WILD FISH HABITAT INITIATIVE

SEMI-ANNUAL REPORT

Reporting period:

July 1 - December 31, 2004

(Covers completion of Phase II and beginning of Phase III)

Submitted by:
Montana Water Center
Montana State University – Bozeman

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Submitted to:

Division of Fish and Wildlife Management Assistance and Habitat Restoration
US Fish and Wildlife Service

MONTANA WATER CENTER

WILD FISH HABITAT INITIATIVE

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.

The Partners for Fish and Wildlife Program, administered by the US Fish and Wildlife Service, is a critical national effort to restore important fish and wildlife habitat. This is a voluntary program that works with private landowners to restore habitat on their lands.

Purpose—The purpose of the Wild Fish Habitat Initiative (Initiative) is to enhance the success of restoration projects conducted through the Partners for Fish and Wildlife Program. The Initiative seeks to augment the success of the Partners Program and other fish habitat restoration programs through the following two activities: conducting targeted research related to native fish habitat restoration techniques, and 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 below.

Defining Restoration—Although there is no question about the need and importance for stream and river restoration projects to restore fish habitat, there is much discussion among professionals as to what projects qualify as true restoration. The term *restoration* is defined as "to bring back to its original state." In the 21st Century, such a goal is likely impossible due to dramatic changes in land use since the early 1900s. Therefore, there has been a recent move to reserve the term for true ecological restoration projects; projects that don't address ecological restoration would be termed *remediation* or *fish habitat enhancement*. (Look for an in-depth debate among professionals and academics regarding standards for ecologically successful river restoration in the fall 2005 issue of the *Journal of Applied Ecology.*) Until consensus is reached and specific standards for ecological restoration criteria are adopted, we will hereafter use the term *restoration* to address any river or stream projects aimed to improve fish habitat.

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, Initiative Program Director; Assistant Director for Research, Montana Water Center

Goals and Objectives

The overall goal of Initiative program administration is 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 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 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; invoiced the USFWS; 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 staff. Major duties during this reporting period involved maintaining communication with the USFWS 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 Bolton, delivery of an annual USFWS-MSU contract and budget, two program progress reports per year, regular invoices to the USFWS, and financial reports.

TECHNOLOGY TRANSFER / OUTREACH / TECHNICAL SUPPORT

Technology Transfer Project & Outreach

Team Members

Molly Boucher, website specialist
Cal Fraser, program biologist
Liz Galli-Noble, program director
Kristin Keith, case history researcher (10/04-present)
Anne Martell, technical assistant (12/04-present)
Alicia Paz-Solis, Montana State University student

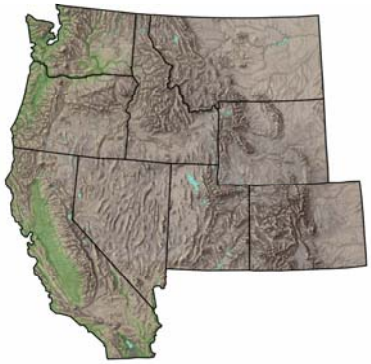

Figure 1. Nine focal states in the Intermountain West.

Background

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 Montana Water Center is collating information on methods and results of various fish habitat restoration projects completed within the Intermountain West (Colorado, Idaho, Montana, Nevada, Utah, Wyoming, and inland areas of California, Oregon, and Washington). Information collected includes narrative descriptions, project goals, restoration methods, project costs, landowner contributions, and monitoring data. It is our intent to augment the success of the Partners Program and other habitat restoration programs by providing useful bibliographic and case history information to landowners and project managers through a web-accessible database.

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 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 of the United States.

Progress to Date

The Initiative web site continues to be updated with on-going research activities and newly-acquired resource information. The site now includes: summaries and progress reports of all Initiative research projects, a searchable bibliography related to fish habitat, a selection of downloadable habitat restoration manuals, and links to pertinent online habitat restoration information.

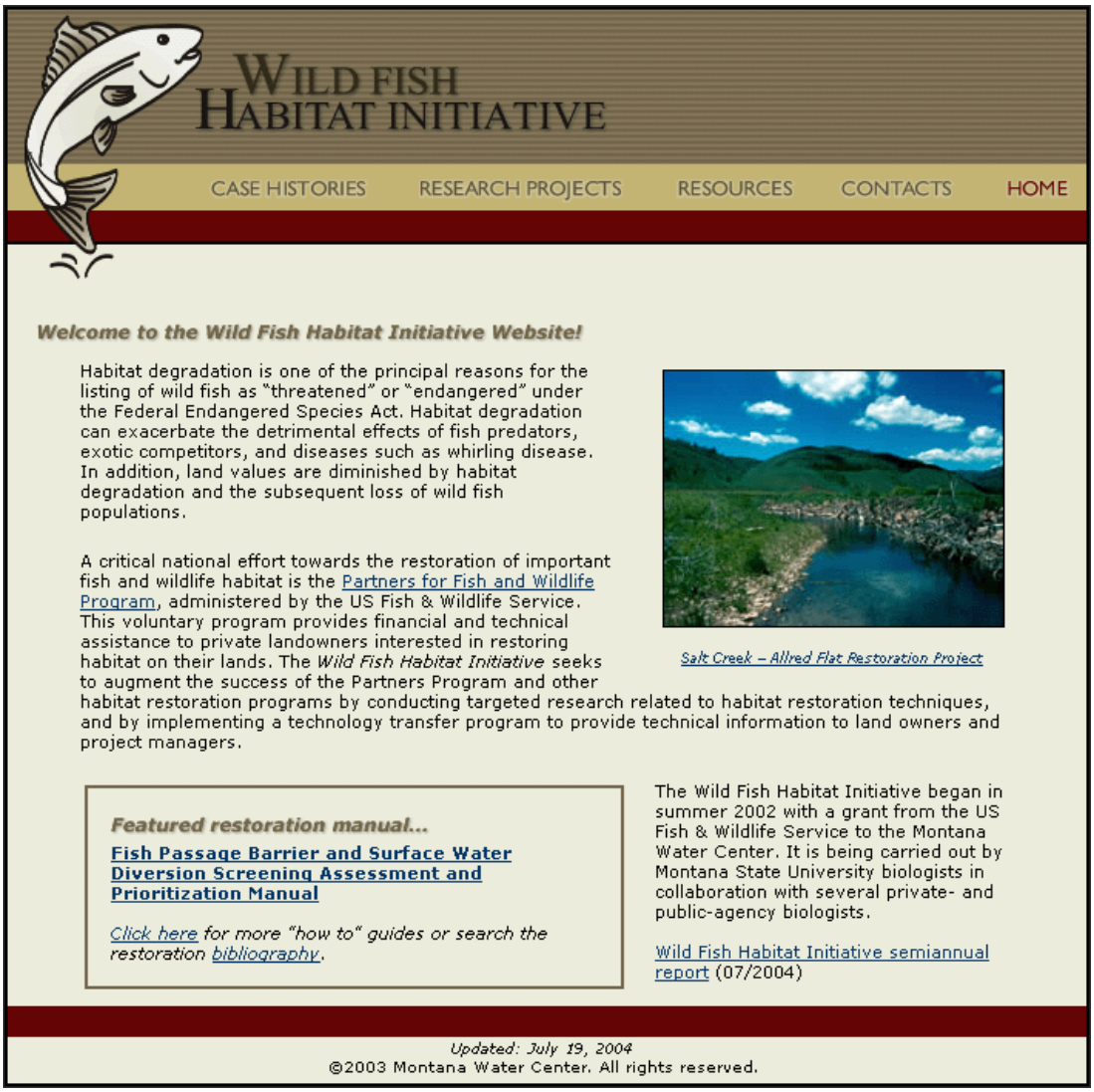

Figure 2. Initiative web site home page.

In May 2004, our website specialist obtained a new Initiative website address: http://wildfish.montana.edu, and in June she optimized and submitted the new site to the top search engines. The result of this action has been increasing our search engine ranking, which in turn, has resulted in increased use of the site. Use of the Initiative web site is now being tracked separately from the main Montana Water Center web site. The number of visitor sessions on the web site in June 2004 was 948 with an average session length of 14:55 minutes. That number almost doubled in just four months to 1,757 visitor sessions in October 2004 with an average session length of 12:46 minutes.

Online Bibliography—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. Presently, there are 1,033 literature entries available in the bibliography. Entries are reviewed periodically and new citations are continually added as they become available.

Habitat Restoration Manuals—Fourteen habitat restoration manuals are showcased on the web site to date. They were selected to provide information relevant to the nine focal states, and each of the manuals—or pertinent chapters within those manuals—are available to the website visitor in an easily-downloadable PDF format. Given their large size and the, oftentimes, lengthy process of securing many of these manuals, we intentionally made these resources instantly available to the website visitor.

New Case History Researcher/Technical Writer Hired—Liz Galli-Noble, program director, was tasked to hire the new case history researcher/technical writer for the Initiative; and from July to October she worked with a Water Center selection committee to develop a position description, solicit applications, conduct interviews, and select the best candidate. Out of more than 15 applicants, Kristin Keith was offered the position and began work on October 18, 2004. Her major responsibilities in this part-time position are working on the technology transfer project team and providing technical and case-history data to project partners engaged in habitat restoration projects to benefit wild fisheries. Specific duties for this position include: engaging and maintaining communication with university researchers, state wildlife and fish experts, federal-agency researchers, private habitat specialists, and private and non-profit organizations to acquire information on fish habitat restoration projects; seeking and documenting new/additional case histories; acquiring photographs and other documentation for featured case studies; updating case histories as new information becomes available; and modifying work products after external review.

Native Fish Habitat Restoration, Case Histories Effort—The case histories database has continued to be updated and expanded over the last six months. Due in large part to the diligence of our new case history researcher and website specialist, several new projects have been added to the web site in late 2004. Currently, the case history database contains 23 detailed fish habitat restoration projects showcasing seven projects from Montana, five from Wyoming, four from California, four from Oregon, two from Idaho, and one from Colorado. Each case history description includes: narrative descriptions, project goals, restoration methods, project costs, landowner contributions, photographs, and monitoring data. The intent of the database is to share information and learn from examples of previous native fish habitat restoration work. It is searchable by project title, project type, and location. In 2005, we will continue to concentrate our efforts on researching and adding projects to the web site, with special emphasis on the following states: Utah, Washington, and Nevada.

Program Publicity/Outreach—Montana Water Center staff have actively publicized the Initiative program and its research and website products over the past six months. Press releases were distributed in the summer and fall 2004 touting the Initiative program and encouraging feedback from interested parties.
Local, regional, and national professional meetings were attended in 2004 to make contacts and present work products; these meetings included:
1. Liz Galli-Noble (presentation), Federation of Fly Fishers 2004 Conclave; August 21, 2004; West Yellowstone, Montana
2. Cal Fraser and Liz Galli-Noble (poster), Wild Trout Conference VIII; September 20-22, 2004; Yellowstone National Park, Wyoming
3. Liz Galli-Noble (poster), 21st Annual Meeting of the American Water Resources Association, Montana Section; October 4-5, 2004; Helena, Montana
4. Liz Galli-Noble (presentation and poster), Northern Rockies Bioneers Conference; October 16, 2004; Bozeman, Montana
5. Liz Galli-Noble (poster), American Water Resources Association, 2004 Annual Water Resources Conference; Orlando, Florida; November 1-4, 2004.

As a result of these outreach actions, we have gotten rave reviews of the web site and Initiative research efforts from our research partners, the public, governmental agencies, and the private sector. This enhanced exposure to the program and website products—case histories and research investigations—has fostered new working relations with regional stream restoration companies, national academics, and regional fisheries managers.

Finally, one additional outreach effort undertaken in October 2004 was a research project tour given to our Montana State University grants and contracts partners. At their request, Al Zale, Gretchen Rupp, and Liz Galli-Noble coordinated and led three G & C personnel and an MSU media staffer on an all-day tour of fish habitat research investigations. At each stop, graduate students and/or project partners gave an overview of their project, demonstrated data collection techniques, and answered questions from the group.

New Project Opportunities—Water Center staff strive to be responsive to newly identified needs of our research and resource partners. About six months ago, one such need was identified. The research team leader from the Eradication and Exclusion Project approached the Water Center website specialist for assistance in developing an online interface for data collection. Although not an identified activity within our technical workplan, we felt this to be a worthwhile endeavor, and a process that potentially could be exported to other research projects, region wide. Since then, the team has developed an ongoing survey to collect barrier designs and information on structural and passage failure. Providing easy access to this type of information helps biologists who are planning or building a barrier to see potential designs and interact with those who have had experience with a specific design. Survey results can be viewed at http://wildfish.montana.edu/projects/barrier/browse.asp. Sharing innovative design ideas and information on barrier failure is a first step toward ensuring that barriers yet to be installed will have a lower failure rate.

Future Activities
In the first six months of 2005, the Technology Transfer team will focus our efforts on the collection of information on native fish habitat restoration projects for the case histories database. We will continue to maintain the web site as needed, with updates to the bibliographic information and restoration manuals. In February and March 2005, we will convene a panel of fisheries biologists, academics, private consultants (stream restoration companies), Partners Program personnel, and other governmental agency personnel to critically evaluate the Initiative web site and its contents. Specifically, we will ask for feedback on website design, clarity and usefulness of products showcased, scientific soundness of data presented, and how we can

improve our deliverables (see *Attachment A* for panel details). Recommendations made by this panel will then be implemented in 2005.

Technology Transfer staff are planning to attend several professional meetings in 2005 to make contacts and present Initiative work products. These meetings include, but are not limited, to the following: (1) American Fisheries Society, 2005 Annual Meeting of the Montana Chapter, February 8-9, 2005, Missoula, Montana; (2) National Institute of Water Resources, 2005 Annual Meeting, March 6-8, 2005, Washington DC; (3) 70th North American Wildlife and Natural Resources Conference, March 16-19, 2005, Arlington, Virginia; (4) Universities Council on Water Resources 2005 Annual Conference, July 12-14, 2005, Portland, Maine; and (5) American Fisheries Society 135th Annual Meeting, Anchorage Alaska, September 11-15, 2005.
We would also welcome additional suggestions for outreach opportunities from our project partners.

Summary
The Technology Transfer project is an ongoing effort that will continue to be expanded and refined as new and better restoration data become available. 2004 was a very positive and productive year for the for the Technology Transfer team. The Montana Water Center expanded our Initiative research staff in order to increase productivity, worked to strengthen our relationship with our project sponsor, strived to increase and enhance our communication with our MSU research and administrative partners, established a very successful and much-needed web-based information outlet, and intensified our outreach program. We plan to build on this positive momentum and make 2005 even more productive.

Technical Support

Cal Fraser, the Montana Water Center Wild Trout Research Laboratory manager, has provided technical support and research assistance to Initiative research teams, as well as to Montana state and federal fisheries agencies, for the past three years. Typically the manger's assistance has focused on the following:

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

In 2004, the Water Center began to plan for the renovation of the trout lab as part of the Yellowstone cutthroat trout thermal study. Through this renovation project, the lab will be made more functional and useable to a broader range of Initiative research teams. The main modification to the lab will be adding the capability of conducting multiple-temperature projects within one system. This action will allow the thermal studies team to move from the Fish Technology Center, which can no longer accommodate its needs due to space restrictions. To date, planning and design progress have been made on the lab renovation. The lab manager hired an engineer in the fall of 2004 to devise boiler and chiller specifications. Cal also designed and built a new thermal selection unit. In the next few months, lab drawings and engineering specifications will be finalized, and MSU Facilities Services will provide a bid for the project. Construction is slated to start in late spring 2005 and project completion is estimated at before the end of the year.

Finally, the lab manager also worked closely with USFWS Fish Technology Center staff in 2004, providing them with technical support and performing the following tasks: facility maintenance support, fish husbandry support, disease identification assistance, community outreach support, and graduate student research assistance.

RESEARCH PROJECTS

Projects Concluded in 2004

Three Initiative Phase II research projects concluded in 2004. Brief summaries from those projects are given below and final reports are provided in *Attachment B*.

Project #1. Irrigation Diversion Project

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

Graduate Student: Steve B. Gale, Montana State University
Principal Investigators: Al Zale, Montana Cooperative Fishery Research Unit and Tom McMahon, Montana State University
Collaborator: Christopher G. Clancy, Montana Department of Fish, Wildlife and Parks

Background
Skalkaho Creek is a 40-kilometer long tributary of the Bitterroot River in southwest Montana. The Bitterroot flows 134 kilometers through irrigated farm and ranch land to its confluence with the Clark Fork River near Missoula, Montana. Five major diversions and numerous smaller canals remove water from the river during irrigation season. Many tributaries of the Bitterroot River are also diverted for irrigation during the summer months and contribute little streamflow to the river during that time. Both the mainstem of the Bitterroot River and its tributaries are therefore chronically dewatered during the irrigation season.

Skalkaho Creek supports a healthy population of westslope cutthroat trout (*Oncorhynchus clarki lewisi*), along with brook trout, brown trout, bull trout, mountain whitefish, redside shiner, and slimy sculpin. This study examined seven lowhead dams on lower Skalkaho Creek that were believed to divert downstream migrant westslope cutthroat trout into irrigation canals. Both post-spawn adults migrating back to the Bitterroot River and juveniles emigrating downstream from nursery reaches of Skalkaho Creek and its tributaries were entrained and became trapped and died in the irrigation canal system, thereby resulting in a net loss to the population. Private landowners and irrigators in the drainage expressed concern over this loss, and collaborated with the research team to help solve the problem. This study has provided beneficial information to project managers regarding the effectiveness of fish screens and the prevention of fish loss due to irrigation diversions.

Goals
Provide private landowners, as well as federal/state agencies, with an in-depth evaluation of the value of fish screens to help make decisions on their use and potential value.

Objectives
1. Quantify downstream migrating age-0, juvenile, and adult westslope cutthroat trout entrained at irrigation diversions on Skalkaho Creek, before and after installation of fish screens.

2. Evaluate passage efficiency of fish screen structures at irrigation diversions of Skalkaho Creek.

Abstract
Post-spawn adult and downstream migrant juvenile westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are entrained, become trapped, and die in the seven irrigation canals on Skalkaho Creek, a tributary of the Bitterroot River. The research team quantified entrainment rates into the canals using telemetry and trapping before (2003) and after (2004) installation of fish screens at three (Highline, Ward, and Hughes) of the canals to provide private landowners and agency personnel with an in-depth evaluation of the value of fish screens. They also examined the efficacy of the screens in returning downstream migrants to the stream. No telemetered adults were entrained in 2003, but most were residents and therefore did not migrate past the canals. Fifteen telemetered adults were entrained in 2004; three were entrained, bypassed, and entrained again further downstream. Nine telemetered fish were entrained at ditches with fish screens and all nine were successfully bypassed. Only one of 74 telemetered adults successfully emigrated back to the Bitterroot River, by swimming upstream out of a ditch. Five telemetered juveniles were entrained at the Highline Ditch in 2003 and three in 2004, but only one was bypassed. A majority of the 117 telemetered juveniles were residents and therefore did not migrate past the canals. We estimated that 33,722 age-0 westslope cutthroat trout (95% CI, 12,044 - 161,799) moved downstream from July 16 to September 20 in 2003; 8,964 (95% CI, 2,840 - 72,141) or about 27 percent were entrained at the Highline Ditch. In 2004, 7,840 fish were bypassed by all three screens, and of those 6,041 were westslope cutthroat trout. No fish were entrained in two of the three ditches with fish screens in 2004, and only a few fish were entrained in the third. The fish screens effectively precluded entrainment and effectively bypassed adult, age-1 juvenile, and age-0 westslope cutthroat trout. Fish screens were an effective management tool to eliminate entrainment of westslope cutthroat trout at Skalkaho Creek and may also be useful elsewhere to eliminate entrainment of inland salmonids.

Completion Date and Deliverables
December 31, 2004, final report provided in *Attachment B*.

Project #2. Thermal Requirements of Westslope Cutthroat Trout

Project Title: Thermal Requirements of Westslope Cutthroat Trout

Graduate Student:	Beth Bear, Montana State University
Principal Investigators:	Tom McMahon, Montana State University and Al Zale, Montana Cooperative Fishery Research Unit
Collaborator:	Bill Krise, Bozeman Fish Technology Center, USFWS

Background
Historically, westslope cutthroat trout (*Oncorhynchus clarki lewisi*) ranged widely over western Montana, Idaho, and portions of eastern Washington and Oregon. Like many other cutthroat and native trout species, westslope cutthroat trout now persist in only a small portion of their native range, and are listed as a “species of special concern” in Montana.

Leading causes for their decline are habitat degradation and displacement by non-native rainbow, brook, and brown trout. Water temperature is considered a key element influencing the abundance and distribution of coldwater species like trout, yet the thermal requirements of westslope cutthroat trout are largely unknown. Proper conservation and management of westslope cutthroat trout requires detailed knowledge of its temperature requirements.

Goals

The goal of this laboratory study is to characterize the thermal biology of westslope cutthroat trout, specifically with respect to the lethal and optimal temperatures for this subspecies, and to compare its thermal biology with that of rainbow trout, a non-native competitor. We are using a laboratory design that we developed for thermal testing with bull trout (Selong et al. 2001). This design allows simultaneous assessment of fish growth and survival under many different temperatures over long time periods. In addition, the thermal preferences of both species are being determined to better aid in characterizing the thermal requirements of each species.

Objectives

1. To define the upper lethal and optimal temperature ranges of westslope cutthroat trout.
2. To define the upper lethal and optimal temperature ranges of rainbow trout.
3. To determine the thermal preference of westslope cutthroat trout and rainbow trout.

Abstract

Westslope cutthroat trout *Oncorhynchus clarki lewisi*, have declined throughout their native range in the Northern Rockies and were considered for listing under the federal Endangered Species Act. Water temperature is widely regarded as playing a key role in determining their persistence, but specific thermal optima and lethal levels for this cutthroat trout subspecies have not been precisely defined. This laboratory study used the acclimated chronic exposure method to determine thermal optima and tolerances for westslope cutthroat trout and for rainbow trout *Oncorhynchus mykiss*, a potential non-native competitor now occupying much of the former range of westslope cutthroat trout. Optimum growth temperature for westslope cutthroat trout (13.6°C; 95% CI, 10.3 - 17.0°C) over the 60-days test period was, unexpectedly, similar to that of rainbow trout (13.1°C; 95% CI, 6.8 - 18.2°C). However, rainbow trout were predicted to grow better over a wider range of temperatures than cutthroat trout, with growth significantly better at temperatures below 6.8°C and above 20.8°C. In addition, the ultimate upper incipient lethal temperature (temperature at which 50% of the population survives for 60-days) of rainbow trout (24.2°C; 95% CI, 20.3 - 24.2°C) was 4°C higher than that of westslope cutthroat trout (19.7°C; 95% CI, 19.1 - 20.3°C). The higher upper temperature tolerance and wider growth range of rainbow trout may account for its increased occurrence at lower elevations than cutthroat trout. We hypothesized that cutthroat-rainbow trout hybrids would have intermediate temperature requirements, but poor survival of hybrid eggs precluded testing this hypothesis. Disease outbreaks also precluded planned experiments of temperature effects on competitive interactions between rainbow trout, brook trout, and westslope cutthroat trout. However, the thermal requirement information we did establish in this study can help guide protection and restoration efforts for this unique cutthroat trout subspecies.

Completion Date and Deliverables

December 31, 2004, final report provided in *Attachment B*.

Project #3. Bacterial Coldwater Disease Project

Project Title: Bacterial Coldwater Disease in Westslope Cutthroat Trout: Hatchery Epidemiology and Control

Principal Investigators: Eileen K.N. Ryce, Montana State University and Al Zale, Montana Cooperative Fishery Research Unit

Background

Bacterial coldwater disease, caused by the gram-negative bacterium *Flavobacterium psychrophilum*, is a septicemic infection that originated in the northwestern United States and is responsible for significant losses of hatchery-reared salmonids worldwide. It is especially problematic at hatcheries rearing fish for native species restoration, because the wild, undomesticated strains used for restoration are prone to stress in the hatchery environment and stress induces the disease. Currently, bacterial coldwater disease is the only fish disease found in State fish hatcheries in Montana. The Washoe Park State Fish Hatchery in Anaconda, Montana, is the only facility in the state that produces westslope cutthroat trout (*Oncorhynchus clarki lewisi)* suitable for restoration programs. However, the severity of bacterial coldwater disease at this hatchery limits fish production and therefore implementation of the westslope cutthroat trout restoration program. Losses typically occur in three episodes among young fish from shortly after swim-up until they reach a length of about 75 millimeters. The first outbreak occurs in indoor raceways at first feeding, the second about three weeks later also indoors, and the third about three weeks after the juvenile fish are moved to outdoor raceways. In aggregate, the three outbreaks can achieve losses of about 30 to 45 percent annually. Successful control of bacterial coldwater disease at Washoe Park State Fish Hatchery would therefore facilitate restoration of native westslope cutthroat trout in Montana.

Goal

To better understand the ecology of *F. psychrophilum* in hatcheries and thereby facilitate development and testing of control measures, eventually leading to increased and enhanced restoration efforts.

Objectives

1. To determine where the pathogen occurred in the hatchery.
2. To determine avenues of transmission within the hatchery.
3. To determine what factors cause disease outbreaks.

Abstract

Bacterial coldwater disease, caused by the gram-negative bacterium *Flavobacterium psychrophilum*, is responsible for significant losses of hatchery-reared salmonids worldwide. We used Washoe Park State Fish Hatchery in Anaconda, Montana, as a case study to enhance understanding of the disease in a hatchery setting and to develop practical hatchery-management strategies to better control the pathogen and the disease. Washoe Park typically loses 30 to 45 percent of its westslope cutthroat trout (*Oncorhynchus clarki lewisi)* production to the disease annually. Our objectives were to determine where the pathogen was located in the hatchery system, how it was transmitted, and what factors caused disease outbreaks. We found the bacterium in the warm-spring water source, in the degassing water tower, and in production and broodstock fish. It was transmitted both horizontally and vertically, with both male and female parents passing the pathogen on to their offspring. Transmission from females was vertical only, but both horizontal and vertical transmission from males occurred. Iodine surface-disinfection post-fertilization eliminated the pathogen from egg surfaces, thereby limiting horizontal transmission. Chronic and mild acute stress did not result in disease outbreaks, but a combination of acute stress events associated with moving juvenile production fish from indoor to outdoor raceways did. These fish harbored the pathogen, primarily in cranial tissues, prior to the

outbreak. Measures resulting from our findings implemented at Washoe Park to reduce horizontal transmission included cleaning and sterilization of hatchery structures and iodine surface-disinfection of eggs post-fertilization. Eradication of the pathogen from the hatchery is unlikely, but efforts to reduce the frequency and intensity of stress events should reduce the frequency of disease outbreaks; management to reduce the number of fish carrying the pathogen may minimize losses during outbreaks.

Completion Date and Products
June 2004, final report provided in *Attachment B*.

Need for Further Study
Hatchery personnel are currently (2004) attempting to reduce prevalence of the pathogen in male broodstock through oxytetracycline and fluorofenicol injections and oxytetracycline-coated feed. These actions are aimed at reducing vertical transmission. Sperm washing techniques, as commonly used in animal husbandry of domestic mammals to eliminate pathogens, may warrant future investigation also.

Phase III Projects

One research project has continued from 2004 into 2005 (Phase II into Phase III) and two projects commenced in October 2004. Brief overviews/updates are provided for those projects below.

Project #4. Eradication and Exclusion Techniques Project

Project Title: Evaluation of the Efficiency and Efficacy of Non-native Fish Eradication and Exclusion Techniques for Native Fish Restoration

Graduate Student:	Peter Brown, Montana State University
Principal Investigator:	Al Zale, Montana Cooperative Fishery Research Unit
Technicians:	John Olson, Montana State University
	William Bailor, Montana State 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 increased ultraviolet light exposure, but the intensity and length of sunlight exposure that makes the chemicals ineffective is unknown. After non-native fish are removed from a water body, a barrier is usually used to prevent reinvasion. In flowing waters, a waterfalls type barrier is usually used to prevent the upstream migration of non-native fish. The success of this type of barrier relies on the top of the falls being higher than non-native fish can jump. Currently only the jumping ability of hatchery reared fish of about 200 millimeters has been tested in a laboratory setting. The ability of larger, wild fish, returning to spawning grounds has not been tested. To build effective barriers we must know the effective height that prevents upstream movement of non-native fish. We are researching the effect of various water quality parameters on the toxicity of fish toxicants as well as the design of barriers in an effort to help conserve native fish.

Goals
The goal of this project is to increase the success rate of native fish restoration projects. By addressing the issues of efficient fish toxicant use and proper barrier design, we hope to increase the efficiency and efficacy of native fish restoration. We are carrying out a thorough investigation of the techniques used to eradicate and exclude non-native fish, specifically addressing the efficiency of piscicide use and proper barrier design.

Objectives
Our specific short-term objectives to reach this goal are to: (1) identify the current methods used for fish eradication and exclusion, and (2) develop functions that can predict the toxicity of a given piscicide at specific levels of various water quality parameters. Subsequent field and laboratory research will focus on increasing the efficiency of fish eradication and exclusion through direct experimentation. Understanding the inefficiencies of fish eradication and exclusion will increase the overall effectiveness of native fish management.

Progress to Date
Several ongoing and past eradication projects and barriers were visited during 2004. The techniques used in these projects were reviewed and the project leaders were interviewed to determine which techniques were useful and what information was lacking. Those using piscicides identified a general lack of direction for application in varying water conditions. For example, in high gradient streams, where water flow is turbulent, it is recommended that piscicide application stations be more closely spaced along the stream. It is also recommended that piscicide application stations be closely spaced in streams of low gradient. The terms “high” and “low” are relative and quantifiable descriptions of these terms need to be established. For example, when stream gradient is 1 to 2.5 percent, piscicides should be applied every one kilometer of stream distance; when stream gradient is 2.6 to 3.5 percent, piscicides should be applied every two kilometers along a stream. Without guidance like this, and in an effort to be cautious and thorough, applicators frequently apply too much piscicide. Over-application of piscicides can be costly and result in high mortality of aquatic invertebrates. Similar vague recommendations exist for stream temperature pH, ultraviolet light, and organic matter. By manipulating water treated with piscicides to a value along a given characteristic, we will be able to see what happens to the toxicity of the piscicides. Multiple tests along a water chemistry gradient will provide the data behind recommendations for piscicide application in varied stream conditions.

Based on visits to barrier sites and through a web-based survey of barrier design, we determined that barrier design varies widely across the United States. Barriers to non-native fish migration can be modified natural structures, structures like culverts designed for other purposes, or structures designed specifically to block migration of non-native fish. Fisheries biologists who have installed or now manage barriers were unable to find specific design criteria and would appreciate guidance on proper barrier dimensions and design. Barrier designers need to consider water flow capacity, site selection, cost, longevity, and height; however, suggestions and guidance on these topics either do not exist or are inaccessible. For example, the height of the barrier is frequently decided by what the biologists “thinks” will keep fish from jumping over. The location of a barrier may be determined by proximity to a road rather than geologic suitability. Studies to determine the jumping height of wild fish and contact information for biologists who operate barriers in similar stream morphology would likely answer these two questions and reduce the likelihood of barrier failure. Improper design can lead to barrier failure by structural failure or passage failure. Structural failure results from an inability to handle all possible water flows. Passage failure results when fish are able to pass over or around a barrier. Understanding these causes of failure is the first step in improving barrier design. We have developed an ongoing survey to collect barrier designs and information on structural and passage failure. Providing easy access to this type of information may help biologists planning or building a barrier to see potential designs and interact with those who have had experience with a specific

design. Survey results can be viewed at http://wildfish.montana.edu/projects/barrier/browse.asp. By sharing innovative design ideas and information on barrier failure, we have taken a first step toward ensuring that barriers yet to be installed will have a lower failure rate.

Future Activities

Future activities include experimental tests of eradication and exclusion techniques and writing a barrier design manual. Guidelines for the use of piscicides in varying water chemistries will be developed during spring and summer 2005. We will be testing the toxicity of piscicides under different water conditions at the Wild Trout Research Laboratory at Montana State University and in the field. We will also be looking to establish the maximum jumping height of several fish species in natural conditions. This will provide guidance for proper barrier design. We will write a manual on how to design an effective fish exclusion device using results of the ongoing barrier survey and analysis of the failure of barriers. We will thereby replace gaps and inconsistencies in piscicide application and barrier design with guidance leading to increased success in native fish conservation.

Projected Completion Date and Deliverables

Completion of the overall project is expected in 2009 pending continued funding; reports will be issued accordingly. The exclusion manual will be completed in fall 2005. Publication of research results will take place as research is completed.

Project #5. Evaluation of Habitat Restoration for the Conservation of Cutthroat Trout

Principal Investigator: Alexander V. Zale, Montana Cooperative Fishery Research Unit
Graduate Research Assistant: Brad Shepard, PhD student, Montana State University
Faculty Consultant: Mark Taper, Montana State University

Introduction and Scope

The distributions and abundances of native westslope *Oncorhynchus clarki lewisi* and Yellowstone cutthroat trout *O.c. bouvieri* have declined from historical levels and both are considered at risk for listing under the Endangered Species Act. Efforts are currently underway to conserve these subspecies throughout the Northern Rocky Mountain region. One important conservation strategy is that of habitat restoration and enhancement, but few studies have quantitatively assessed the response of cutthroat trout populations following habitat restoration. In fact, few studies have described what constitute ideal habitats for the conservation of these subspecies. In addition, another major threat to the conservation of these subspecies is competition and predation by non-native trout species, particularly brook trout *Salvelinus fontinalis* that occur in sympatry with both subspecies over much of their range. Interactions between brook and cutthroat trout are likely regulated by habitat condition, but little is known about these relationships. Our study will evaluate past and ongoing 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. In the future, we will describe what constitutes quality habitat for westslope and Yellowstone cutthroat trout and determine how habitat condition and the presence of brook trout interact to affect densities of cutthroat trout.

Goal and Objectives

The distributions and abundances of native westslope *Oncorhynchus clarki lewisi* and Yellowstone cutthroat trout *O.c. bouvieri* have declined from historical levels and both are considered at risk for listing under the Endangered Species Act. Efforts are currently underway to conserve these subspecies throughout the Northern Rocky Mountain region. One important conservation strategy is that of habitat restoration and enhancement, but few studies have quantitatively

assessed the response of cutthroat trout populations following habitat restoration. In fact, few studies have described what constitute ideal habitats for the conservation of these subspecies. In addition, another major threat to the conservation of these subspecies is competition and predation by non-native trout species, particularly brook trout *Salvelinus fontinalis* that occur in sympatry with both subspecies over much of their range. Interactions between brook and cutthroat trout are likely regulated by habitat condition, but little is known about these relationships. Our study will evaluate past and ongoing 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. In the future, we will describe what constitutes quality habitat for westslope and Yellowstone cutthroat trout and determine how habitat condition and the presence of brook trout interact to affect densities of cutthroat trout.

Activities
During 2005 we will evaluate the effectiveness of habitat restoration projects on the conservation of cutthroat trout. We will locate habitat restoration projects that targeted cutthroat trout populations where pre-project population estimates had been made and make post-treatment estimates at those sites. In addition, we will collect pre-treatment estimates at sites where habitat restoration is proposed. 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 increasing frequencies of woody debris might favor brook trout over westslope cutthroat trout and we will further test these preliminary observations.

Milestones
We have located habitat restoration projects suitable for this study in 2004, and will sample these projects during the summer of 2005. We plan to continue sampling habitat and fish populations at habitat restoration project sites through 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
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 will involve local landowners.

Project #6. Thermal Requirements of Yellowstone Cutthroat Trout

Principal Investigators: Thomas E. McMahon, Montana State University, and Alexander V. Zale, Montana Cooperative Fishery Research Unit
Partner: Cal Fraser, Director, Wild Trout Laboratory, Montana Water Center, MSU
Graduate Research Assistant: TBA

Introduction and Scope
Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri* are in decline throughout their native range in the Northern Rockies, are listed as a Species of Special Concern in Montana, and have been petitioned for listing under the Endangered Species Act. Habitat degradation and competition and predation by non-native trout are the primary causes of their decline. Water temperature is widely regarded as playing a key role in determining persistence of native salmonids, yet specific thermal requirements and optima of this and other cutthroat trout subspecies are largely unknown. Water temperature also plays an important role in tipping the balance in favor of non-native over native trout, yet how temperature influences competitive

interactions of Yellowstone cutthroat with their non-native competitors has not been investigated. This lack of information precludes effective reintroduction and restoration programs, development of land management policies, and hatchery propagation protocols. Summer maximum water temperatures are likely a major limiting factor for this and other native trout; however, no studies have been conducted to determine the upper incipient lethal temperature of Yellowstone cutthroat trout or the temperatures at which growth is optimized during summer rearing in the presence and absence of non-native competitors. Such data are critical to further develop and evaluate temperature criteria for native cutthroat habitats and better understand the factors responsible for the decline of this unique subspecies.

Arctic grayling, bull trout, westslope cutthroat trout, and Yellowstone cutthroat trout are the primary native trout species in Montana, and all are listed as Species of Special Concern. The Yellowstone cutthroat trout is the last remaining of this group for which temperature data are unavailable. Thermal information for westslope cutthroat trout has been gathered under Phases I and II of the Wild Fish Habitat Initiative, and prior to that, bull trout thermal requirements were evaluated by our research team (Selong, J.H., T.E. McMahon, A.V. Zale, and F.T. Barrows. 2001. *Effect of temperature on growth and survival of bull trout, with application of an improved method for determining thermal tolerance in fishes*. Transactions of the American Fisheries Society 130:1026-1037). The Yellowstone cutthroat trout studies proposed here will build upon this thermal information and provide some of the most extensive thermal information available for a group of native and non-native salmonid species.

Results of this study are critical to the development and evaluation of temperature criteria for Yellowstone cutthroat trout waters. This information will promote effective habitat protection, restoration, and species reintroduction programs, and assessment of land management policies in watersheds inhabited by this cutthroat subspecies with the desired outcome of minimizing risk of further decline and increasing their current range. Recent controversy over bull trout temperature tolerances as land management policy clearly illustrates that having well-defined temperature criteria for now-rare fishes are required for effective protection and management, and our study will provide that information. Intended users include state and federal land management agencies, USFWS Ecological Services and hatcheries, state and federal natural resource agencies, and the timber and grazing industries. The information will be especially helpful in implementing conservation plans for this native cutthroat trout in Montana, Idaho, and Wyoming.

Goals and Objectives

Our project goals are (1) to renovate the existing MSU Wild Trout Laboratory in order to conduct our thermal research investigation; and (2) to characterize the thermal biology of Yellowstone cutthroat trout.

Our research objectives are to define the maximum growth temperature, upper incipient lethal temperature (i.e., the highest temperature that can be survived indefinitely), and preferred temperature of Yellowstone cutthroat trout.

Activities

In 2004, the thermal studies team was informed that we will no longer be able to conduct future investigations at the USFWS Fish Technology Center. There is simply too great a need for internal USFWS research at that facility to accommodate us in the future. Fortunately, we have the MSU Wild Trout Laboratory as an alternative location to conduct our work. From October 2004 to July 2005, we will assist the Montana Water Center in renovating a portion of their existing laboratory, thereby enabling our research team to conduct our thermal experiments in that facility starting in 2005.

Laboratory trials will be conducted in the thermal testing facility housed at the Montana Water Center Wild Trout Lab. The thermal testing facility will consist of 36 treatment tanks supplied with water from multiple recirculating process systems to provide a wide range of test temperatures. A three-year study of bull trout thermal requirements using similar apparatus was completed in 2000 (Selong et al. 2001), and the westslope cutthroat thermal studies were completed in 2005.

Eyed eggs of Yellowstone cutthroat trout will be obtained from the wild broodstock maintained at the Yellowstone River State Fish Hatchery in Big Timber, Montana. Juveniles will be reared at the Montana Water Center Wild Trout Lab until they reach about 8 to 10 centimeters. Growth and survival will be examined at 12 constant temperatures over the range of 8 to 28^{o} Celsius to span the entire range of temperatures potentially encountered by Yellowstone cutthroat trout during summer. Optimal growth temperature and upper incipient lethal temperature will be determined in a series of long-term (60 days) temperature trials following the protocol established by Selong et al. (2001).

Milestones

Lab renovations will be conducted from October 2004 to July 2005. Experiments will be conducted in 2005 following completion of the lab renovation.

Deliverables

A written scientific report detailing the thermal requirements of Yellowstone cutthroat trout will be produced and a manuscript describing this research will be submitted for publication in a peer-reviewed journal. Results of the study will also be presented at scientific meetings. For example, results of our bull trout and westslope cutthroat trout thermal studies have been presented at seven national or regional conferences.

Partners

The study is being conducted in close cooperation with the Montana Department of Fish, Wildlife and Parks, which will provide Yellowstone cutthroat trout eggs for our experiments, and the Montana Water Center Wild Trout Laboratory, which will house the thermal testing and fish rearing facilities.

PROJECT 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. In addition to exercising overall program leadership, he is the research leader of the Irrigation Diversions project, the Eradication and Exclusion project, and co-leader for the Bacterial Coldwater Disease project. 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 Montana State University whose principal research interests are wild trout management, fish-habitat relationships, winter ecology, and conservation biology of salmonids. He is the leader of the Westslope and Yellowstone Cutthroat Thermal Testing projects.

Eileen Ryce, Post-Doctoral Associate in the Ecology Department at Montana State University, was co-leader for the Bacterial Coldwater Disease project. Dr. Ryce specializes in fish health issues.

Liz Galli-Noble is the Assistant Director for Research at the Montana Water Center. She is responsible for the management of the Center's aquatic biology research programs and administration of the Wild Fish Habitat Initiative. Ms. Galli-Noble attended the University of Montana for her undergraduate studies and received a Master's degree from Yale University in 1995.

William C. Fraser is a fishery biologist who serves as Manager of the Wild Trout Research Laboratory at the Montana Water Center. Mr. Fraser works on the Technology Transfer project. His chief professional interests are fisheries ecology and culture.

Molly Boucher is a Website Specialist with the Montana Water Center. She has a degree in environmental studies and develops web sites and databases for the Center. Ms. Boucher is the website developer for the Wild Fish Habitat Initiative and works on the Technology Transfer project.

Kristin Keith is the case history researcher and technical writer for the Wild Fish Habitat Initiative. She has a Bachelor of Science degree in Biology and a Master's degree in Soil Science with an emphasis in water quality.

Beth Bear is a Graduate Research Assistant with the Montana Cooperative Fishery Research Unit at Montana State University. She is working with Thomas McMahon on the Westslope Cutthroat Thermal Testing project.

Steve Gale is a Graduate Research Assistant with the Montana Cooperative Fishery Research Unit at Montana State University. He is working with Dr. Zale and Dr. McMahon on the Irrigation Diversions project.

Peter Brown is a Graduate Research Assistant with the Montana Cooperative Fishery Research Unit at Montana State University. He is working with Dr. Zale on the Eradication and Exclusion Project.

John Olson was the student technician working with Peter Brown and Dr. Zale on the Eradication and Exclusion Project during the summer 2004.