

TECHNICAL WORKPLAN

WILD FISH HABITAT INITIATIVE PHASE V

October 1, 2006 – December 31, 2007

submitted by:
Montana Water Center
Montana State University - Bozeman

submitted to:
Division of Fish and Wildlife Management Assistance
US Fish and Wildlife Service

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WILD FISH HABITAT INITIATIVE

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INTRODUCTION

Wild Fish Habitat Initiative Background & Purpose

Degradation of fish habitat is one of the principal reasons for the listing of wild fish under the Endangered Species Act. In addition, the detrimental effects of exotic competitors and diseases such as whirling disease are exacerbated by habitat degradation. 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 (hereafter referred to as the Initiative or WFHI) is being carried out by Montana 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. The Initiative seeks 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.

Phase V of the WFHI will build on the successes of previous program phases by continuing to pursue relevant research investigations and by continuing to refine and expand our ongoing information-transfer project. Four research projects are continuing and one new research project will be initiated in this new phase. Activities for each of the Phase V actions and projects are outlined in the subsequent sections of this report.

PROGRAM ADMINISTRATION

Wild Fish Habitat Initiative Program Administration

Principal Investigators

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

Liz Galli-Noble, WFHI Program Director; Assistant Director for Research, Montana Water Center

Goal and Objectives

The overall goal of WFHI program administration is to meet the needs of the USFWS Project Officer regarding the Initiative, and to support the research teams in carrying out the five research projects described later in this report. Specific 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 conduct outreach activities and publicize Initiative projects, research results, and program deliverables to interested parties.

Activities

During the period of October 1, 2006 to December 31, 2007, Montana Water Center administrative personnel will manage the annual USFWS contract and all research subcontracts; process invoices and track the fiscal status of each project; submit progress reports to the USFWS; submit a single compiled final project report to the USFWS; respond to USFWS requests for information or assistance; and support the research teams in acquiring information, supplies and facilities, in contractual or hiring matters, and in other ways as needed.

Milestones

Administrative milestones are shown in *Table 1*. All administrative duties are the responsibility of Montana Water Center staff—namely, Liz Galli-Noble, the Assistant Director for Research—in consultation with the Principal Investigator, Dr. Alexander Zale. Major duties involve developing an annual Initiative contract and budget, maintaining communication with the USFWS, and submitting detailed reports on outreach activities, research investigations, and financial actions of the Initiative.

Deliverables

Deliverables for program administration as a whole are regular communication and updates to Division Chief Hannibal Bolton, two program progress reports per year, regular invoices and financial reports to the USFWS, and a compiled final project report.

TECHNOLOGY TRANSFER / TECHNICAL SUPPORT / PROGRAM OUTREACH

Technology Transfer Project

Project Team Members

Liz Galli-Noble, Program Director, Montana Water Center

Kristin Keith, Case history researcher and technical writer, Montana Water Center

Molly Boucher, Web site specialist, Montana Water Center

Trey Kucherka, Program Biologist/Aquatic Sciences Laboratory Manager, Montana Water Center

Administrative assistant, Montana Water Center staff

Introduction and Scope

In recent years, many techniques regarding fish habitat enhancement and restoration 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 technology transfer project—a continuing and expanding effort of the Initiative—is collating information on methods and results of various fish habitat restoration projects within the Intermountain West (California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming), Alaska, South Dakota, and ultimately throughout the Missouri River Basin. Information is organized in a searchable bibliography and case history database, which is accessible through the Initiative Web site at: <http://wildfish.montana.edu/>. Web site products are being continuously updated and revised as new restoration project information is made available, and/or as monitoring data are collected and shared with project staff.

Goal and Objectives

The overall project goal of the technology transfer project is to provide useful bibliographic and case history data to those responsible for native fish habitat projects within the Partners Program and other interested parties.

Specific objectives for Phase V of the project are:

- (1) To continue to maintain a positive and productive collaboration between the Montana Water Center and our many project partners: the USFWS, Montana State University, Initiative research teams, tribes, private landowners, land managers, non-profit organizations, and a multitude of state and federal agencies.
- (2) To refine our online fish habitat literature bibliography, and continue to update the bibliography with timely, pertinent literature.
- (3) To refine our online habitat restoration manuals clearinghouse, and continue to update and maintain that resource.
- (4) To refine our online case history database of fish habitat restoration projects; continue to update the restoration projects showcased; move older, less relevant, case histories into a newly created project archive; and expand our case histories database geographic range to include additional projects in Alaska and South Dakota, and ultimately throughout the Missouri River Basin.

- (5) To actively publicize Web site features and products, and enhance information exchange among USFWS personnel, tribes, land managers, fishery professionals, private landowners, non-profit organizations, university students, and other interested parties.

Activities

Four general types of technology transfer activities will be carried out in Phase V of the project. First, Montana Water Center staff will continue to enhance our outreach efforts. We will work to broaden our communication base with USFWS personnel, regional fisheries biologists, landowners, tribes, and habitat specialists; we will continue to solicit feedback on our accomplishments and products; we will explore more effective ways in which the Initiative Web site can address our partners' and audience's needs; we will vigorously publicize the Web site and its products; and we will seek collaborations with the National Fish Habitat Initiative and the Western Native Trout Initiative.

Second, we will continue to collect new and innovative restoration project information. The team will focus on filling information data gaps and provide follow-up monitoring data collected for projects already showcased on the Web site. When warranted, we will seek new information or follow-up data through remote access or site visits. We will also expand our geographic focus to include additional projects conducted in Alaska, South Dakota and we are beginning an expansion to cover restoration projects in the Missouri River Basin states.

Third, team members will expand resource information availability on the Initiative Web site. Several target actions for this project phase include: establishing an expertise directory; adding a search engine to the case histories database and the bibliography; adding links to other pertinent technical and non-technical conservation Web sites; adding a feedback mechanism for Web site visitors; restructuring the categories used for the case histories database; and developing a section within the case histories database documenting common problems in restoration project development and application.

Finally, we will continue to refine recommendations made by our 2005 Web site review panel. Using this initial review as a template to formally evaluate the program, we plan to solicit feedback from a follow-up panel late in Phase V.

Milestones

Existing Web Site Products—Most technology transfer project products are ongoing efforts that will continue to be updated and refined for years to come.

New Project Needs/New Project Opportunities—Montana Water Center personnel strive to be responsive to newly identified needs of our research and resource partners. We also welcome new opportunities to collaborate on novel fish habitat endeavors and with new project partners.

National Fish Habitat Initiative (NFHI)—In June 2005, our audience expanded to the national level when we agreed to share our case histories database with by Andrea Ostroff, National Fish Habitat Initiative Liaison for the International Association of Fish and Wildlife Agencies. As the NFHI effort solidified in early 2006, the WFHI joined the NFHI Partner Coalition. In 2006/2007 it is our intent to play a more active role in the NFHI effort. Liz Galli-Noble will officially join the NFHI Communications Team in July 2006. Rachel Brittin has also welcomed a collaboration between the WFHI and NFHI, specifically focusing on improving NFHI Web site layout, design, and function.

Western Native Trout Initiative (WNTI)—The WFHI has also been encouraged and invited to participate in the new WNTI, but in what capacity and serving what purpose is still unclear. The WFHI could provide valuable assistance to the WNTI both in their upcoming strategic plan development and in the communication component of their effort. The WFHI is considering seeking opportunities in Phase V to secure funding that will allow us to work on WNTI strategic plan development. Potential collaborative plans will likely solidify in late summer and fall 2006, when Robin Knox (the new WNTI coordinator) begins to provide structure and organization to the group. Liz Galli-Noble has also communicated with Mike Stone and Virgil Moore regarding a possible collaboration between the WFHI and WNTI, which was well received and encouraged.

Outreach and Program Publicity—Liz Galli-Noble and Kristin Keith will actively publicize the WFHI Web site through media contact, partner correspondence, and professional outreach presentations. Molly Boucher will continue to publicize the site through online means, including linking and search engine ranking.

Montana Water Center personnel are planning to attend several professional meetings in 2006/2007 to make contacts and present Initiative work products. Several meetings already scheduled for fall/winter 2006 include: (1) Federation of Fly Fishers' 41st Annual International Fly Fishing Show and Conclave in Bozeman, Montana, July 25-29, 2006; (2) American Fisheries Society 136th Annual Meeting in Lake Placid, New York, September 11-15, 2006; (3) 4th Annual River Center Meeting at the University of Montana in Missoula, Montana, September 28-29, 2006; (4) 23rd Annual Meeting of the Montana Section of the American Water Resources Association in Polson, Montana, October 12-13, 2006; and (5) 67th Annual Midwest Fish and Wildlife Conference—*The Economic and Social Values of our Natural Resources* in Omaha, Nebraska, December 3-6, 2006.

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

Deliverables

Deliverables for this project include: a continuously updated web-based bibliography of fish habitat literature; a continuously updated compilation of habitat restoration manuals (in PDF-format) applicable to our project areas; and continuously refined web-based case studies of completed habitat restoration projects. Case histories of various types of fish habitat restoration projects include narrative descriptions, data tables, photographs, engineering diagrams, and project cost information, insofar as this information can be collected for each case.

Potential Partners

Project information will be collected from, and disseminated to, a number of sources, including: university researchers, state fish and wildlife biologists, Federal agency personnel, tribes, private landowners, and fishery biologists employed by private and non-profit organizations in the focal regions.

Technical Research Assistance & Support

Laboratory Staff

Trey Kucherka, Manager, Aquatic Sciences Laboratory (previously known as the Wild Trout Research Lab), Montana Water Center

Eve Davey, Lab Technician, Montana Water Center

Bryan Stueve, Lab Technician, Montana Water Center

Since the inception of the Initiative in 2002, Montana Water Center Aquatic Sciences Lab personnel have provided technical support and research assistance to many WFHI research teams, as well as Montana state and federal fisheries agencies. This collaboration will continue into Phase V of the Initiative with the laboratory manager and the lab technicians assisting researchers with the following tasks:

1. Experimental apparatus design, development, maintenance, and use.
2. Graduate student husbandry assistance.
3. Disease identification assistance.
4. Disease treatment support.
5. Graduate student data collection assistance.
6. Emergency on-call support.
7. Graduate student technician support.

The Montana Water Center hired a new laboratory manager in August 2005. In addition to laboratory duties, the lab manager also functions as the fisheries biology advisor for other departments within the Montana Water Center, working closely with the Technology Transfer team.

Laboratory Renovation Project— Due to the need for a more flexible and functional research lab that could accommodate a broader range of fisheries-based research investigations, the Water Center initiated a renovation of the Aquatic Sciences Laboratory. This renovation began in the fall of 2005 and will be completed by the fall of 2006. During this time, every possible measure has been successfully taken to prevent hindrance to research projects conducted in the lab facilities. The major equipment and supplies needed for the renovation have been purchased, and research systems are currently being assembled in phases so as not to hamper any of the research projects underway (including a WFHI study and three other MSU-affiliated studies on whirling disease).

In the coming year, the lab will continue to provide facilities and expertise to WFHI-funded projects, such as Peter Brown's piscicides for use in non-native fish eradication study.

PHASE V RESEARCH PROJECTS

Project 1. Evaluation of Entrainment Losses of Westslope Cutthroat Trout at Private Irrigation Diversions on Skalkaho Creek, Montana

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

Introduction and Scope

The Bitterroot River system supports populations of both the non-migratory resident and fluvial migratory life-history forms of westslope cutthroat trout (*Oncorhynchus clarki lewisi*). However, the migratory form has experienced significant declines caused by 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 because of several irrigation diversions and severe dewatering.

We are 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. Estimates were obtained during the 2003 irrigation season to quantify the magnitude of entrainment losses at the seven irrigation diversions. During the winter of 2003/2004 fish screens were installed in three irrigation canals of Skalkaho Creek to preclude such entrainment. Estimates of entrainment and the efficiency of the fish screens were evaluated during the 2004 irrigation season. The fish screens were an effective management tool for reducing entrainment of adult and age-0 westslope cutthroat trout in Skalkaho Creek (Gale 2005). However, a distinct knowledge gap exists regarding: (1) the efficiency of fish screens at preventing entrainment of age-1 to age-4 westslope cutthroat trout juveniles, (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. We are currently addressing these information gaps as part of Phase IV and plan to complete this work in Phase V.

Goal and Objectives

The goal of this project is to provide private landowners, as well as state and federal agencies, with an in-depth evaluation of the use and potential value of screening or siphoning irrigation canals to prevent entrainment and enhance the migratory component of a population. The objectives are to: (1) quantify the efficiency of fish screen structures at preventing loss of westslope cutthroat trout to irrigation canals throughout the irrigation season, (2) determine the effect of screening on age-0 westslope cutthroat trout movement, and (3) quantify the magnitude of westslope cutthroat trout entrainment in the unscreened Hedge Canal and the

effect this entrainment has on the recruitment of fluvial westslope cutthroat trout juveniles to the Bitterroot River.

Activities

Passive Integrated Transponder (PIT) tag-detecting antennae were installed in all three screened irrigation canals of Skalkaho Creek in 2005. Antennae were located in the headgate openings, on the bypass pipes, and below the fish screens. Fish screen efficiency trials, which involve PIT-tagging of westslope cutthroat trout and introducing them into the irrigation canal between the headgates and the fish screen, were performed at two of the three screened irrigation canals in 2006. Ninety westslope cutthroat trout were PIT-tagged and released into the Highline and Ward irrigation canals between the headgates and the screens. Headgate velocities and bypass discharge were measured weekly to determine what effect these variables have on fish screen efficiency. Bypass and entrainment estimates of age-0 westslope cutthroat trout at screened and unscreened irrigation canals of Skalkaho Creek were obtained throughout the 2005 irrigation season. These data will be compared with pre- and post-fish screen entrainment estimates to evaluate the effect of screening on the westslope cutthroat trout population of Skalkaho Creek.

PIT tag-detecting antennae were installed in the Hedge Canal both upstream and downstream of its intersection of Skalkaho Creek, as well as in Skalkaho Creek below the diversion to determine what effect the Hedge Canal has on downstream-migrating westslope cutthroat trout juveniles. A screw trap was installed in Skalkaho Creek above the Hedge diversion to provide an estimate of the number of downstream migrating westslope cutthroat trout that encounter the unscreened Hedge, Republican, and C&C diversions. Juveniles weighing greater than 12 grams were PIT-tagged to determine what proportions of these fish are entrained in the Hedge Canal or pass over the Hedge diversion dam.

An estimate of fluvial westslope cutthroat trout recruitment to the Bitterroot River was obtained during the 2005 irrigation season and an estimate for 2006 is currently being obtained. Comparing these values with the number of migrants estimated by the screw trap above the Hedge diversion will provide an estimate of the number of downstream-migrating westslope cutthroat trout that are entrained in the Hedge, Republican, and C&C Canals. Temperature and discharge data were obtained throughout Skalkaho Creek and its canals during the 2005 season, and are being measured again during the 2006 season, to evaluate the effect of these variables on westslope cutthroat trout movement and entrainment.

Fish screen efficiency trials are being conducted at all three screened irrigation canals during the 2006 irrigation season. A screw trap placed above all irrigation canals will allow us to obtain an estimate of the number of age-0 westslope cutthroat trout that emerge from upper Skalkaho Creek and move downstream into the irrigation-affected reach. Bypass and entrainment estimates of age-0 westslope cutthroat trout are being obtained at all screened and unscreened irrigation canals of Skalkaho Creek. Randomly selected reaches between the Highline and Ward/Hughes diversions are being electrofished monthly following emergence to determine the extent of movement and mortality of age-0 westslope cutthroat trout between the Highline and Ward/Hughes diversions. Estimates of downstream-migrating westslope cutthroat trout are being obtained from above the Hedge diversion and at the mouth of Skalkaho Creek to determine the extent of entrainment at the Hedge, Republican, and C&C Canals. Westslope

cutthroat trout are being PIT-tagged above the Hedge diversion. These data will be used to evaluate the efficacy of the fish screens, and to determine the effect of the unscreened Hedge Canal on the recruitment of fluvial westslope cutthroat trout juveniles to the Bitterroot River.

Milestones

Field work began in spring of 2005 (under Phase III), and will be completed in autumn of 2006 (under Phase IV). Analyses will be conducted under Phase V and a final report will be completed by December 31, 2007.

Deliverables

A detailed final report 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.

Partners

The study is being conducted in close cooperation with Montana Fish, Wildlife and Parks, local irrigation companies, and local landowners.

Literature Cited

Gale, S. B. 2005. Entrainment losses of westslope cutthroat trout into screened and unscreened irrigation canals on Skalkaho Creek, Montana. Master's Thesis. Montana State University, Bozeman.

Project 2. Evaluation of the Efficiency and Efficacy of Piscicides for use in Non-Native Fish Eradication

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

Graduate Student: Peter Brown, PhD student, Montana State University

Collaborators: Brad Shepard and Jim Olsen (Montana Fish, Wildlife and Parks), Carter Kruse (Turner Enterprises), Hilda Sexauer (Wyoming Game and Fish), Chad Mellison (US Fish and Wildlife Service), and Todd Koel (Yellowstone National Park)

Introduction and Scope

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 increased 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 streams of low gradient. 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 piscicides. Non-native fish eradication will be more effective after piscicide application instructions are better defined.

Goal and Objectives

The goal of this project is to increase the success rate of native fish restoration projects. We hope to increase the efficiency and efficacy of native fish restoration by making piscicide use more efficient and effective. We are therefore carrying out a thorough investigation of the techniques used to eradicate non-native fish, specifically addressing the efficiency of piscicide use. Objectives to be addressed in Phase V 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.

Activities

Ongoing and past eradication projects and established non-native fish exclusion barriers were visited during 2005 (Phase III). Restoration techniques used in these projects were reviewed and project leaders were interviewed to determine which techniques were useful and what information was lacking. Results of these interviews provided guidance for research into the environmental conditions that may degrade piscicides. Sunlight, turbulence, and organic matter are suspected to degrade piscicides. A series of laboratory studies has been started that isolate sunlight, turbulence, and organic matter to determine their individual effect on piscicide toxicity (Phase IV). Preliminary 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. Results of these experiments were presented at the Western Division of the American Fisheries Society meeting in May 2006.

Milestones

Laboratory experiments will continue in summer and fall 2006, and field experiments will take place in summer 2006 and 2007 (under Phase V). We will be exposing piscicides to turbulence and organic matter at the Aquatic Sciences Laboratory at Montana State University and will be testing piscicide toxicity in streams across the western United States.

Deliverables

A detailed final report 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.

Partners

Relationships with native-fish managers from several agencies are critical to this study. These include Brad Shepard (Montana Fish, Wildlife and Parks), Carter Kruse (Turner Enterprises), Hilda Sexauer (Wyoming Game and Fish), Chad Mellison (US Fish and Wildlife Service), Jim Olsen (Montana Fish, Wildlife and Parks), and Todd Koel (Yellowstone National Park).

Project 3. Evaluation of Habitat Restoration for the Conservation of Cutthroat Trout

Principal Investigator: Alexander V. Zale, Montana Cooperative Fishery Research Unit
Graduate Student: Brad Shepard, PhD student, Montana State University
Co-Principal Investigator: Mark Taper, Department of Ecology, Montana State University

Introduction and Scope

The distributions and abundances of native westslope and Yellowstone cutthroat trout (*Oncorhynchus clarkii lewisi* and *O. c. bouvieri*) 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 (*Salvelinus fontinalis*), which 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.

The first year of our study under Phase III included (1) a description of what constitutes quality habitat for westslope and Yellowstone cutthroat trout in central Montana, and (2) a determination of how habitat condition and the presence of brook trout interact to reduce densities of cutthroat trout. We began compiling three large databases: (1) presence/absence surveys for cutthroat and brook trout conducted at over 4,000 sites throughout the historical range of westslope cutthroat trout (collaboratively developed with the US Forest Service Rocky Mountain Research Station); (2) relative abundance information (CPUE) for all salmonid species at about 3,000 sites within the historical ranges of both westslope and Yellowstone cutthroat trout in Montana; and (3) fish population abundance estimates for all trout species and habitat information collected at about 850 sites occupied by either westslope or Yellowstone cutthroat trout in Montana. We contacted Montana Fish, Wildlife and Parks, US Forest Service, and BLM fisheries biologists to locate sites where fish habitat and stream restoration projects have occurred, or are planned, and developed a sampling program for habitats and fish populations within these sites. We began baseline sampling at some of these sites and have compiled information collected at some other sites prior to habitat restoration activities.

During the second year (Phase IV), we completed compilation of the three large databases. We began to assess what habitat variables regulate cutthroat trout distribution and abundance and how these habitat variables influence the effect brook trout have on cutthroat trout. All information in these databases is geo-referenced within a geographic information system (GIS) and we used GIS layers to derive estimates of many of the physical attributes that we will be testing. We used ArcView to delineate watersheds above many of these sample sites for overlaying other GIS layers to derive these estimates. Watershed delineation is computer-intensive and requires tedious editing. Our efforts included validating data, determining what additional variables can be estimated using geographic information systems, and deciding what types of data analyses are most appropriate for these three large databases. We continued to

examine statistical properties of habitat and fish data in preparation for developing models that predict the distribution and abundance of cutthroat trout based on habitat conditions and the presence and abundance of brook trout. We estimated fish population abundances and collected habitat data at 99 sites during 2005 to evaluate habitat enhancement activities.

We summarized water temperature data collected at 33 sites during the summer of 2005 and used it to validate and calibrate a water temperature model we developed earlier. We are using this model to estimate (predict) water temperatures at all 850 sample sites where we have fish population and detailed field habitat information. At some sites, we are sampling prior to habitat restoration activity and will sample immediately following restoration. At other sites, we will use fish population and habitat information collected by other biologists prior to restoration along with information we will collect after restoration to evaluate effects of habitat restoration on cutthroat trout.

We have initiated a collaborative effort with graduate students at Humboldt State University to apply an individual-based model for assessing the influence of habitat on cutthroat trout abundance and on competitive interactions between brook and cutthroat trout. This model should allow us to evaluate how different habitat enhancement projects might affect cutthroat and brook trout abundances. To help parameterize this simulation work, we have begun two field experiments. One will assess food availability and selection of food by age-1 and older brook and cutthroat trout. The second examines direct measures of inter- and intra-specific competition among age-0 brook and cutthroat trout.

Goal and Objectives

Our goal 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. Our specific objectives are to: (1) evaluate how habitat condition interacts with brook trout presence and abundance to affect the abundance and distribution of cutthroat trout, (2) evaluate the effect of presence of non-native fishes on success of cutthroat trout habitat restoration projects, and (3) demonstrate the impact of inter-specific competition with brook trout on cutthroat trout.

Activities

Under Phase V, we will continue to evaluate past and on-going habitat restoration and enhancement projects that specifically targeted conservation of cutthroat trout to assess whether these projects resulted in increased densities or distributions of cutthroat trout. We will integrate our results on habitat conditions that relate to presence and abundance of cutthroat trout with findings from our habitat restoration evaluation. We will incorporate presence and abundance of brook trout into these models and determine how habitat might mitigate impacts of brook trout on cutthroat trout. We will expand on our experimental pilot work to test whether age-0 brook trout compete with age-0 cutthroat trout.

Fish population abundances and habitat variables will be estimated at habitat restoration projects sites throughout western Montana during summer 2007 to evaluate the effectiveness of the projects on the conservation of cutthroat trout. We will focus on habitat restoration projects that targeted cutthroat trout populations and for which pre-project population abundance estimates exist. Pre- and post-restoration estimates will be compared to habitat

parameters that were changed by each habitat restoration project. Previous work we have done suggests that increased frequencies of woody debris may favor brook trout over westslope cutthroat trout; we will further test this hypothesis. We will also conduct additional experiments testing impacts of competition of age-0 brook trout on age-0 cutthroat trout; these experiments will include proximate analysis of fish tissues to quantify physiological effects of competition.

Milestones

Field work began in June 2005 (under Phase III), continued through 2006 (Phase IV), and will be completed during 2007 (Phase V). Analyses and a final report will be completed by December 31, 2007.

Deliverables

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

Partners

The study is being conducted in close cooperation with Montana Fish, Wildlife and Parks, the US Forest Service, the US Bureau of Land Management, and local landowners.

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

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

Introduction and Scope

The Powder River Basin in Wyoming and Montana is currently undergoing one of the world's largest coalbed natural gas (CBNG) developments with about 12,000 wells in place in 2003, 14,200 in 2005, and up to 70,000 projected over the next 20 to 30 years. Because CBNG development involves production and disposal of large quantities of coalbed ground water that differs from surface waters, potential exists for substantial effects on aquatic ecosystems. Coalbed natural gas product water typically has high concentrations of dissolved solids, including elevated levels of sodium and bicarbonate ions. However, information on effects of CBNG product water on warmwater fishes of the Powder River Basin is lacking, presenting a substantial gap in predicting the potential effects of saline discharges in the Great Plains ecosystem. This study is designed to provide scientifically sound information to aid agency, tribal, and industry resource managers in making land and water use decisions in Montana and Wyoming. Additionally, it creates a framework for the evaluation of potential effects of CBNG development to aquatic life worldwide.

Goal and Objective

Our goal is to better understand the influence of coalbed methane development on the biota and habitats of southeast Montana and northeast Wyoming. Our specific objective is to determine the effect on coalbed methane development on intermittent prairie stream fish assemblages.

Activities

Our research process includes five complementary approaches:

1. Treatment versus control streams. We are comparing fish assemblages in streams with coalbed methane development to those in streams without development. Comparisons are made only where appropriate, for example, in similar sized streams with similar expected physical and biological conditions. Samples are collected by seining according to Montana Prairie Riparian Native Species Study protocols.
2. Upstream versus downstream comparisons. We are comparing fish assemblages in areas upstream of development to those in areas downstream of development within the same stream. In the absence of effects, the expected condition is 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. If we identify areas that are as yet without development, but will soon be developed, we will sample them before and after development to monitor fish assemblage changes, if any. We will also compare existing fish assemblage data from streams sampled in the early 1990s (prior to development) to samples taken at the same locations in 2004 and 2005. We will sample both in streams with development and in streams without development to assess if any observed changes are attributable to development or to unrelated temporal trends.
4. Sampling product water streams. Some formerly ephemeral streams now flow perennially as a result of product water discharge. We are sampling these streams to determine which, if any, fishes occupy these unique habitats.
5. In-situ acute toxicity testing. We are testing the acute toxicity of stream water in areas of development using wild-caught fish held in sentinel cages. This approach complements observations of fish distributions made during treatment versus control and upstream versus downstream surveys. If for example, fish are present in areas without development, but absent in areas with development, we capture fish in the area without development and place them in cages in the area with development to test for acute toxicity. We also place fish in cages in areas without development to control for effects of capturing and caging fish.

Field work began in summer 2005 with funding from the BLM and is continuing during summer 2006 under 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 all streams 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 to 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, 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.

All of the fish surveys conducted in 2005 are being repeated in 2006. Additionally, at least one additional site will be sampled on Youngs Creek as well as the remainder of the historical comparisons. In situ toxicity tests will be conducted in 2006. Water quality samples will be collected at all sites.

Milestones

Field work began in summer 2005 with funding from the BLM and is continuing during summer 2006 under Phase IV of the WFHI. Analyses will be conducted under Phase V and a final report will be completed by December 31, 2007.

Deliverables

A detailed final report describing the methods, findings, and management implications of the study will be produced. 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.

Partners

Partners include 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, the US Forest Service, and the coalbed methane industry.

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

Principal Investigator: Alexander V. Zale, Montana Cooperative Fishery Research Unit
Co-Principal Investigator: Robert E. Gresswell, USGS, Northern Rocky Mountain Science Center, Bozeman, Montana.
Graduate Student: To be recruited.

Introduction and Scope

The Arctic grayling (*Thymallus arcticus*) is a circumpolar species the distribution of which historically included two disjunct populations in Michigan and Montana. Arctic 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 about 95 percent of its historic range. The last remaining reproductively-viable population of this grayling life-history type is limited to the upper 130 kilometers of Big Hole River and its tributaries.

In 1994, fluvial Arctic grayling in the Big Hole and Madison Rivers were identified by the US Fish and Wildlife Service as a Distinct Population Segment under the Endangered Species Act.

Following subsequent review in 2004, this stock was elevated to the highest listing priority that can be given to a Distinct Population Segment. Furthermore, grayling in the Big Hole River have been identified as a "species of special concern" by 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 drainage is on or adjacent to private land, a close relationship between private landowners and regulatory agencies has been developing since the 1980s. The increasing 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 a recent draft Candidate Conservation Agreement with Assurances). Specifically, these programs are attempting to increase instream flow, lower summer water temperatures, and improve riparian habitat conditions throughout the upper river.

Although the Arctic grayling and sympatric fish species have been monitored in the Big Hole River since the early 1980s, numerous gaps in the basic population ecology of the species still exist. For example, it is commonly accepted that grayling spawn in upper portions of the river near Wisdom, Montana, and postspawning adults subsequently move downstream to feed and overwinter. Recent evidence suggests that many of the tributaries are also used for spawning and refuge, in particular during periods of prolonged warming. If so, numerous discrete spawning groups may exist in the watershed and be linked to unique local habitat characteristics.

Further knowledge about the basic population structure of Arctic grayling in the river is essential for conservation planning and ongoing habitat restoration efforts. Specifically, it may be useful to perceive the system as a complex stream network that consists of a variety of heterogeneous habitats that are physically and temporally linked by fish movements. Documenting the habitat complexities and movement patterns of the fishes currently occupying the upper Big Hole River is integral for interpreting the effects of habitat restoration on fish assemblages and behavior across the stream network.

Goal and Objectives

Our goal is to investigate the relationships between instream flow, water temperature, and fish assemblage composition on Arctic grayling distribution, abundance, and movement patterns in the upper Big Hole River. Specific objectives are to (1) determine seasonal distribution patterns of grayling in the upper Big Hole River, (2) determine the frequency and timing of grayling movement between mainstem and tributary habitats in the Big Hole River, and (3) develop a monitoring plan for evaluating the effects of habitat restoration on grayling distribution, abundance, and movement patterns in the upper Big Hole River.

Activities

Prior to the initial survey, stream segments will be identified using existing databases, topographic and geologic maps, aerial photographs, and field reconnaissance. During field surveys, geomorphic stream reaches will be classified in each segment, and channel units will be delineated in each geomorphic reach. Physical variables that describe habitat unit size (e.g.,

length, depth, and width), substrate size class, channel type, valley segment type, and woody debris will be estimated or measured for all sampled habitat units.

Fish distribution and relative abundance will be assessed using electrofishing as the primary means of fish collection. All Arctic grayling ≥ 100 millimeters (total length) will be implanted with a passive integrated transponder (PIT) tag prior to release. Receiver antennae will be placed on four tributaries so that movements can be monitored continuously (24 hours/day, 7 days/week). Additionally, portable sensing units will be used to relocate tagged individuals during subsequent surveys. This information will be used to detect shifts in fine-scale fish distribution and movement patterns (e.g., timing, direction, and distance) that can be related to segment-scale stream discharge, water temperature, and riparian habitat.

Milestones

Logistical planning will begin October 2006 and field work will commence in March 2007. Analyses and a final report will be completed by December 31, 2007.

Deliverables

A final report describing the methods, findings, and management implications of the study will be submitted at the completion of the project. A minimum of one manuscript will be submitted for publication in a peer-reviewed journal. Results will be presented at professional meetings.

Partners

The study will be conducted in close collaboration with Montana Fish, Wildlife and Parks, the US Fish and Wildlife Service, the US Forest Service, the Big Hole River Watershed Committee, and local landowners.

Table 1. Phase V Milestones for Program Administration, the Technology Transfer Project, Technical Research Assistance and the Aquatic Sciences Lab—October 1, 2006 to December 31, 2007.

Project / Task	Deliverables / Outputs	2006	2007			
		4	1	2	3	4
I. Program Administration						
Provide administrative & management services	USFWS-MSU Contract—Work plan & budget Communication w/USFWS Managing subcontracts Maintain financial records Reporting: Semi-annual report Final report Manage WFHI staff & maintain office	X X X X X X X	 X X X X X X	 X X X X X X	 X X X X X X	 X X X X X X
Research project management & technical oversight	Meetings with PIs Communication with research teams Reporting: Web site project updates Briefings	X X X X	X X X X	X X X X	X X X X	X X X X
II. Technology Transfer Project						
Update & maintain Web site	Web site maintenance Implement panel recommendations	X X	X X	X X	X X	X X
Update & maintain bibliography	Bibliography updates Export/add references Establish expertise dictionary	X X X	X X X	X X X	X X X	X X X
Showcase habitat manuals	Manual updates	X	X	X	X	X
Research & showcase case histories	Make project contacts Case history updates Site visits	X X X	X X X	X X X	X X X	X X X
Outreach / project promotion	Presentations Publicity, media contact Correspondence	3 X X	2 X X	1 X X	1 X X	3 X X
III. Technical Research Assistance						
Assistance to WFHI research teams	Student research assistance Student technical support Disease ID & treatment	X X X	X X X	X X X	X X X	X X X
IV. Aquatic Sciences Lab	Interior renovation: electrical installation, construction, plumbing, installation of tanks, etc. Maintaining ongoing investigations and setting up new research projects Technical support to research teams	X X X	 X X	 X X	 X X	 X X

ATTACHMENTS

- Attachment A. Phase V Program Budget**
- Attachment B. Budget Justification**
- Attachment C. Budget: Program Administration and Technology Transfer Project**
- Attachment D. Research Project Budget: Evaluation of Entrainment Losses of Westslope Cutthroat Trout at Private Irrigation Diversions on Skalkaho Creek, Montana**
- Attachment E. Research Project Budget: Evaluation of the Efficiency and Efficacy of Piscicides for use in Non-Native Fish Eradication**
- Attachment F. Research Project Budget: Evaluation of Habitat Restoration for the Conservation of Cutthroat Trout**
- Attachment G. Research Project Budget: Effects of Coalbed Methane Development on Great Plains Fish Assemblages**
- Attachment H. Research Project Budget: Evaluation of Habitat Restoration for the Fluvial Arctic Grayling in the Big Hole River, Montana**
- Attachment I. Dr. Alexander V. Zale's Curriculum Vita**
- Attachment J. Elizabeth Galli-Noble's Curriculum Vita**