFER / OUTREACH / TECHNICAL SUPPORT

Technology Transfer and Outreach

Team Members

Kristin Keith, Program Director
Rick Holscher, Web Site/Publications Specialist
Trey Kucherka, Aquatic Sciences Laboratory Manager
Dr. Thomas McMahon, Technical Advisor
Dr. Alexander V. Zale, Technical Advisor

Background

In recent years, many techniques regarding stream restoration and fish habitat enhancement have been implemented, but project results generally have not been shared or exist only in "gray literature"—where they are difficult to access. To address this problem, the Montana Water Center is collating information in the field of stream/riparian restoration science, with an emphasis on recovery of wild fish populations. Information collected includes a database of more than 1,000 publications and manuals reporting techniques and research in the field of restoration science. We also have a collection of detailed case histories on outstanding stream restoration projects completed within the Intermountain West (Colorado, Idaho, Montana, Nevada, Utah, Wyoming, and inland areas of California, Oregon, and Washington) and more recently in Alaska. Our intent is to augment the success of the USFWS Partners Program and other restoration efforts by providing useful, highly-technical bibliographic and case history information through a web-accessible database (<http://wildfish.montana.edu>).

Goal

The overall goal of the Technology Transfer Project is to increase the long-term effectiveness of fish habitat restoration projects by providing easily accessible information on effective fish habitat restoration and monitoring techniques.

Objectives

1. To alert Partners program personnel, private landowners, tribes, land managers, and fisheries biologists to the project and solicit their informational needs.
2. To provide a web-accessible resource on fish habitat restoration, including bibliographic information of pertinent literature.

3. To provide a web-accessible case history database of fish habitat projects pertinent to Partners activities in the Intermountain West states, Alaska, and South Dakota. Projects selected: (1) are well-designed, based on investigation of the causes of degradation of fish habitat and/or stream hydrologic, geomorphic, and ecological processes, and (2) have an effectiveness monitoring component assessing the "success" of the restoration project.

Progress to Date

Wild Fish Habitat Initiative Web Site— The Initiative Web site continues to be updated with on-going research activities and newly-acquired resource information. The site includes: summaries and progress reports of all Initiative research projects, a collection of native fish habitat restoration case histories, a searchable bibliography related to fish habitat and restoration science, a selection of downloadable habitat restoration manuals, and links to pertinent online habitat restoration information. Also available are fact sheets related to: the definition of the term "restoration," "wild fish" versus "native fish," and a fact sheet providing information on common problems addressed in the field of stream and fish habitat restoration.

Over the past three years, use of the WFHI Web site has been tracked on a quarterly basis. This year, the number of visitor sessions on the WFHI Web site more that doubled that in 2006 (Table 1).

Table 1. General statistics for visitor sessions on the Wild Fish Habitat Initiative Web site.

	Visitor Sessions	Average Per Day	Average Session Length
January to March 2006	13,452	162	13:35
January to March 2007	31,223	346	20:09
March to June 2007	29,252	321	17:32

Online Resources—The Initiative online bibliography is a collation of information on various fish habitat restoration techniques chosen to facilitate information exchange among fisheries biologists and project managers. Each year, we collect new resource materials from conferences and meetings in an effort to provide the most current information available to the fisheries biologist and restoration professional. In addition to adding new resource materials to our Web site, we made a significant effort this spring to reorganize the resources link so that it would be more user-friendly. We also enhanced the "links" page, which will have many private, agency, and other links relevant to the topic of stream/habitat restoration, as well as a "tools" category, which links to various calculators and practical tools to assist the restoration professional in the design process.

Native Fish Habitat Restoration, Case Histories Database— This year we have focused on finding projects in Utah, Nevada, Idaho, California, and Alaska. Eight case histories have been added to the site, from these states. Each case history description includes: narrative descriptions, project goals, restoration methods, project costs, landowner contributions, photographs, and monitoring data. The intent of the case histories database is to share information and learn from examples of previous native fish habitat restoration work. Currently, the case histories database showcases 48 projects: twelve in Montana, five in Wyoming, four in California, seven in Oregon, two in Idaho, five in Colorado, three in Washington, two in Utah, four in Nevada, one in South Dakota, and three in Alaska. There are other case history projects that have been completed but have yet to be posted on the Web site. They are either going through a final technical review or are scheduled to be posted by the Web site Specialist.

In addition to writing new case histories, much time was spent updating old case histories. The magnitude of the task to update case histories required employing a part time work-study to assist in the collection of information. Approximately half the case histories were updated — many of them needed significant revision. Reasons for revisions were: more restoration work done on the project, additional information from project reports, which would enhance the case history; and new

monitoring data, which needed to be incorporated into the old case history. The remaining case histories require another round of inquiry to project manager(s), who did not respond to the work-study's requests.



Pictured left: Lefthand Creek near Longmont, Colorado prior to restoration. Historical agricultural practices and channel straightening severely degraded aquatic habitat in the creek. Pictured right: Lefthand Creek with over-bank flow during the spring. Post-restoration monitoring showed a full complement of native fish utilizing the newly-constructed habitat in abundance. Channel stability and revegetation efforts were also a success.

Program Publicity and Outreach— Montana Water Center personnel have actively publicized the Initiative program and its research and Web site products. Local and national professional meetings were attended, to make contacts, give program updates, and present work products. These outreach activities have helped to foster new working relations with regional stream restoration professionals, state and national academics, tribes, state and federal agency personnel, and regional fisheries managers. Initiative outreach activities included:

1. Kristin Keith (poster), 40th Annual meeting of the Montana Chapter of the American Fisheries Society, February 13-16, 2007; Missoula, MT.
2. Kristin Keith (presentation), Association of State Wetland Managers, Western State Workshop; June 5-6. Park City, UT.

New Project Opportunities

Expansion of geographic coverage— In 2007, the Technology Transfer team made an attempt to expand our program's geographic coverage by adding the Missouri River Basin to our case history database. In December 2006, the Aquatic Sciences Lab Manager attended the Midwestern Fish and Wildlife Conference in Omaha, Nebraska, where he actively pursued potential Missouri Basin projects and contacts. The Technology Transfer team followed up on those potential contacts; however, no projects which met our case history guidelines materialized. A student employee also spent time contacting USGS Fisheries Cooperative Unit leaders for potential case history leads. Again, nothing materialized. Because Phase V is the last phase of this program, we elected to forgo any further pursuit of case histories in this region.

Western Native Trout Initiative (WNTI)— WFHI staff have been encouraged to participate in the new WNTI effort. This was emphasized again in a February 2007 meeting between Gretchen Rupp, Hannibal Bolton, and Stuart Leon. After initial scoping meetings, Robin Knox (the WNTI coordinator) suggested that WFHI staff involvement be in outreach, technical writing/editing, and in the strategic planning process. Kristin Keith attended the first two WNTI Strategic Planning Committee meetings and was placed on the Communications Committee. This committee will provide guidelines for a

WNTI communication strategy to be incorporated into the WNTI Strategic Plan. Kristin and the Outreach Team produced the first outreach materials for WNTI – two posters and a brochure. Currently, WNTI is completing a report entitled, “Western Native Trout: Status, Concerns, and Opportunity”, which will be designed and formatted by WFHI staff for print publication.

Western Division of the American Fisheries Society Documentary DVD

The Western Division of the American Fisheries Society produced a new documentary film on DVD entitled “Rising from the Shadows: the Return of the Cutthroat Trout.” This documentary was produced with filmmakers at Montana State University, with the support of several American Fisheries Society chapters, state fish and wildlife agencies, and federal resource management agencies. The film is an informative and entertaining documentary about the cutthroat trout, from their historic spread across the western landscape to the present day. Approximately 250 DVDs were distributed to representatives of all chapters of the Western Division American Fisheries Society, federal and state agencies, and private organizations throughout the western United States. Distribution of the DVDs was partially sponsored by the Wild Fish Habitat Initiative. More will be distributed upon request.

Future Activities

In the 2nd half of 2007, the Technology Transfer team will concentrate our efforts on closing out the WFHI. This effort will include a synthesis paper on important information and trends identified across the projects showcased on the WFHI Web site — information which could be useful and practical to the restoration professional. When it is complete, we will submit this paper to the American Fisheries Society *Fisheries* journal. We will continue seeking updated information on older case history projects, updating the online bibliography and habitat restoration manuals, streamlining additional Web site features, collecting information on native fish habitat restoration projects for the case histories database, carrying out outreach activities, and maintaining the Web site as needed. We will also focus our efforts on partnering with the NFHI and WNTI. The Water Center Director will continue to seek funding opportunities to continue Initiative activities.

Kristin Keith is considering additional travel to restoration projects, which would benefit from a site visit to acquire current, on-the-ground photo documentation, and to meet with project managers.

Montana Water Center staff members are planning to attend several professional meetings in 2007 to make contacts and present Initiative work products. These meetings include, but are not limited to, the following: (1) Ecological Society of America and Society for Ecological Restoration Joint Conference, August 5-10, 2007; (2) University of Montana annual River Conference, September 20, 21; and 3) 9th Wild Trout Symposium, October 9-12, 2007.

We welcome additional suggestions for outreach opportunities from our project partners.

Aquatic Sciences Laboratory and Technical Support

A major focus of the Aquatic Sciences Laboratory is its involvement in WFHI research projects. Peter Brown, a doctoral student for Al Zale, uses lab facilities for his research entitled, “*Evaluation of the efficiency and efficacy of non-native fish eradication and exclusion techniques for native fish restoration.*” Under full operating study conditions he is making use of two 64-tank recirculating systems, as well as two specially designed experimental systems housed at the lab. Both the Lab Manager and the Water Center Director have assisted Peter in technical issues related to laboratory equipment operation and with guidance on assessing how photolysis, hydrolysis, complexation, diffusion, and dispersion might determine the behavior of piscicides in natural streams.

In early 2007, an experiment was initiated by Shane Vatland, a doctoral candidate under Bob Gresswell, investigating the effects of PIT tags on Arctic grayling growth, survival, and swimming performance; however, the grayling suffered from parasitic infection and the experiment was stopped. The Lab Manager has been assisting Shane with the redesign of laboratory research for his

Arctic grayling study. A new group of early-juvenile-stage grayling will arrive at the lab in the fall to be raised at the lab in the hope of reducing the potential effects of confinement stress. The grayling will be housed and grown in a recirculating, aquarium tank system until they are large enough to be moved to the Lab's recirculating raceway system. The actual experimental procedure will make use of the raceway system and a specially designed fish stamina tunnel.

The Aquatic Sciences Lab Manager continues to engage in discussions with individuals outside the scope of the WFHI – discussions that are relevant to Initiative goals. In December 2006, the Lab Manager attended the Midwestern Fish and Wildlife Conference in Omaha, Nebraska, where he actively pursued potential partnerships with Midwestern U.S. fisheries biologist. He is engaged in discussions with a number of regional individuals to address the issue of non-native lake trout invasions of western waters and their impact on native fish. An offshoot of this discussion is the potential use of pheromone attractants to control brook trout populations, which are negatively impacting native bull trout. The Salish-Kootenai Confederated Tribes has shown interest in this research, and opportunities to fund this work will be pursued in the near future. The Lab Manager has partnered with the Western Transportation Institute (WTI) to pursue funding for research projects related to stream passage design and for toxicology studies to analyze the effects of road de-icers on trout. The Lab manager, in cooperation with WTI personnel, professor Tom McMahon of MSU, and Don Skaar with the state of Montana are designing a pilot project to begin studies on deicer LC50 toxicity on rainbow and cutthroat trout species. This work will be funded by local nonprofit organizations.

RESEARCH PROJECTS

Phase IV Research Projects Continuing into Phase V

Four research projects are continuing from Phase IV into Phase V and one new project has begun in Phase V of the WFHI. Brief overviews and updates of those projects are provided below.

Project #1. Evaluation of the Efficiency and Efficacy of Non-native Fish Eradication and Exclusion Techniques for Native Fish Restoration

Graduate Student: Peter Brown, PhD student, Montana State University
Principal Investigator: Alexander V. Zale, Unit Leader, Montana Cooperative Fishery Research Unit
Technicians: Heather Johnson, Montana State University
Troy Buckel, West Virginia University

Background

Native fish conservation has become a pressing issue for resource managers, often because of threats posed by non-native fish species. Predation and competition for resources can drive native populations extinct, while hybridization reduces the overall genetic integrity of native populations. Fishery restoration projects have been undertaken throughout the United States to conserve threatened and endangered species as well as to rid water bodies of non-native species. These projects use fish toxins



(piscicides) to eradicate non-native fish species, and physical barriers to prevent their reinvasion. The use of fish toxicants has been shown to be very effective; however, there are many unknown variables in their use. For example, it is suspected that piscicides change their toxicity with high sunlight exposure, but the intensity and length of sunlight exposure that makes the chemicals ineffective is unknown. It is also recommended that piscicide application stations be closely spaced in low-gradient streams. In this context the terms high and low are relative. Quantifiable descriptions need to be established for these terms. Currently, without more specific piscicide application guidelines, applicators frequently apply too much piscicide in an effort to be cautious and thorough. Over-application of piscicides can be costly and result in high mortality of aquatic invertebrates. Similarly, only vague recommendations exist for applications where sunlight and organic matter could significantly alter the toxicity of piscicides. Once piscicide application instructions are better defined, non-native fish eradication will be more effective. This research team is investigating the toxicants used to eradicate non-native fish to better define piscicide application guidelines.

Goal and Objectives

The goal of this project is to increase the success rate of native fish restoration projects. The research team hopes to increase the efficiency and efficacy of native fish restoration by making piscicide use more efficient and effective. Researchers are carrying out a thorough investigation of the techniques used to eradicate non-native fish, specifically addressing the efficiency of piscicide use.

Specific short-term objectives are to: (1) Determine the relationship between piscicide toxicity and sunlight, turbulence, and organic matter, (2) determine the duration of piscicide toxicity when exposed to characteristics of natural streams, and (3) develop models to predict the probability of target species eradication using piscicides.

Progress to Date

A series of laboratory studies have been conducted that isolate sunlight, turbulence, and organic matter to determine their individual effect on piscicide toxicity. Results of sunlight experiments provide evidence that piscicides are rapidly detoxified when exposed to direct sunlight. Piscicides applied at concentrations recommended by their manufacturers are ineffective after less than one hour of exposure to direct sunlight. Even if piscicide treated water is shaded from 80 percent of sunlight, exposure to the remaining 20 percent cause the piscicides to be ineffective. Turbulence affects piscicide toxicity less than sunlight. Constant mixing for 24 hours made rotenone and antimycin ineffective.

Stream studies of piscicide toxicity applied rotenone at a single point and used regularly spaced bioassay fish along the stream's course to determine toxicity. Knowing where along a stream the piscicide became non toxic allowed the research team to measure the stream characteristics that caused that change. Repeating this process on six streams in Montana and Wyoming allowed the researchers to develop a model that identifies common characteristics of streams that cause piscicide detoxification. Large substrates, total dissolved solids, and oxidation-reduction potential are characteristics that are likely causing piscicides to become non-toxic. Measuring these characteristics and applying the predictive model should allow piscicide applicators to predict rotenone persistence.

This project has been changed by removing research on barrier construction and field tests of antimycin. Barriers are an important part of biological restoration of streams but research on barriers and piscicides are significantly divergent. The graduate student and his advisors decided to limit barrier research to the Online Barrier Survey and focus his research on piscicide toxicity. During research on piscicide toxicity the toxicity of the commercially available form of antimycin became unreliable. Small amounts of highly refined antimycin are available from chemical suppliers allowing laboratory research to continue; however, the amount necessary to treat streams is not available. Research on stream application of rotenone will be expanded by comparing two brands of rotenone.

Future Activities

Laboratory experiments will continue in the summer of 2007. The research team will continue exposing piscicides to simulated environmental conditions at the Aquatic Sciences Laboratory at Montana State University. Higher concentrations of piscicides (15 ug/L) will be exposed to simulated environmental characteristics to determine if increasing the concentration can overcome the effects of environmental degradation. The predictive ability of models developed during stream studies of piscicide toxicity will be tested later in the summer of 2007. The researchers will be testing models of piscicide toxicity during ongoing restoration of streams across the western US.

Projected Completion Date and Deliverables

Completion of the overall project is expected in 2009 pending continued funding; reports will be issued accordingly. Publication of research results and presentations at scientific meetings will take place as research is completed.

Project #2. Evaluation of Habitat Restoration for the Conservation of Cutthroat Trout

Graduate Student: Bradley B. Shepard, PhD student, Montana State University
Principal Investigator: Alexander V. Zale, Unit Leader, Montana Cooperative Fishery Research Unit
Faculty Consultant: Mark Taper, Quantitative Ecologist, Ecology Department, Montana State University
Technicians: Luke Renner and Drew Pearson, Montana State University

Background

The distributions and abundances of native westslope and Yellowstone (*Oncorhynchus clarkii lewisi* and *O. c. bouvieri*) cutthroat trout in the Northern Rocky Mountain region have declined from historical levels, and both subspecies are considered at risk for listing under the Endangered Species Act. Efforts are currently underway to conserve these subspecies throughout the region. One important conservation strategy is that of habitat restoration and enhancement, but few studies have quantitatively assessed the responses of cutthroat trout populations following habitat restoration. In fact, few studies have described what constitutes ideal habitat for these subspecies, making restoration imprecise and unpredictable. In addition, competition and predation by non-native trout species, particularly brook trout that frequently occur in sympatry with both subspecies, is another major threat to their conservation. Interactions between brook and cutthroat trout are likely regulated by habitat condition, but little is known about these relationships.

During the first year of our study (under Phase III) WFHI researchers collected and compiled data to: (1) describe what would constitute high-quality habitat for westslope and Yellowstone cutthroat trout in central Montana, and (2) determine how habitat condition and the presence of brook trout would interact to reduce densities of cutthroat trout. In collaboration with the USDA Forest Service Rocky Mountain Station and Beaverhead-Deerlodge National Forest, researchers have compiled and edited a database with species presence data for brook and cutthroat trout throughout the range of cutthroat trout. It contains over 4,500 sites in Montana and Idaho. Another database has been compiled that consists of systematic samples collected by WFHI researchers at intervals of 1 to 3 kilometers in almost all tributaries within seven major basins in Montana. This second database includes fish abundance information (catch per unit effort) for each site and detailed habitat survey data. All information in these two databases is geo-referenced within a geographic information system (GIS), and GIS layers have been used to derive estimates of many of the physical attributes tested. ArcView and ArcGIS have been used to delineate watersheds above all sample sites where researchers have collected data to overlay other GIS layers to derive these estimates.

Under Phase IV, researchers have been evaluating past and on-going habitat restoration and enhancement projects that specifically targeted conservation of cutthroat trout. The purpose of this evaluation has been to assess whether these projects resulted in increased densities or distributions of cutthroat trout or brook trout and how these projects influenced potential interactions between these two species.

Goal and Objectives

The goal of this project is to identify habitat conditions that will promote the continued persistence and conservation of westslope and Yellowstone cutthroat trout in the Northern Rocky Mountains through habitat restoration and enhancement projects. Specific objectives are: (1) to evaluate how habitat condition interacts with brook trout presence and abundance to affect the abundance and distribution of cutthroat trout, and (2) to evaluate the effect of presence of non-native fishes on success of cutthroat trout habitat restoration projects.

Progress to Date

Our January 2007 progress report provided detailed appendices showing sites where we are collecting data and literature we have reviewed. Data collected during the three years of this project continues to be analyzed to add to data collected from 1993 through 2004. In early June, thermographs were placed in streams sampled in 2007, and researchers began re-sampling sites sampled during 2005 and 2006. Initial drafts reporting on results of two studies examining mechanisms by which brook trout displace cutthroat trout have been completed. One study evaluated food habits of juvenile and adult brook and cutthroat trout in two streams during the summer of 2005. The other evaluated competition between age-0 brook and cutthroat trout prior to their first winter within cage enclosures located in a stream during 2005 and 2006.

Future Activities

Since an additional year of field data was collected in 2006, researchers elected to delay producing a final report until 2007. The final report will be prepared, and at least one portion of this report will be submitted as a manuscript to a peer-reviewed journal for publication. Researchers plan to present these findings at meetings and symposia during 2007 and 2008.

Projected Completion Date and Deliverables

This project will be completed by December 31, 2007. To meet contractual agreements, researchers will deliver a final report and manuscript(s), a CD containing the report and manuscripts, all the raw and summarized data, and GIS maps showing all sample sites along with GIS shapefiles and metadata for the sample sites, thermograph sites, and drainage polygons. As stated above, researchers will present these results at conferences in 2007 and 2008 and will acknowledge the support of the WFHI in all reports, publications, and presentations.

References

Sloat, M. R., B. B. Shepard, R. G. White, and S. Carson. 2005. Influence of stream temperature on the spatial distribution of westslope cutthroat trout growth potential within the Madison River basin, Montana. *North American Journal of Fisheries Management* 25: 225-237.

Project #3. Evaluation of Entrainment Losses of Westslope Cutthroat Trout at Private Irrigation Diversions on Skalkaho Creek, Montana

Graduate Student: Ryan A. Harnish, MS student, Montana State University
Principal Investigator: Alexander V. Zale, Unit Leader, Montana Cooperative Fishery Research Unit
Collaborator: Christopher G. Clancy, Montana Department of Fish, Wildlife and Parks
Technicians: James L. Ervan and Bruce Hunner, Montana State University

Background

The Bitterroot River system supports populations of both the non-migratory resident and fluvial migratory life-history forms of westslope cutthroat trout (*Oncorhynchus clarkii lewisii*). However, the migratory form has experienced significant declines due to habitat fragmentation, migration barriers, dewatering, and irrigation canal entrainment. Despite having a healthy population of resident westslope cutthroat trout, and being one of the largest tributaries to enter the Bitterroot River from the east side, Skalkaho Creek contributes little flow and few migratory cutthroat trout to the Bitterroot River due to several irrigation diversions and severe dewatering.

The research team is examining the effect of seven lowhead dams located on lower Skalkaho Creek that divert downstream migrant westslope cutthroat trout into irrigation canals. Post-spawn adults migrating back to the Bitterroot River and juveniles emigrating downstream from nursery reaches of Skalkaho Creek can become entrained and die in the irrigation canal system, resulting in a net loss to the population. Private landowners and irrigators in the Skalkaho Creek drainage expressed concern over the entrainment losses of westslope cutthroat trout to irrigation canals and worked with Montana Fish, Wildlife and Parks to successfully request funds from the Fish Restoration and Irrigation Mitigation Act program to install fish screens and siphons at some of the diversions to preclude such losses. The screens were installed in 2003 and became operational in April 2004. Siphon installation is projected for fall 2007. Evaluations estimating entrainment losses of migratory, non-anadromous westslope cutthroat trout at screened and unscreened irrigation canals have not been conducted and published in the peer-reviewed literature to date, thereby inhibiting private landowners and agencies throughout the Northern Rockies from investing in fish screens and siphons as part of their fish habitat management and restoration efforts. The first two phases of this study began addressing these information gaps.

During the first phase of our study, estimates were obtained prior to fish screen installation to quantify the magnitude of entrainment losses at the seven irrigation diversions. Significant entrainment, particularly of age-0 juveniles, was observed at the unscreened diversions. During the second phase of the study, after installation of fish screens at three diversions, estimates of entrainment and the efficiency of the fish screens were evaluated. Entrainment of both age-0 juveniles and adults was high at unscreened diversions but negligible or absent at screened diversions. Results regarding the efficiency of fish screens were inconclusive because some fish unexpectedly swam back out of the irrigation canals through the headgates, thereby evading detection. Whereas fish screens were an effective management tool for reducing irrigation canal entrainment of adult and age-0 westslope cutthroat trout, a distinct knowledge gap existed regarding: (1) the efficiency of fish screens at preventing entrainment of age-1 to age-4 westslope cutthroat trout, (2) the effect that screening irrigation canals has on young-of-the-year westslope cutthroat trout movements, and (3) the effect of entrainment at the unscreened Hedge Canal on emigrating fluvial westslope cutthroat trout juveniles. The research team is currently addressing these information gaps.

Goal and Objectives

The goal of this project is to evaluate the efficacy of fish-screen and siphon structures in western Montana in preventing entrainment of fluvial inland salmonids. Our specific objectives in Phase IV and V have been to: (1) evaluate the efficacy of the screens using an improved study design that incorporates detection of fish moving upstream through the headgates, (2) determine the effect of screening on age-0 westslope cutthroat trout movements, and (3) evaluate the effect of the unscreened Hedge and Republican canals, which are to be siphoned, on the recruitment of fluvial westslope cutthroat trout juveniles to the Bitterroot River.

Progress to Date

Data obtained in 2006 from fish screen efficiency trials was analyzed during the spring of 2007 to determine the efficacy of fish screens installed in three irrigation canals of Skalkaho Creek, Montana. Overall, the three screens prevented the loss of about 89 percent of the PIT-tagged fish that were released into the canals during fish screen efficiency trials.



Data obtained in 2006 regarding the downstream movement of age-0 westslope cutthroat trout was analyzed during the spring of 2007. Although large numbers of age-0 westslope cutthroat trout moved downstream into the irrigation-affected reach in 2005 and 2006, relatively few migrated downstream beyond the Ward-Hughes diversion dam.

The effect of the unscreened Hedge and Republican canals, which are to be siphoned under Skalkaho Creek, was analyzed during the spring of 2007 with data that was obtained throughout the 2006 irrigation season. As much as 70 percent of downstream-migrating westslope cutthroat trout juveniles were entrained into the Hedge and Republican canals as they attempted to emigrate to the Bitterroot River in 2006.

Results were presented at the annual meeting of the Montana Chapter of the American Fisheries Society in February 2007.

Future Activities

Data will continue to be analyzed during the summer and autumn of 2007. A detailed final report and a Thesis describing the methods, findings, and management implications of the study will be finalized. Results will be presented at the annual meeting of the American Fisheries Society in San Francisco in September 2007.

Projected Completion Date and Deliverables

A detailed final report and a Thesis describing the methods, findings, and management implications of the study will be produced. A manuscript based on this study will be submitted for publication in a peer-reviewed journal. Results will be presented at scientific meetings.

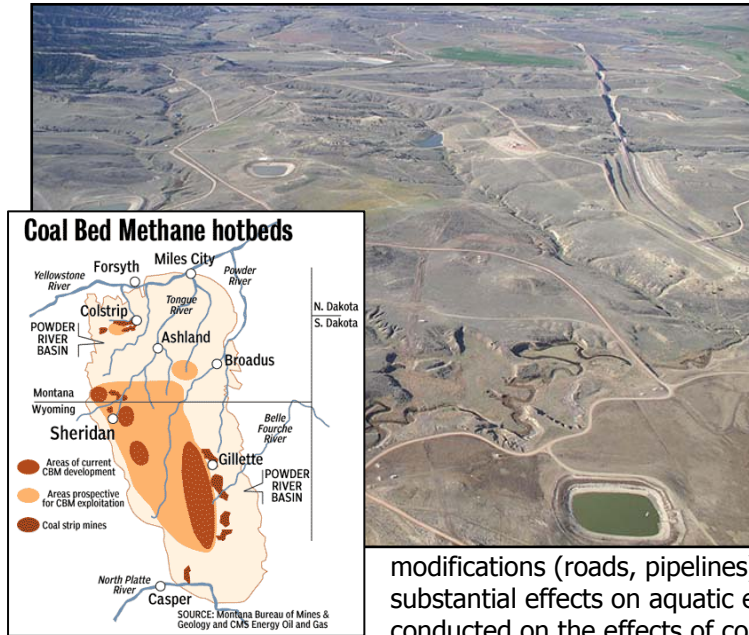
Project #4. Effects of Coalbed Methane Development on Great Plains Fish Assemblages

The WFHI portion of this project started in October 2005.

Graduate Student: Windy N. Davis, MS student, Montana State University
Principal Investigator: Alexander V. Zale, Unit Leader, Montana Cooperative Fishery Research Unit
Co-Principal Investigator: Robert G. Bramblett, Department of Ecology, Montana State University

Project Partners:

Montana Fish Wildlife and Parks, Montana Department of Environmental Quality, US Bureau of Land Management, US Environmental Protection Agency, US Fish and Wildlife Service, Wyoming Fish and Game, US Forest Service, and the coalbed methane industry.



Background

The recent development of coalbed methane resources in the Powder River Basin in Wyoming and Montana and elsewhere in the United States has created a need for scientifically sound information by agency, tribal, and industry resource managers regarding its potential effects on land and water resources and on biota. Coalbed methane development involves the production and disposal of large quantities of coalbed groundwater, often characterized by high concentrations of dissolved ions and/or elevated sodium adsorption ratios, as well as surface environment

modifications (roads, pipelines); therefore, the potential exists for substantial effects on aquatic ecosystems. Little research has been conducted on the effects of coalbed methane development on fish

assemblages, and no research has compared effects resulting from different product-water management strategies (for example, direct discharge, treatment, disposal in evaporation ponds, re-injection).

Goal and Objectives

The goal of this research is to better understand the influence of coalbed methane development on the aquatic biota and habitats of southeast Montana and northeast Wyoming. The research team's specific objective is to determine the effect of coalbed methane development on intermittent prairie stream fish assemblages. The research process includes five complementary approaches:

1. Treatment versus control streams— Fish assemblages in streams in areas of coalbed methane development (treatment streams) were compared to those in streams in areas without coalbed methane development (control streams). Comparisons were only made where appropriate — for example, in similar-sized streams with similar expected physical and biological conditions. Samples were collected by seining according to Montana Prairie Riparian Native Species Study protocols.
2. Upstream versus downstream comparisons— Fish assemblages were compared in areas upstream of development to those in areas downstream of development within the same stream. In the absence of effects, the expected condition was for fish species richness to stay the same or increase in downstream areas. Reductions in species richness at downstream sites would suggest deleterious effects.
3. Pre-development versus post-development samples— In 2005, areas that were without coalbed methane development were identified and sampled, but were scheduled to be developed by 2006. Because of complications with permitting, the areas were not developed in 2006. However, fish assemblage data were compared from streams sampled in the early 1990s (prior to development) to samples that were at the same locations in 2005 and 2006. Samples were collected both in streams in developed areas and in streams in areas without development and assessed if any observed changes were attributable to development or to unrelated temporal trends.
4. Sampling product water streams—There are some formerly ephemeral streams, which now flow

perennially as a result of product water discharge. These streams were sampled to determine which, if any, fishes occupy these unique habitats.

5. In-situ acute toxicity testing—The acute toxicity of stream water in areas of development was tested using wild-caught fish held in sentinel cages. This approach was intended to complement observations of fish distributions made during treatment versus control, and upstream versus downstream surveys. Fish were captured in undeveloped areas and placed in cages in developed areas to test for acute toxicity. Fish were also placed in cages in undeveloped areas to control for effects of capturing and caging fish.

Progress to Date

Field work began in summer 2005 with funding from BLM and was completed during summer 2006 under WFHI Phase IV. In 2005, 57 sites were sampled, including all treatment, control, and longitudinal sites. Crazy Woman and Salt creeks were sampled for historical comparisons. Water quality samples were collected from each stream and sent to Energy Labs, Inc., in Billings, Montana, for ion analysis. Twenty-four fish species were collected. Treatment streams had a range of 0 to 8 fish species whereas control streams had a range of 1-12 fish species. Plains killifish (*Fundulus zebrinus*) and river carpsucker (*Carpoides carpio*) were found exclusively in treatment streams whereas channel catfish (*Ictalurus punctatus*), stonecats (*Noturus flavus*), shorthead redhorse (*Moxostoma macrolepidotum*), and plains minnows (*Hybognathus placitus*) were found exclusively in control streams. Preliminary results were presented at the 2006 Great Plains Fishery Worker Association Meeting and the 2006 Western Division Annual Meeting of the American Fisheries Society.

In 2006, all sites were re-sampled, and 13 additional sites were sampled at locations that had been sampled in the 1990s. Water quality samples were collected from all sites and sent to Energy Labs, Inc., in Billings, Montana, for ion analysis.

A total of 17 fish species was collected at treatment and control streams. Fifteen species were collected in control streams, including 12 native and 3 non-native species. Thirteen species were collected in treatment streams, including 9 native and 4 non-native species. Channel catfish, plains minnow, shorthead redhorse, and stonecats (*Noturus flavus*) were captured exclusively in control streams. Lake chub (*Couesius plumbeus*) and plains killifish were captured exclusively in treatment streams. However, all of these species were found infrequently.

Most species were observed during fewer than 20 percent of the 68 sampling events; however, 5 native species were more ubiquitous. Creek chub, fathead minnow, longnose dace, sand shiner, and white sucker were observed during 15 or more sampling events. Longnose dace, sand shiner, and white sucker occurred more frequently at control sites than treatment sites, whereas no common species occurred more frequently in treatment streams. Longnose dace were observed in 14 (38 percent) control samples in 4 (50 percent) streams and in only 3 (10 percent) treatment samples in 2 (25 percent) streams. Similarly, sand shiners were observed in 16 (43 percent) control samples in 5 (63 percent) streams and in only 8 (28 percent) treatment samples in 3 (38 percent) streams. White suckers were observed in 12 (33 percent) control samples in 3 (37 percent) streams and in 7 (24 percent) treatment samples in 4 (50 percent) streams. Creek chub and fathead minnow were observed at similar frequencies at both control and treatment sites.

An index of biotic integrity (IBI; Bramblett et al. 2005) score for northwestern Great Plains streams was computed for each site. The IBI consists of 10 metrics and has a potential range of scores from 0 to 100. Overall IBIs, individual IBI metrics, and species richness were compared between treatment and control streams using ANOVA. The mean IBI score of the fish assemblages in control streams was higher than in treatment streams but the difference was not significant ($P = 0.25$). Seven of ten mean individual IBI metrics scored higher in control streams, but no metrics were significantly higher in control streams than treatment streams. Similarly, the mean species richness in control streams was higher than in treatment streams but the difference was not significant ($P = 0.87$).

Treatment streams did not all have equal amounts of CBNG development. Databases containing the locations of CBNG wells were obtained from the Wyoming Geographic Clearinghouse (2007) and the Bureau of Land Management Miles City Field Office. The amount of CBNG development upstream of each site was determined by calculating the number of CBNG wells and well density (number of wells/km²) within the watershed upstream of the sample point using ArcView 9.1. Regression analysis was used to determine whether a significant relationship existed between biotic integrity or its component metrics and the amount or density of CBNG development upstream of each sample site. The amount or density of CBNG development within the drainage areas of treatment streams did not affect fish assemblages. No relationship existed between site IBI scores and the number or density of CBNG wells upstream of sites. The two treatment sites with the highest IBI scores were in relatively dense CBNG development on SA Creek.

Product-water management varied among and within watersheds. We evaluated whether fish assemblages responded differently to the types of water management upstream of the sampling sites. A database of approved Wyoming Pollutant Discharge Elimination System (WYPDES) and Montana Pollutant Discharge Elimination System (MPDES) permits for CBNG product-water was acquired from the Wyoming and Montana Departments of Environmental Quality. Product-water outfalls were designated as discharges to on-channel reservoirs, off-channel reservoirs, or discharges to stream channels. The total number, type, and density of outfalls within the watershed upstream of each sample site were determined using ArcView 9.1 (ESRI 2006; Table 4). Regression analysis was used to determine whether a significant relationship existed between biotic integrity and the total number of product-water outfalls and the number of each type of outfall upstream of each sample site. Product-water management did not appear to have an effect on fish assemblages. No relationship existed between IBI scores and the number of product water outfalls. Similarly, no relationship existed between IBI scores and the number of product water outfalls discharged to on-channel reservoirs, off-channel reservoirs, or stream channels. Index of biotic integrity scores varied widely among sites with similar water management strategies.

Physical properties of water quality were highly variable throughout the study area. No significant differences in physical properties existed between treatment and control streams, but mean specific conductance of treatment streams was higher than control streams. Mean specific conductance was more than 800 µmhos/cm greater in treatment streams than control streams in field observations and laboratory analyses. Specific ion and dissolved metal concentrations were highly variable throughout the study area and few patterns existed among the relationships of fish assemblages to these measures of water quality. Treatment streams had significantly higher concentrations of alkalinity, bicarbonate, and magnesium than control streams.

We compared existing fish assemblage data from streams sampled in the early 1990s (prior to development) to samples that were at the same locations in 2006. In streams that have been developed, lake chub (*Cousieus plumbeus*), plains minnow, river carpsucker, sturgeon chub (*Macrhybopsis gelida*), and western silvery minnows (*Hybognathus argyritis*) were observed in 1995, but were not observed in 2006. However, brown trout (*Salmo trutta*), largemouth bass (*Micropterus salmoides*), and spottail shiner (*Notropis hudsonius*) were not observed in 1995, but were observed in 2006. In undeveloped streams, brassy minnow (*Hybognathus hankinsoni*) and lake chub were observed in 1995, but were not observed in 2006. However, black bullhead (*Ameiurus melas*), channel catfish, and plains killifish were observed in those streams in 2006, but not in 1995. We calculated IBI scores for 1994 and 2006 at each site. The mean change in IBI score (Δ IBI) between 1994 and 2006 was not significantly different between treatment and control sites ($P = 0.462$). Sixty-seven percent of control and 60 percent of treatment sites had higher biotic integrity scores in 1994 than in 2006.

We determined that some product water streams had been colonized by fish. Burger Draw and Beaver Creek were occupied by several species of fish, including fathead minnow (*Pimephales*

promelas), plains killifish, green sunfish (*Lepomis cyanellus*), and black bullheads. Some sites in product water streams had no fish.

In situ toxicity tests were conducted at a total of 9 sites on 7 streams in July, 2006. Fish growth and survival was not significantly different between streams with and without development. In Squirrel Creek, fish grew and survived in a location below CBNG development where only two fish were observed in the 2005 and 2006 surveys. Summary reports and an educational field guide were distributed to landowners. Preliminary results were presented at the Coalbed Natural Gas Aquatic Task Group Meeting, the 2007 Montana Chapter Annual Meeting of the Wildlife Society, and the 2007 Montana Chapter Annual Meeting of the American Fisheries Society.

Future Activities

Analyses and a final report in the form of a Master's thesis will be completed by August 2007.

Projected Completion Date and Deliverables

A detailed final report describing the methods, findings, and management implications of the study will be produced in the January 2008 semi-annual report. At least one manuscript based on this study will be submitted for publication in a peer-reviewed journal. Results will also be presented at scientific meetings.



Project #5: Evaluation of Habitat Restoration for the Fluvial Arctic Grayling in the Big Hole River, Montana

Principal Investigator: Alexander V. Zale, Unit Leader Montana Cooperative Fishery Research Unit

Co-Principal Investigator: Robert E. Gresswell, USGS, Northern Rocky Mountain Science Center, Bozeman, Montana

Graduate Student: Shane Vatland, PhD student, Montana State University

Project Partners:

Montana Fish Wildlife and Parks, US Fish and Wildlife Service, US Forest Service, Big Hole River Watershed Committee, and local landowners.

Background

Arctic grayling (*Thymallus arcticus*) is a circumpolar species, and historically, there were two disjunct populations that occurred in Michigan and Montana. Grayling became extinct in Michigan in the late

19th century, and although the species still occurs in Montana, the fluvial (permanently stream dwelling) form has been extirpated from approximately 95 percent of the historic range. The last remaining reproductively-viable assemblage of this grayling life-history type is limited to the upper 130 kilometers of the Big Hole River and its tributaries.

In 1994, fluvial grayling in the Big Hole and Madison rivers was identified by the US Fish and Wildlife Service as a Distinct Population Segment under the Endangered Species Act. Following subsequent review in 2004, this assemblage was elevated to the highest listing priority that can be given to a Distinct Population Segment. However, in 2007, the US Fish and Wildlife Service determined the fluvial Arctic grayling was not an endangered species. In contrast, grayling in the Big Hole River remains a species of "special concern" according to the Endangered Species Committee of the American Fisheries Society, the Montana Chapter of the American Fisheries Society, Montana Fish, Wildlife, and Parks, and the Montana Natural Heritage Program of the Nature Conservancy.

Because most of the habitat occupied by grayling in the Big Hole River watershed is on, or adjacent to, private land, a close relationship between private landowners and regulatory agencies has been developing since the 1980s. The prior potential for listing under the Endangered Species Act and the critical need to engage the majority of landowners in watershed-scale solutions to conserve and restore grayling have resulted in variety of integrated conservation programs (including one of the largest Candidate Conservation Agreement with Assurances in the United States). Specifically, these programs are attempting to increase instream flow, lower summer water temperatures, and improve riparian habitat conditions throughout the upper Big Hole River Watershed.

Goals

Our primary goal is to investigate relationships between stream habitat conditions, fish community composition, and Arctic grayling distribution, abundance, and movement patterns in the upper Big Hole River. By gaining further knowledge about the basic population ecology and movement patterns of Arctic grayling and other fish species in the Big Hole River and its tributaries, we aim to provide essential information for grayling conservation planning and ongoing habitat restoration efforts.

Objectives

1. To consolidate and analyze past sampling data on Arctic grayling in the upper Big Hole River.
2. To determine seasonal distribution and movement patterns of grayling in the upper Big Hole River.
3. To determine the frequency and timing of fish movement between mainstem and tributary habitats in the upper Big Hole River.
4. To investigate the relationship between fish movement, habitat use patterns, and stream habitat conditions.

Progress to Date

Through a series of ongoing planning meetings and communications, we are collaborating with biologists from the Montana Fish, Wildlife and Parks (MFWP) and other scientists involved in the Arctic Grayling Recovery Program (AGRP). As a result of these efforts, AGRP has purchased approximately \$10,500 in passive integrated transponder (PIT) equipment for our use during this research project.

We have compiled a database of over 6,500 individually marked Arctic grayling in the Big Hole River from 1986-2005. Preliminary analyses of mark-recapture locations suggest that Arctic grayling exhibited strong interannual fidelity to seasonal habitat. Among-season movement patterns varied, and fish tended to move upstream in the spring, downstream in the fall, or remain in the same area of the watershed in spring and fall. Smaller fish (≤ 250 mm) tended to occupy the same locations, independent of season, but larger fish (> 250 mm) exhibited much broader differences in movement

among seasons (0-80 km). We presented these preliminary findings and our future research plans at the annual AGRP meeting in February 2007.

Passive integrated transponder (PIT) technology provides us with a robust tool to assess the research goals and objectives outlined above. In a riverine system, such as the upper Big Hole, where opportunities for snorkel and electrofishing surveys are limited, PIT-tagging allows for passive monitoring at a fine temporal scale (nearly continuous) with fixed antenna and at a fine spatial scale with portable PIT antenna. Compared to traditional mark-recapture approaches that require physical handling at each recapture event, this approach greatly reduces the amount of handling necessary to collect information from individual fish.

MFWP has requested that experimental evidence concerning the effects of PIT-tagging (specific to Arctic grayling) be available prior to PIT-tagging any wild Arctic grayling in the Big Hole River. Accordingly, we initiated an experiment investigating the effects of PIT tags on Arctic grayling growth, survival, and swimming performance in April at the Wild Trout Laboratory. Unfortunately, these grayling suffered from a parasitic infection of the gastrointestinal tract, and we were unable to complete the experiment. We are planning to repeat the experiment this fall and/or winter (see Future Activities). In addition to the laboratory experiment, a short-term mortality experiment was conducted at the Green Hollow Arctic grayling brood pond on Turner Enterprise's Flying D Ranch. A total of 41 fish were held for 5 days, and 100 percent of control and PIT tagged fish survived (excluding one individual killed by an avian predator). We also observed 100 percent retention of PIT tags, and implantation wounds were healing well on day 5. We are currently preparing a report of these results for MFWP personnel.

In preparation for monitoring PIT-tagged grayling in the Big Hole River and its tributaries, three antenna stations were installed in May (with two channel-spanning antennas at each station to detect direction of movement). We also assembled five additional monitoring stations, complete with solar power supplies that will be installed prior to tagging operations. Permission to access private land has been acquired for most of the proposed antenna locations.

While awaiting permission to proceed with PIT-tagging, we have focused on the timing and extent of fluvial Arctic grayling activity in tributaries to the upper Big Hole River. To identify factors influencing this potential mainstem-tributary dynamic, we are currently conducting continuous snorkel and habitat surveys of two tributaries, Fish Trap Creek and LaMarche Creek. These tributaries were selected because: 1) in the past few years, the relative abundance of grayling, as measured by fall electrofishing catch per unit effort (CPUE), was higher in these reaches than in other sampled portions of the Big Hole River watershed; 2) visibility in these two tributaries provides the opportunity for quantitative snorkel surveys.

Future Activities

We will continue to analyze the historic grayling tagging-recapture database for patterns of movement, trends in abundance, survival, habitat covariates, and fish species composition. This data will be presented in a poster at the 2007 American Fisheries Society Meeting in September and in an oral presentation at the 2007 Wild Trout Symposium in October.

Field sampling will continue through October 2007. We will complete continuous snorkel and habitat surveys of Fish Trap and LaMarche Creeks in July-August, and Sept-October. In addition, we will conduct extensive, spatially-continuous temperature surveys in July and August in these tributaries and in the adjacent mainstem Big Hole River. These data will allow us to compare seasonal trends in the fish assemblage of tributaries with fine-resolution water temperature and flow data.

In late August, installation of eight PIT monitoring stations will be completed (at mouths of tributaries and in main-stem sections upstream of Wisdom, MT) to further evaluate fish movement and habitat use. In September and October, fish will be captured by electrofishing throughout the upper Big

Hole River watershed. These efforts will be coordinated with the annual MFWP fish monitoring surveys. All Arctic grayling and most other fish will be PIT tagged to facilitate movement monitoring at the stationary antenna stations and portable antennae. Capture information will provide information on the movement, habitat use, growth, and demography of captured fish species. As a pilot study, fish locations will be monitored with one fixed PIT antenna and one portable antenna during the winter.

A lab experiment will be implemented at the Wild Trout Laboratory (MSU Water Center) to evaluate the effects of PIT tag implantation on Arctic grayling growth, survival, and swimming performance. The timeline of this experiment is still tentative, because the source of fish and duration of acclimation prior to treatment are still being determined.

Projected Completion Date and Deliverables

A final report on the Arctic grayling movement and habitat use project will be submitted by December 31, 2007. This report will detail the past and present information gathered on Arctic grayling movement and habitat use in the upper Big Hole River basin. In addition, the results of our PIT-tag experiments will be included.

PROGRAM PERSONNEL

Dr. Alexander Zale is the Principal Investigator for the Wild Fish Habitat Initiative. Dr. Zale is the Cooperative Fishery Research Unit Leader for Montana and a Professor in the Department of Ecology at Montana State University. Dr. Zale's research interests center on applied aquatic ecology and fisheries management.

Dr. Thomas McMahon is the Project Biologist. Dr. McMahon is a Professor in the Ecology Department at MSU whose principal research interests are wild trout management, fish-habitat relationships, winter ecology, and conservation biology of salmonids.

Kristin Keith is the WFHI Program Director. She is responsible for the management of the Center's aquatic biology research programs and administration of the WFHI. She has a Bachelor of Science degree in Biology and a Master's degree in Soil Science with an emphasis in water quality.

Trey Kucherka is the Aquatic Sciences Laboratory Manager and a member of the Technology Transfer project. He functions as the fisheries biology advisor to the other departments within the Montana Water Center, and provides technical support and research assistance to many Initiative research teams. Trey has a Bachelor of Science degree in Biology (Marine emphasis) and a Master's degree in Mariculture.

Rick Holscher is a Web Site and Publications Specialist with the Montana Water Center. He has an M.S. degree in Geography and develops Web sites, publications, and databases for the Center.

Peter Brown is a PhD student with the Montana Cooperative Fishery Research Unit at MSU. He is working with Dr. Zale on the Eradication and Exclusion Project.

Brad Shepard is a PhD student at MSU and a fisheries biologist with the Montana Department of Fish, Wildlife and Parks. He is working with Dr.s Zale and Taper on the Habitat Restoration project.

Ryan A. Harnish is a MS Student with the Montana Cooperative Fishery Research Unit at MSU. He is working with Dr. Zale and Dr. McMahon on the Irrigation Diversions project.

Shane Vatland is a PhD student at MSU working with Dr.s Zale and Gresswell on the Arctic grayling project.

Windy N. Davis is a MS Student with the Montana Cooperative Fishery Research Unit at MSU. She is working with Dr. Zale on the Coalbed Methane Development project.

Eve Davey is an Aquatic Sciences Lab Technician and provides technical editing assistance to WFHI research team. She has a Bachelor of Arts degree in English from Vassar College and a Master's degree in English from the University of Iowa. Eve just attained her Bachelor of Science degree in Wildlife Management from MSU.

Bryan Stueve is an Aquatic Sciences Lab Technician. He is currently a junior in the College of Business at MSU. His lab duties include maintenance of the tanks and filtration system and daily feeding and treatment of the fish.

Heather Johnson is an Aquatic Sciences Lab Technician. She and Troy Buckel (West Virginia University) are the field technicians on the Eradication and Exclusion Project working with Peter Brown. Heather has also been providing assistance to Kristin Keith in the technology transfer component of the project.

James L. Ervan and Bruce Hunner are MSU student technicians working with Ryan Harnish on the Irrigation Diversions project.

Luke Renner and Drew Pearson are MSU student technicians working with Brad Shepard on the Cutthroat Conservation project.