Montana Cooperative Fishery Research Unit

2012 Briefing Booklet

MONTANA COOPERATIVE FISHERY RESEARCH UNIT

Coordinating Committee Meeting
Bozeman, Montana
25 April 2012

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Westscape Native Plants Nursery
- Robert Dunn
- Laura Smith

Wildlife Conservation Society
- Brad Shepard

Wyoming Game and Fish Department
- Paul Gerrity
- Rob Gipson
- Dave Zafft

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Jan Boyer	M.S.
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Carter Fredenberg	M.S.
Ben Galloway	M.S.
Andrew Gilham	M.S.
Sean Lewandoski	M.S.
Ann Marie Reinhold	Ph.D.
David Ritter	M.S.
John Syslo	Ph.D.
Brian Tornabene	M.S.
Patrick Uthe	M.S.

Current Graduate Students Advised by Cooperating Faculty

Kristen Homel	Ph.D.
Russell Smith	M.S.
Shane Vatland	Ph.D.

Research Technicians 2011

Charles Birch	Jacquelyn Jones	Ryan Richards
Joel Bischoff	Nate Laulainen	Nick Rubino
Jeff Glaid	Colin Manning	Mike Stein
Beca Gunderson	Tyler Morrison	Lora Tennant
Luke Holmquist	Tommy Pederson	Jon Wester

Graduate Students Receiving Degrees in 2011

Dan Drinan graduated with a M.S. in Biological Sciences and is pursuing a Ph.D. at the University of Washington in Aquatic and Fishery Sciences.

Edwin (Ted) Sedell graduated with a M.S. in Biological Sciences and is working for the Oregon Department of Fish and Wildlife as a Supervisory Fish and Wildlife Biologist.

Ryan Richards graduated with a M.S. in Fish and Wildlife Management and is working for Montana Fish, Wildlife and Parks as a Fisheries Technician III.

2010 Statement of Direction

Research of the Montana Cooperative Fishery Research Unit will continue to focus on applied fisheries-management problems and issues. Our studies are initiated in response to the needs of the Cooperators and other management agencies and are designed to provide information useful in directly improving management of aquatic resources. Technical areas of special emphasis include habitat associations and requirements of fishes, large-river fish assemblages, native aquatic community restoration, effects of exotic fishes on native species, and regulated-river and reservoir fisheries. Other topics are addressed as needed, in keeping with the Cooperative Research Program's mission to best meet the needs of the Cooperators by remaining flexible and open to new areas of inquiry, as exemplified by our current emphasis on prairie streams. When Cooperator's needs occur outside our areas of expertise, we will recruit the assistance of appropriate University faculty.

Unit staff will advance the training and education of graduate students in fisheries science at Montana State University by teaching up to one graduate-level course per year, chairing graduate committees of Unit students, and serving on graduate committees of non-Unit students. In-service training will be provided to Cooperators and other agencies as the need exists.

Availability and use of coldwater thermal refugia by native and nonnative salmonids: Implications for fluvial Arctic grayling conservation in Montana

Investigators
Robert Gresswell
USGS Northern Rocky Mountain Science Center
Alexander Zale
Unit Leader, MTCFRU

Graduate Student
Shane Vatland, Ph.D.

Project Duration
October 2006- December 2010
Completed

Collaborators
Emily Cayer
Montana Fish, Wildlife and Parks
Buddy Drake
Arctic Grayling Recovery Program

Funding
Wild Fish Habitat Initiative, Montana University System Water Center, MSU index 4W1331
Arctic Grayling Recovery Program, MSU index 423077
USGS Northern Rocky Mountain Science Center SSP SPP, MSU index 4W2377
Big Hole River Watershed Committee, MT Trout Unlimited

Fluvial Arctic grayling occupy less than 5% of their historic range in Montana, and monitoring of the Big Hole River population suggests distribution and abundance are declining. Understanding Arctic grayling movement and habitat use within the Big Hole River watershed is essential for conservation planning and effective habitat restoration. We are investigating relationships among stream habitat conditions, fish assemblage composition, and Arctic grayling distribution, abundance, and movement patterns in the upper Big Hole River. We are specifically evaluating the availability and use of coldwater thermal refugia for Arctic grayling and nonnative salmonids.

In the autumns of 2007-2009, we captured fish by electrofishing throughout the upper Big Hole River watershed in collaboration with Montana Fish, Wildlife, and Parks annual fish monitoring surveys. We implanted 23-mm half-duplex passive integrated transponders (PIT tags) in about 2,800 fish > 120 mm (total length). These PIT-tagged fish included Arctic grayling, burbot, brook trout, rainbow trout, brown trout, mountain whitefish, and white and longnose suckers. From 2007-2010, we used a combination of fixed-station and portable PIT-tag antennas to evaluate the movement and habitat use of tagged fish at multiple spatial and temporal scales. Field effort peaked in the summer and autumn of 2009, when we used a network of 15 fixed stations and a series of portable antenna surveys to relocate PIT-tagged fish in the mainstem Big Hole River and tributaries in the valley bottom. Multiple antenna designs were necessary to maintain effectiveness across a wide range in stream size (about 2 to 60 m wetted width). We directly evaluated the detection efficiency of our portable antennas in five tributaries and one reach of the mainstem. Overall, we conservatively estimated a 54% ($n = 6$, $SD = 0.13$) detection efficiency for one-pass surveys, with detection efficiencies varying among fish species and, to a lesser extent, among sites. Detection efficiency estimates for shed tags were consistent among sites and averaged 93% ($n = 4$, $SD = 0.10$). Overall, using a combination of fixed and portable antennas proved a useful and efficient approach to evaluating fish movement and distribution in this stream network.

Low summer discharge and warm stream water temperatures threaten the persistence of native Arctic grayling, and harsh thermal conditions may exacerbate negative interactions between grayling and introduced trout species. To evaluate the present extent of suitable thermal habitat, stream temperatures were assessed with a combination of remote sensing (thermal infrared or TIR), continuous longitudinal temperature profiling, and fixed-station water temperature loggers. Continuous longitudinal profiling and TIR imaging were effective methods for evaluating explicit spatial patterns in temperature data at multiple spatial scales, and fixed temperature loggers provided precise estimates of temporal variation in stream temperature. Using this combination of data, we characterized the distribution of thermally suitable habitat during the summer and identified associated habitat attributes. Suitable thermal habitat was patchily distributed throughout the study area, and cold-water tributaries appear to provide critical cold-water thermal refugia. Stream-temperature and fish-location data have been incorporated into a geographic information system (GIS), and the occurrence and location of suitable thermal habitat is being quantified and evaluated for grayling and nonnative salmonids. We also incorporated spatially and temporally explicit thermal data into statistical stream temperature models, and future changes in thermal habitat were assessed using regional climate change predictions. Under scenarios of increasing and more variable summer air temperatures, we predicted a significant increase in the occurrence of stream temperatures that exceed chronic and acute thermal tolerance thresholds for salmonids. Evaluating spatial patterns in observed and predicted stream temperatures allowed us to identify areas critical to maintaining suitable coldwater habitat in the future.

Total Project Cost		$111,850.00
Beginning Balance - June 2010		$ 12,244.35
Expenditures - July 2010 - Dec 2011		
Salaries and Benefits	$ 8,866.84	
Travel	$ 0	
Communication	$ 6.26	
Supplies	$ 300.00	
Rent	$ 0	
Awards	$ 1,451.90	
Maintenance	$ 0	
IDCs @ 15%	$ 1,619.35	
Total Spent		$ 12,244.35
Balance		$ 0
Waived IDCs		$ 2,921.88

Distribution, abundance, and movement of native cutthroat trout in the Snake River below Jackson Lake

Investigators
Robert Gresswell
USGS Northern Rocky Mountain Science Center

Graduate Student
Kristen Homel, Ph.D.

Project Duration
January 2008 – January 2012

Collaborators
Rob Gipson
Wyoming Game and Fish Department
Sue O'Ney
National Park Service

Funding
National Park Service, USGS RWO 57, MSU index 4W1974

Over the last century, native trout in western North America have experienced declines in abundance and distribution because of habitat degradation, fragmentation, invasive species, and hybridization. Declines have been particularly pronounced for the riverine migratory forms that rely on intact corridors to access seasonal habitat. In response to these declines, conservation of native trout has focused on factors that promote population resiliency including life-history diversity and habitat patch size. However, the majority of habitat models for trout species have been constructed and empirically tested in small stream systems with limited physical template complexity, limited life-history diversity, and limited seasonal movement among habitats. In these systems, assessment of habitat use has focused on instream attributes, and generally, there is an implicit assumption that the spatial arrangement of habitat, behavioral patterns, and the position in the river network do not influence occurrence in a particular habitat. As river systems increase in size and complexity, changes in the physical template often correspond to changes in the diversity of movement patterns, life-history strategies, and habitat-use patterns. Consequently, it is unclear whether patterns observed in small streams or habitat models derived from attributes of small streams can be applied to conservation of fish in large river networks.

Given the pronounced differences in the physical template of small streams and large rivers, and the potential for a diverse response to that template, there is a need to develop a more complete understanding of the life-history variation and habitat-use patterns of trout in large river networks. The Snake River finespotted cutthroat trout *Oncorhynchus clarkii behnkei* is a model taxon for evaluating life-history patterns of native trout in a relatively intact, complex, and large river network. Snake River finespotted cutthroat trout are distributed throughout the historic range in the upper Snake River between Jackson Lake Dam and Palisades Reservoir. Multiple migration patterns have been identified, and each may be associated with unique habitat requirements and limited by habitat availability. In this study, radio telemetry was used to identify spawning patterns, life history diversity, distribution patterns, and habitat use before, after, and during the spawning migration. Specifically, we addressed the following research questions: (1) what spawning and life-history patterns are expressed by native cutthroat trout in the upper Snake River, (2) how is the spatial arrangement of spawning habitat (topology) related to distribution patterns of adult cutthroat trout before and after spawning, and (3) what are the effects of life-history diversity, channel geometry, and spawning-habitat topology on habitat use by adult cutthroat trout in a large river network?

A total of 248 cutthroat trout were implanted with radio tags in 2007 (49) and 2008 (199), and individual movements were monitored for one year. In the process of analyzing the telemetry data, it was apparent that existing analytical approaches were insufficient to address sparse location data collected at uneven sampling intervals, typical of fish telemetry studies. When data are sparse, it is difficult to detect important ecological features associated with fish movement, and locations where fish are detected are overrepresented in subsequent analyses. Therefore, a new interpolation method (adaptive kernel density interpolation; AKDI) was developed to characterize the probabilistic amount of time spent by individuals in locations throughout the Snake River. The AKDI method was compared to existing interpolation methods (fixed kernel density, linear interpolation, and raw data) using modeled datasets, and results suggested that this innovative approach more accurately represented the amount of time spent in each location. A manuscript was prepared and submitted to *Ecosphere* in 2012. Using this new method, habitat use was evaluated for spawning cutthroat trout during prespawning, spawning, and postspawning periods.

In 2008 and 2009, radio-tagged cutthroat trout exhibited a diverse array of migration patterns that corresponded with complex life-history strategies and postspawning movement patterns. Distribution patterns of spawners were spatially structured by spawning group throughout the year spawning occurred. Consequently, habitat-use patterns were nonrandom and differed among individuals and among spawning groups. Two distinct patterns of habitat use emerged: occurrence in locations adjacent to spawning areas irrespective of other physical attributes, and occurrence in seasonal locations (nonspawning habitat in unconstrained, braided reaches) during prespawning and postspawning periods. Ultimately, individual variation in spawning patterns, life-history organization, home range, distribution, movement, and habitat-use patterns among cutthroat trout in the Snake River could not have been predicted from patterns observed in smaller or degraded systems. Because life-history variation appears to be positively related to persistence, maintaining the connectivity and physical characteristics that promote this diversity may be a conservation priority.

Total Project Cost		$ 75,270.60
Beginning Balance - July 2010		$ 5,249.63
Additional Funding – 2011		$ 43,176.40
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 26,596.87	
Supplies	$ 8,289.69	
Travel	$ 1,724.24	
Contracted Services	$ 200.00	
Maintenance	$ -0-	
Tuition	$ 5,150.10	
IDCs @ 15%	$ 6,294.13	
Total Spent		$ 48,255.03
Balance		$ 171.00
Waived IDCs		$ 11,539.25

Landscape-scale effects of wildfire on aquatic systems in the Rocky Mountains of Colorado

Investigators
Robert Gresswell
USGS Northern Rocky Mountain Science Center

Graduate Student
Edwin Sedell, M.S.

Project Duration
April 2008 – January 2011
Completed

Collaborators
Jon Ewert
Colorado Department of Wildlife
Chris Kennedy
U.S. Fish and Wildlife Service
Kelly Larkin, Rick Henderson, and Christine Hirsch
U.S. Forest Service

Funding
U.S. Geological Survey, USGS RWO 58, MSU index 4W2056

Native trout populations have declined over the last century because of habitat fragmentation and degradation, and the introduction/invasion of nonnative species. Many native species of salmonids exist in reduced ranges, primarily residing in headwater stream systems. Negative effects of predicted climate change, including increased water temperature, reduced precipitation, and increased risk of wildland fire may further jeopardize persistence of native trout populations. Headwater streams may be especially susceptible to disturbances such as debris flow torrents. Because the probability of debris flow increases in landscapes that have recently burned, identifying susceptible areas before the occurrence of wildfire may provide information necessary to protect remnant headwater populations. Predicting the timing, extent, and severity of wildfires and subsequent precipitation and runoff events is difficult; however, it is possible to identify channels in stream networks that may be prone to debris flows. In this study, we conducted fine-scale spatial analyses of debris flow potential in 11 high-elevation stream networks of the Colorado Rocky Mountains. We identified at-risk channels using models based on characteristic storm and burn scenarios, and data from geographic information systems (GIS) describing topographic, soil, and vegetation characteristics, and assessed the potential for catastrophic population disturbance given a variety of wildfire and post-wildfire storm scenarios. Results from GIS models suggest that populations in many of the study watersheds occupy areas with a high probability of experiencing post-wildfire debris flows, but the extent of their distribution and location within the stream network may provide sufficient refuge to prevent watershed-scale extirpation of fishes. These models yield a decision making tool that is intended only to provide qualitative assessment of debris flow potential in stream reaches within a basin context. A design criterion for the reach-scale model was made for simplicity and flexibility; thus, they can be used to develop comprehensive management strategies for restoration, protection, and post-disturbance remediation of headwater stream networks that support remnant populations of native fishes.

Total Project Cost		$ 67,019.00
Beginning Balance - July 2010		$ 11,791.66
Expenditures - July 2010 - April 2011		
Salaries and Benefits	$ 7,644.78	
Supplies	$ 1,016.50	
Communications	$ -0-	
Travel	$ -0-	
Rent	$ -0-	
Maintenance	$ -0-	
Tuition	$ 1,450.80	
IDCs @ 15%	$ 1,516.80	
Total Spent		$ 11,628.88
Balance		$ 162.78
Waived IDCs		$ 2,780.82

Effects of climate change on the distribution of Yellowstone Cutthroat Trout

Investigators
Bradley Shepard, Wildlife Conservation Society
Robert Al-Chokhachy, USGS Northern Rocky Mountain Science Center

Project Duration
March 2011 – December 2011
Completed

Funding
U.S. Geological Survey, USGS
RWO 65, MSU Index 4W3479

The Montana Cooperative Fishery Research Unit worked collaboratively with the USGS Northern Rockies Science Center (Drs. Robert Al-Chokhachy and Robert Gresswell) and Oregon State University's College of Oceanic and Atmospheric Sciences (Dr. Steve Hostetler and Jay Alder) to evaluate how disturbance, climate change, and non-native trout influence the current and potential future distribution of Yellowstone cutthroat trout (YCT) throughout their historical range. We used data on YCT distributions compiled during a range-wide assessment of the status of YCT conducted by the Multi-state Interagency Yellowstone Cutthroat Trout Conservation Working Group, predictions of past and future stream water temperatures and flows provided by the USGS (Steve Hostetler and his team), existing geographical information system layers, and laboratory study results relating water temperature to potential fish growth by species to conduct these analyses.

Inverse distance weighting was used to predict air temperatures across the range of YCT based on long-term air-temperature monitoring stations located throughout the area. Linear regression reasonably predicted water temperatures from air temperatures as most R^2-values were greater than 0.8. Decadal analyses of air and water temperatures across the historical range of YCT indicated that temperatures have increased significantly during the last few decades, with the most recent decadal temperatures exceeding those of the period of the Great Dust Bowl during the 1930s. Over the past century, stream temperatures warmed more than 1 °C over much of the study area. Predictions of the future using various climate change models all indicate that both air and water temperatures will continue to increase with some climate models indicating faster rates of temperature increases.

Hierarchical regression indicated that the current distribution of YCT was more influenced by the presence of non-native species and habitat conditions than climate. For extant YCT populations, anticipated changes in climate will have variable effects, with minimal (-10% to +10%) or positive (> 10%) changes in total growth potential predicted across much of the current range of YCT (92% of sites). The anticipated increases in air temperatures during the next 50 years are likely to lead to longer growing seasons across the range of YCT, a pattern similar to that observed for vegetation over recent decades in North America. In some locations, the increased duration of the growth season will be off-set by high mid-summer water temperatures that reduce growth resulting in a bi-modal growth pattern, but in other locations annual growth will increase in a unimodal growth pattern. Unfortunately, future changes in temperatures are likely to translate to increasingly inhospitable conditions for YCT at lower elevation sites, where primary productivity is often higher. It appears that portions of stream networks at higher elevations that are currently unoccupied by YCT due primarily to cold temperatures that limit the growing season (17% of currently unoccupied sites) may represent areas for potential range expansion.

Our predictions suggest that where non-native brook and rainbow trout are sympatric with YCT, future thermal regimes are likely to be equally or more favorable for these non-native species. Higher growth rates for these non-native species caused by warming stream temperatures and the strong relationship between growth and fecundity for salmonids suggests global climate changes may indirectly result in increasing trends in abundance and propagule pressure of these non-natives, which could lead to further colonization by these species within the range of YCT.

Total Project Cost		$ 15,000.00
Beginning Balance – March 2011		$ 15,000.00
Expenditures – March 2011 - December 2011		
Salaries and Benefits	$ 11,555.80	
Contracted Services	$ 27.00	
Travel	$ 847.70	
IDCs @ 15%	$ 1,864.50	
Total Spent		$ 14,295.00
Balance		$ 705.00
Waived IDCs		$ 3,418.39

Phytoremediation and revegetation of highly salinized, emerging shorelines of Hailstone Basin National Wildlife Refuge consequent to reservoir dewatering by upslope water spreading and evaporation

Investigators
James W. Bauder, Professor
MSU Land Resources and Environmental Sciences

Collaborators
Robert Dunn, Laura Smith
Westscape Native Plants Nursery

Graduate Student
Russell Smith, M.S.

Funding
U.S. Fish and Wildlife Service
USGS RWO 62
MSU index 4W2934

Project Duration
December 2009 – January 2013

Hailstone National Wildlife Refuge, located about 3.5 miles northeast of Rapelje, MT, is part of the Big Lake Complex, a large drainage area beginning with Hailstone Basin to the north and ending at the state-owned and managed Big Lake to the south. This complex is one of the most productive breeding grounds for migratory birds and waterfowl in central Montana. The refuge has also served in the past as a principal stop-over flight for migratory birds of the Intermountain and Central Flyways. A large alkaline lake, the Hailstone Refuge is in wide-open short grass prairie country dominated by rocky outcroppings and small grassy hills. Anthropogenic factors, which include (1) restricted flows out of the Basin due to construction of an impoundment at the southern end of the Basin, and (2) discharges of saline water via ephemeral tributary channels into the basin as a consequence of long-term crop-fallow dryland cereal grain production on the northern fringe of the Basin, collectively contributed to progressively increasing salinity and selenium levels within surface waters impounded within the Basin. Water quality deteriorated to the point of recorded waterfowl mortality and reproduction failures. The U.S. Fish and Wildlife Service dewatered the Basin in 2010-2011, thereby reducing the open-water salinity and selenium hazards to migratory birds. In concert with this effort, this project has 1) completed a detailed characterization of plant communities existing and adaptable to the emerging lakebed conditions, 2) developed detailed quantification of abiotic factors either limiting or capable of allowing establishment of sustainable plant communities in saline-sodic environments, 3) identified bioremediation practices and proactive management strategies that will facilitate sustainable plant communities that will both stabilize salt-rich land surfaces subject to wind scouring and sequester/volatilize soil-borne selenium, and 4) established large-scale field demonstrations and trials that will serve as prototype settings and long-term monitoring locations. The long-term goal of the project is to establish expansive areas of sustainable, salt-tolerant plant communities across the recently exposed lake-bottom sediments. Tasks completed during this reporting period included 1) summary of plant community data and abiotic environmental characteristics within the emerging lake sediments, 2) construction and field trial performance evaluation of self-contained selenium volatilization trapping chambers, 3) seed collection and isolation of selected species geneotypes of salt-tolerant plant species found growing in Hailstone Basin, 4) assessment of 2010 planting trials, and 5) completion planting of large-scale demonstration plots incorporating diverse species selections, mechanical surface manipulations, and multiple planting techniques.

Total Project Cost		$322,927.79
Beginning Balance – July 2010		$ 54,110.43
Additional Funding – 2011		$214,436.79
Expenditures – July 2010 - December 2011		
Salaries and Benefits	$ 49,869.88	
Contracted Services	$ 56,735.54	
Supplies	$ 2,345.78	
Communications	$ 652.72	
Travel	$ 2,401.14	
Training	$ -0-	
Tuition	$ 4,352.40	
IDCs @ 15%	$ 16,070.88	
Total Spent		$132,428.34
Balance		$136,118.88
Waived IDCs		$ 31,998.30

Thermal adaptation of westslope cutthroat trout

Investigators
Molly Webb
U.S. Fish and Wildlife Service
Bozeman Fish Technology Center
Alexander Zale
Unit Leader, MTCFRU

Collaborators
Steven Kalinowski and Mark Taper
MSU Department of Ecology
Brad Shepard
Montana Fish, Wildlife and Parks

Graduate Student
Daniel Drinan, M.S.

Funding
National Science Foundation
$670,000 to the MSU Department of Ecology

Project Duration
April 2008 – August 2010
Completed

Understanding local adaptations is a fundamental goal of evolutionary biology and would provide managers information necessary to better protect and conserve species. Salmonids are a particularly useful system for studying local adaptations as they often persist in disparate and isolated environments. In addition, their sensitivity to temperature provides a likely candidate for natural selection to act. We studied thermal adaptation in four wild populations and one hatchery stock of westslope cutthroat trout. Native stream mean summer temperatures ranged from 6.7° to 11.2°C. Embryos were collected from the wild and differences in embryonic development, embryonic survival, and juvenile growth were measured. A significant relationship existed between median embryonic survival and native stream temperatures at warm incubation temperatures (Rank test; $P = 0.04$). The change in embryonic survival across incubation temperatures was consistent for populations from warm streams, but changed drastically for populations from cool streams. This difference suggests that populations from warmer streams may be thermal generalists, and populations from cooler streams may be thermal specialists. Results have both short- and long-term implications. In the short-term, managers should use these data to support the consideration of local adaptations when performing translocation projects. In the long-term, these data suggest that global climate change may be detrimental for westslope cutthroat trout.

Limiting factors, thermal refuges, and connectivity in the Smith River system
(aka Tenderfoot Creek—Bair Ranch Foundation Fisheries Research)

Investigators
Alexander Zale
Unit Leader, MTCFRU

Graduate Student
David Ritter, M.S.

Project Duration
July 2009 – June 2013

Collaborators
George Liknes
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W2688

The Smith River is a popular recreational sportfishery in western Montana, but salmonid abundances there are relatively low and believed to be potentially limited by high summer water temperatures and low discharges resulting from irrigation withdrawals and land-management practices. Smith River tributaries may serve as thermal refuges during summer and also as important spawning and nursery areas. If so, then maintaining connectivity between the mainstem river and its tributaries would be a management priority. Such use would also help identify deficiencies in the mainstem that could potentially be corrected through habitat or water management. Moreover, an understanding of salmonid habitat use and management in a thermally stressed and dewatered system could help identify potential global climate change adaptation management strategies and tactics. Our goal is to identify limiting factors in the Smith River system and evaluate the importance of its tributaries as spawning and nursery areas and thermal refuges. Our focus is on the lower reaches of Tenderfoot Creek, a largely undeveloped major tributary to the Smith River. Five PIT-tag stations have been installed throughout the lower 8.5 miles of Tenderfoot Creek. This PIT-tag detection network has monitored the seasonal movements of about 500 tagged fish. Abundances have been estimated by depletion electrofishing surveys, mark-recapture studies, and snorkeling. Fish abundance was high in areas of low temperature, and mountain whitefish and brook trout exhibited distinct spatial patterns throughout the study reach. Fall spawning surveys resulted in the location of 47 brown trout redds and observation of thousands of mountain whitefish, providing evidence that Tenderfoot Creek serves as an important spawning area. We are currently examining the relationships among fish movement and abundance and stream temperature and discharge, as well as abundances of juvenile fish in Tenderfoot Creek.

Total Project Cost		$145,003.00
Beginning Balance - July 2010		$ 27,696.76
Additional Funding – 2011		$ 45,708.00
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 30,470.15	
Supplies	$ 5,579.92	
Communications	$ 1.77	
Travel	$ 6,552.15	
Rent	$ 154.00	
Repairs Maintenance	$ 74.25	
Tuition	$ 5,704.95	
Total Spent		$ 48,537.19
Balance		$ 24,867.57
Waived IDCs		$ 20,628.31

Feasibility assessment for translocation of imperiled bull trout populations in Glacier National Park

Investigators
Christopher Guy
Assistant Unit Leader, MTCFRU
Clint Muhlfeld
USGS Northern Rocky Mountain Science Center

Graduate Student
Ben Galloway, M.S.

Collaborators
Chris Downs
National Park Service

Funding
U.S. Geological Survey
National Park Service
MSU index 4W3190

Project Duration
May 2010 - December 2012

Native bull trout populations are at risk of extirpation in several lakes in Glacier National Park because of the invasion and establishment of non-native lake trout. This project was designed to assess the feasibility of conserving specific genetic lineages of bull trout through translocation. We evaluated spawning, rearing, foraging, and overwintering habitats and aquatic biota in four isolated headwater lakes (Camas Lake, Lake Evangeline, Grace Lake, and Lake Ellen Wilson) and three streams (Camas, Logging, and Lincoln). Camas Creek is mostly composed of pool (38%) and glide (28%) habitats with gravel substrate (38%). Logging Creek is mostly composed of riffle habitat (65%) with mainly large gravel (30%) and cobble substrates (32%). Both systems contain non-native Yellowstone cutthroat trout. Lincoln Creek is composed mostly of pool (36%) and riffle (38%) habitats with less large gravel (11%) and small gravel (14%) substrates than Camas and Logging creeks; furthermore, non-native brook trout are present in the system. Future work will assess thermal characteristics of lake and stream environments, assess plankton and invertebrate assemblages, and compare the genetic composition and demographic status of potential donor stocks. The combined results will be used to prioritize and plan the potential translocation strategy for bull trout within drainages in Glacier National Park. Furthermore, this project will provide a broader understanding of the feasibility of applying this approach elsewhere.

Total Project Cost		$ 69,158.00
Beginning Balance – July 2010		$ 25,967.80
Additional Funding – 2011		$ 31,963.00
Expenditures – July 2010 - December 2011		
Salaries and Benefits	$ 29,844.10	
Communication	$ 79.77	
Travel	$ 1,852.34	
Supplies	$ 113.11	
Tuition	$ 2,732.10	
IDCs @ 15%	$ 5,193.20	
Total Spent		$ 39,814.62
Balance		$ 18,116.18
Waived IDCs		$ 9,520.89

Suppression of lake trout in Quartz Lake, Glacier National Park

Investigators
Christopher Guy
Assistant Unit Leader, MTCFRU
Clint Muhlfeld
USGS Northern Rocky Mountain Science Center

Graduate Student
Carter Fredenberg, M.S.

Collaborators
Chris Downs
National Park Service

Funding
through USGS Northern Rocky Mountain Science Center

Until the discovery of nonnative lake trout in 2005, Quartz Lake was considered to be among the largest natural bull trout lakes in the Columbia River Basin that contained an intact native fish assemblage. Quartz Lake currently hosts the most viable and un-impacted bull trout population remaining among the larger lakes in Glacier National Park and thus provides a model of a fully functioning native aquatic ecosystem. The concern is that invading lake trout will probably overwhelm and replace bull trout within 10-20 years in this system, as they have done in several other lakes in Glacier National Park. Delay of measures that abate this expanding population will undoubtedly result in the proliferation of invasive lake trout, making it impossible to control them in the future. It is expected that if lake trout successfully reproduce in Quartz Lake, then the entire Quartz Lake chain will be severely and perhaps permanently compromised for native fish and wildlife, including osprey, otters, eagles, loons, and bears. Therefore, failure to immediately implement research-based conservation measures to protect existing bull trout populations from this imminent threat will result in further declines and probable extirpation of one of the last intact bull trout populations in Glacier National Park. This multi-year project will assess demographics of the expanding lake trout population and use this information to inform and implement experimental removal and control alternatives to reduce or eliminate competitive interactions in the Quartz Lake system.

Lake trout suppression in Yellowstone Lake: developing benchmarks for harvest and a sampling design to measure efficacy

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Graduate Student
John Syslo, Ph.D.

Project Duration
February 2010 - December 2012

Collaborators
Todd Koel and Patricia Bigelow
National Park Service

Funding
U.S. Geological Survey
National Park Service
MSU index 4W2997

Introduced lake trout threaten to extirpate native Yellowstone cutthroat trout, a keystone species in the Yellowstone Lake ecosystem of Yellowstone National Park. A National Park Service (NPS) lake trout suppression program has been on-going since 1994; however, the effort has not resulted in a lake trout population decline. Consequently, recovery of the cutthroat trout is lacking. In August 2008, a panel of 15 independent scientists convened and evaluated the program. It was determined that because of the lack of an adequate monitoring design, existing data and analyses are insufficient for guiding the program. A top recommendation was that NPS address this issue and ultimately determine the level of harvest required to reduce lake trout abundance and set quantifiable benchmarks for the number of lake trout to be removed annually. The proposed project will result in the development of a sampling design suitable for evaluating the effectiveness of the suppression program. A rigorous sampling design that takes spatial and temporal stratification, as well as statistical power, into account will be developed to assess the lake trout fishery in future years. In addition, the project will expand on existing analyses by USGS and University partners to develop matrix models that will predict the level of harvest needed to cause a decline in the lake trout population (i.e., establish benchmarks for success). The project will result in the ability of NPS to determine whether removal benchmarks were met and to assess if the suppression program is causing a decline in the lake trout population. The matrix model program will allow NPS to assess the lake trout population in future years, given population characteristics obtained with the newly developed sampling design.

Total Project Cost		$102,770.00
Beginning Balance – July 2010		$ 25,414.33
Additional Funding – 2011		$ 33,100.00
Expenditures – July 2010 - December 2011		
Salaries and Benefits	$ 26,156.85	
Contracted Services	$ 38.23	
Supplies	$ 847.09	
Travel	$ 2,039.03	
Communication	$ 8.80	
Tuition	$ 2,212.35	
IDCs @ 15%	$ 4,695.28	
Total Spent		$ 35,997.63
Balance		$ 22,516.70
Waived IDCs		$ 8,608.15

Use of seismic air guns to reduce survival of lake trout eggs and embryos: a pilot study

Investigators

Michael Quist
Assistant Unit Leader, Idaho Cooperative Fish and Wildlife Research Unit
Andy Dux, Idaho Fish and Game
Ben Cox, University of Idaho
Christopher Guy, Assistant Unit Leader, MTCFRU

Project Duration

March 2010 - March 2011
Completed

Funding

Idaho Fish and Game to the Idaho Cooperative Fish and Wildlife Research Unit

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The detrimental effects of nonnative lake trout in the western USA have prompted natural resource management agencies in several states to implement lake trout suppression programs. These programs rely on mechanical removal methods (i.e., gill nets, trap nets, and angling) to capture sub-adult and adult lake trout. We conducted a study to explore the potential for using high-intensity sound from a relatively small (655.5 cm^3, 40 in^3) seismic air gun to reduce survival in lake trout embryos. Lake trout embryos at multiple stages of development were exposed to a single discharge of the seismic air gun at two depths (5 m and 15 m) and two distances from the air gun (0.1 m and 2.7 m). Control groups for each developmental stage, distance, and depth were treated identically, except that the air gun was not discharged. Mortality in lake trout embryos treated at 0.1 m from the air gun was 100% at 74 daily temperature units in degrees Celsius (TU°C) at both depths. Median mortality in lake trout embryos treated at 0.1 m from the air gun at 207 (93%), and 267 (78%) TU°C appeared higher than controls (49%, 48% respectively) at the 15 m depth. Mortality at the 2.7 m distance did not appear to differ from controls at any developmental stage or either depth. These data indicate seismic air guns have potential as an alternative tool for controlling nonnative lake trout and further investigation is warranted.

Use of mobile electrofishing to induce mortality in lake trout embryos

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Collaborators
Leo Rosenthal
Joel Tohtz
Montana Fish, Wildlife and Parks

Post Doc Researcher
Peter Brown

Funding
Montana Fish, Wildlife and Parks
MSU index 4W3625

Project Duration
July 2011 – June 2014

An apparent rapid increase in the abundance of nonnative lake trout has occurred in Swan Lake, which is of concern to state, federal, tribal, and private entities because Swan Lake contains one of the most stable bull trout populations in Montana. Consequently, an experimental lake trout suppression program has been initiated on Swan Lake, which targets juvenile and adult lake trout, but targeting lake trout embryos may be a complementary and effective method for suppressing lake trout. Exposure of fish embryos to voltage gradients similar to those produced by electrofishing equipment has been shown to result in mortality. Therefore, the efficacy of using benthic-oriented, mobile electrofishing techniques to induce mortality in lake trout embryos was evaluated *in situ* in Swan Lake. Two trials were conducted in which lake trout embryos were placed in enclosures at known locations in Swan Lake and an electrode array was dragged over the enclosures. The electrode array was either energized (650 V non-pulsed DC; treatments) or not energized (procedural controls). Mortality varied from 0 to 5% for procedural controls and from 0 to 100% for treatments (among enclosures for both trials combined). These data indicate that application of a lethal voltage gradient to lake trout embryos on the benthic substrate of Swan Lake is possible using slightly modified, boat mounted electrofishing equipment. However, variability in mortality for treatment enclosures was high, and it is suggested that this variability is a result of 1) uncertainty in the ability to target the relatively small enclosures from a boat and 2) variability in the voltage gradient surrounding the electrode. Future studies should reduce uncertainty in experimental applications by using techniques that reduce or remove the possibility for missed enclosures, and should evaluate biological and environmental factors that may influence the efficacy of this technique for large-scale applications. Additionally, electrode array designs that incorporate more flexible drop electrodes should be considered for future use. Electrode array design limitations may be partially overcome by use of more power (i.e., greater generator wattage).

Total Project Cost		$ 96,300.00
Beginning Balance – July 2011		$ 96,300.00
Expenditures – July 2011 - December 2011		
Salaries and Benefits	$ 25,353.33	
Contracted Services	$ 4,019.00	
Supplies	$ 6,072.32	
Travel	$ 2,704.65	
Rent	$ 525.00	
Repair and Maintenance	$ 814.99	
Equipment	$ 6,710.00	
IDCs @ 0%	$ -0-	
Total Spent		$ 46,199.29
Balance		$ 50,100.71
Waived IDCs		$ 19,635.70

Cost-effectiveness of gill netting for suppressing non-native lake trout in Swan Lake, Montana

Investigators
Christopher Guy
Assistant Unit Leader, MTCFRU
John Syslo, Ph.D. student, MTCFRU
Ben Cox, Oregon Department of Fish and Wildlife

Funding
MTCFRU

Project Duration
January 2011 – December 2012

The mechanical removal of nonnative lake trout has become a common management endeavor for large lakes in the Intermountain West. Eradication is not a likely outcome given current technology; therefore, management goals may best be quantified as the greatest reduction in lake trout abundance possible for a given time frame and cost. An experimental lake trout removal program occurred in Swan Lake, Montana, from 2008 through 2011. We used data from this removal to develop a density-dependent population model to assess the efficacy of 41 management scenarios. Each scenario was a temporal combination of netting actions, where one of four actions could occur in a given year (i.e., no netting, targeting subadults, targeting spawning adults, or targeting subadults and spawning adults). For each scenario, we assessed the percent reduction in abundance relative to an unharvested population after 5, 10, 20, 30, 40, and 175 years as a function of cost. Reductions in abundance generally increased as a function of annual cost; however, substantial variation existed in the reduction that can be achieved for a given cost. For example, the most expensive scenario (harvesting subadults and spawning adults every year) resulted in the greatest decline in abundance after 10 years (reduction of 0.986; 0.968-0.995 95% CI). However, other scenarios (e.g., alternating harvest of both subadults and spawning adults with harvest of spawning adults only) produced similar results with a 35% reduction in cost. Natural resource managers have several options for the long-term suppression of lake trout in Swan Lake depending on goals and funding.

Movements and spawning locations of shovelnose sturgeon and pallid sturgeon in the Missouri River above Ft. Peck Reservoir

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Graduate Student
Ryan Richards, M.S.

Project Duration
December 2005 – September 2010
Completed

Collaborators
Sue Camp
Bureau of Reclamation
William Gardner
Montana Fish, Wildlife and Parks

Funding
Bureau of Reclamation, MSU index 4W0965

Some *Scaphirhynchus* spp. populations are endangered, in decline, or extirpated. Operation of dams and reservoirs on the Missouri River has been implicated in declines in *Scaphirhynchus* spp. abundance. It is hypothesized that discharge from dams upstream of *Scaphirhynchus* spp. populations is insufficient to provide the environmental cue initiating spawning migrations. The goal of this project was to investigate the effects of variations in spring discharge on movements of *Scaphirhynchus* spp. in the Missouri River above Fort Peck Reservoir. A secondary goal was to provide information on the distribution of *Scaphirhynchus* spp. locations relative to larval drift distance. Twenty-four hatchery-reared juvenile pallid sturgeon, seven adult pallid sturgeon, and 192 shovelnose sturgeon were tracked from 2006 through 2009 and movements were compared among years with hydrologic conditions from above to below average discharge. Seventy-eight shovelnose sturgeon in five reproductive categories (i.e., males, confirmed spawning females, potentially spawning females, atretic females, and reproductively inactive females) were tracked in 2008 and 2009. Movements were compared among all reproductive categories within years and between years for confirmed spawning females while integrating the environmental effects of discharge and water temperature. The majority of pallid sturgeon locations in all years was within 75 km of the headwaters of Fort Peck Reservoir. Shovelnose sturgeon locations were distributed across the entire study reach, and were 100 km further upstream than pallid sturgeon locations. Based on current estimates, an insufficient length of river exists upstream of the Fort Peck Reservoir headwaters for pallid sturgeon larval drift. Movement rates of *Scaphirhynchus* spp. did not differ among years 2006-2009, and movements did not differ between years for confirmed spawning female shovelnose sturgeon 2008-2009, indicating that discharge did not influence movements. At the conditions in this study, movement rates of confirmed spawning female shovelnose sturgeon were highest at water temperatures suitable for spawning regardless of discharge, providing support for the hypothesis that water temperature rather than discharge is a more likely proximate cue initiating spawning migrations in *Scaphirhynchus* spp.

Total Project Cost		$263,314.00
Beginning Balance - July 2010		$ 22,310.23
Additional Funding – 2011		$ 35,950.00
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 34,937.71	
Rent	$ -0-	
Maintenance	$ -0-	
Contracted Services	$ 90.00	
Travel	$ 1,504.25	
Supplies	$ 11,548.63	
Communication	$ 51.73	
Tuition	$ 1,450.80	
IDCs @ 17.5%	$ 8,677.11	
Total Spent		$ 58,260.23
Balance		$ -0-
Waived IDCs		$ 12,395.78

Effects of the reservoir headwater environment on survival and behavior of larval sturgeon: are reservoirs an ecological sink for recruitment of sturgeon?

Investigators
Christopher Guy
Assistant Unit Leader, MTCFRU
Molly Webb and Kevin Kappenman
U.S. Fish and Wildlife Service
Bozeman Fish Technology Center

Collaborator
William Gardner, Anne Tews
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks,
MSU index 4W1928

Research Associate
Hilary Billman

Project Duration
January 2008 – December 2012

Natural recruitment of shovelnose sturgeon has been documented in the upper Missouri River; however, pallid sturgeon are not recruiting to the wild adult population. The reservoir headwater environment is hypothesized to be the mechanism of this recruitment failure, and understanding how specific abiotic components of the headwater environment contribute to larval pallid sturgeon mortality is important to the recovery goal of the species. Based on habitat data collected from the Fort Peck Reservoir headwater in 2008 and 2009, we selected three environmental factors (i.e., sedimentation rate, dissolved oxygen concentration, and substrate type) and designed controlled laboratory experiments to determine their individual effects on the development, behavior, and survival of immediate post-hatch (IPH) and 40-days post hatch (DPH) pallid sturgeon (PS) and shovelnose sturgeon (SNS). Treatment levels were selected based on empirical field conditions in the upper Missouri River and Fort Peck Reservoir headwater environment. Sedimentation rates were from turbidity data collected in 2008 and 30 years of USGS data collected above Fort Peck Reservoir; treatment levels were 0.00 g/cm^2 (control), 0.39 g/cm^2 (medium), and 0.77 g/cm^2 (high), which maintained turbidity at 0.00 mg/L (control), 482.75 mg/L (medium), and 984.6 mg/L (high), respectively. Dissolved oxygen concentrations were 7.5 mg/L (control), 2.5 mg/L, and 1.5 mg/L, and were established from empirical data collected in 2008. Substrate treatment levels were as follows: no substrate (control), sand, gravel, Fuller's Earth, and Missouri River "muck." Muck was collected from the Fort Peck Reservoir headwater in May of 2011.

While we completed trials with the sedimentation rate system, problems with system design (sedimentation rate) arose that most likely confounded, to some degree, the mortality data associated with this system. We are currently assessing and redesigning this experiment in order to obtain more reliable information in 2012. Dissolved oxygen experiments provided important information on the minimum oxygen requirements for survival and growth of shovelnose sturgeon and pallid sturgeon larvae at two ages. Natural behavior of larvae was suppressed at the 1.5 mg/L and 2.5 mg/L treatments for each species at both age groups. There was a significant treatment effect on larval mortality in the 1.5 mg/L treatment among species and ages ($P < 0.01$), but there was no effect of treatment at 2.5 mg/L. These findings provide important information on how dissolved oxygen conditions in a reservoir headwater environment affect paddlefish, shovelnose sturgeon, and pallid sturgeon larvae. We can apply these results to the Fort Peck Reservoir headwater to better inform pallid sturgeon conservation. In the substrate experiments, mortality of IPH larvae varied by substrate type. Given the high variability in the substrate experiments we will be repeating this study in 2012.

Total Project Cost		$249,667.00
Beginning Balance - July 2010		$ 48,615.80
Additional Funding – 2011		$103,554.00
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 29,262.49	
Contracted Services	$ 27,826.06	
Supplies	$ 2,996.03	
Communications	$ 391.65	
Travel	$ 1,240.22	
Rent	$ 50.00	
Maintenance	$ -0-	
Awards	$ 1,704.65	
IDCs @ 0%	$ -0-	
Total Spent		$ 63,471.10
Balance		$ 88,698.70
Waived IDCs		$ 26,975.22

Spawning of Pallid Sturgeon and Shovelnose Sturgeon in an Artificial Stream

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU
Kevin Kappenman, Molly Webb
U.S. Fish and Wildlife Service

Collaborator
Greg Watson
U.S. Fish and Wildlife Service

Project Duration
May 2011 – March 2013

Funding
U.S. Fish and Wildlife Service SSP
USGS RWO 66
MSU index 4W3528

Understanding the spawning behavior and spawning habitat requirements of shovelnose sturgeon and pallid sturgeon affected by regulated rivers is necessary to better manage shovelnose sturgeon and recover endangered pallid sturgeon. For the first time, research biologists were able to observe and characterize shovelnose sturgeon spawning behavior. Shovelnose sturgeon were observed volitionally selecting mates and spawning habitat in the constraints of a semi-natural environment (e.g., artificial river) created at the Bozeman Fish Technology Center. We performed concurrent trials with both hormone treated shovelnose sturgeon and shovelnose sturgeon that received no hormone treatment under defined temperature, flow, and substrate conditions in the artificial river. We used luteinizing hormone releasing hormone (LHRHa) to initiate the hormonal cascade that led to spawning in shovelnose sturgeon in two test groups. In both trials, males and females that were treated with LHRHa responded to the hormone and selected multiple mates during spawning events that varied from 8 to 18 h (e.g., 8-18 h female spawning duration; defined as the shortest and longest periods from first oviposit to final oviposit for an individual female). In both trials, a single non-treated (no hormone) male participated in multiple spawning bouts with females treated with LHRHa. In addition to determining the spawning duration for female shovelnose sturgeon, we determined the duration of an individual spawning bout (a single male/female pairing; generally < 5 sec), observed many behaviors previously undocumented including polyandrous and polygynous mating, and ingestion of freshly spawned eggs by male and female shovelnose sturgeon.

Developing the conditions that provide the necessary environmental cues and habitat in which a female shovelnose sturgeon will ovulate without exogenous hormonal stimulation remains a critical unknown factor. Though we attempted to address this question in year one of the study, we were unable to provide conditions leading to an untreated female spawning in the artificial river. Research in 2012 will consist of similar laboratory investigations and focus on developing techniques that provide conditions that promote spawning without the use of hormone.

Total Project Cost		$107,840.00
Beginning Balance – May 2011		$ 43,645.00
Additional Funding – 2011		$ 29,812.00
Expenditures – May 2011 - December 2011		
Salaries and Benefits	$ 9,128.52	
Supplies	$ 6,795.60	
Travel	$ 289.30	
IDCs @ 15%	$ 2,432.00	
Total Spent		$ 18,645.42
Balance		$ 54,811.58
Waived IDCs		$ 4,458.69

White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam

Investigators
Molly Webb and Kevin Kappenman
U.S. Fish and Wildlife Service
Bozeman Fish Technology Center
Christopher Guy
Assistant Unit Leader, MTCFRU

Project Duration
October 2006 – September 2012

Collaborators
Washington Department of Fish and Wildlife

Funding
Oregon Department of Fish and Wildife, MSU indexes 4W1587, 4W1960, 4W2412, 4W2965 4W3495

During 1 April 2010 through 31 March 2011, Montana State University and U.S. Fish and Wildlife Service researchers collected gonadal biopsies from adult white sturgeon below Bonneville Dam with Washington Department of Fish and Wildlife. The objective of this research is to describe the maturation cycle in wild white sturgeon. All of the white sturgeon were caught by set-line in 2010. Gonadal tissue was collected by biopsy, and the gonad samples were processed histologically. A total of 748 adult white sturgeon have been marked with spaghetti tags, scute marks, and PIT tags below Bonneville Dam since 2000 (183 in 2000, 90 in 2001, 67 in 2002, 101 in 2003, 57 in 2004, 37 in 2005, 67 in 2006, 58 in 2007, 32 in 2008, 35 in 2009, and 21 in 2010). In 2010, a total of 98 fish were handled, 52 of which were tagged in previous years, 21 of which were "new" fish to the study, and 25 of which were handled twice or more in the season (i.e., within season recapture). A total of 73 gonad samples were collected for histological analysis from white sturgeon below Bonneville Dam. Of the 73 gonad samples, 43 were collected from females and 29 were collected from males. One of the gonad samples did not contain germ cells (i.e., sex could not be confirmed histologically). The one fish with a gonad sample without germ cells was identified as male with small testicular lobes in the field macroscopically. The reproductive structure of the adult white sturgeon population below Bonneville Dam was determined using the 2000-2010 data. Of the females (n=526), 63% were pre-vitellogenic (Stages 1 and 2), 24% were vitellogenic (Stages 3 and 4), 3% were post-vitellogenic or ripe (Stage 5), 7% were postovulatory (Stage 7), and 3% were undergoing follicular atresia (Stage 8). Of the males (n=283), 68% were pre-meiotic (Stage 2), 13% were mid-spermatogenic (Stage 3 and 4), 13% were spermiating (Stage 5), and 6% were post-spermiation (Stage 6). Using the shortest maturation cycle assigned, a 2-year or longer maturation cycle was possible in 16% of the females, a 3-year or longer cycle was possible in 47% of the females, and a 4-year or longer cycle was possible in 20% of the females. A 1-year or longer maturation cycle was possible in 9% of the males, 2-year or longer cycle was possible in 68% of the males, and 18% of the males displayed the potential for a 3-year or longer cycle. Over the decade, it has become apparent that we can assume that a fish identified in the field as a male is most likely a true male. Given this assumption, the sex ratio of the adult white sturgeon population below Bonneville Dam using the 2005-2010 data was 1:1.6 males to females.

Total Project Cost		$ 64,542.00
Beginning Balance - July 2010		$ 5,491.57
Additional Funding – 2011		$ 22,319.00
Expenditures - July 2010 - December 2011		
Rent	$ 3,822.54	
Communication	$ 52.92	
Contracted Services	$ -0-	
Travel	$ 7,240.00	
Supplies	$ 438.54	
IDCs @ 42.5%	$ 4,910.14	
Total Spent		$ 16,464.14
Back to Sponsor (closed 4W2965)		$ 62.10
Balance		$ 11,284.33
Waived IDCs		$ -0-

Determining morphological and immunochemical parameters associated with ovarian follicular atresia and caviar quality and yield in white sturgeon

Investigators
Christopher Guy
Assistant Unit Leader, MTCFRU
Molly Webb
U.S. Fish and Wildlife Service
Serge I. Doroshov
University of California, Davis

Funding
Western Regional Aquaculture Center, MSU index 4W1714 4W2504, 4W3084, 4W3456

Project Duration
August 2007 – August 2012

Research Associate
Mariah Talbott

Currently, the only means to assess ripeness of white sturgeon females and properly time caviar harvest is measurement of the oocyte polarization index (PI), which requires surgical biopsy. This technique is accurate but invasive and stressful to fish, time consuming, and not an effective tool for handling a large number of female fish. The large caviar farms that harvest thousands of females cannot determine oocyte PI for every fish resulting in decreased caviar yield and quality due to follicular atresia (phagocytosis of ovarian eggs). Even the early stage of atresia causes a reduction in the firmness, flavor, and shelf life of caviar, and sometimes the complete loss of the product. The long-term goal of this study was to optimize the yield and quality of sturgeon caviar by developing less invasive, faster, and better predictors of maturity than oocyte PI. In this project, we examined the ability of non-invasive short wavelength near infrared spectroscopy (SW-NIR), Fourier transform infrared spectroscopy (FT-IR), and immunochemical assays to identify early atresia in females and replace the surgical biopsy procedure currently used to determine ripeness in sturgeon. The radioimmunoassay of plasma steroids, spectral analysis of plasma by FT-IR, and abdominal and follicular scans by SW-NIR were suitable for detecting early atresia with 55-93% accuracy depending on the tool, and the FT-IR was determined to be the most accurate in determining maturational stage (oocyte PI) and may be used in lieu of the surgical biopsy technique (90% accuracy). The analysis of caviar harvest found that the stage of maturity manifested by the oocyte PI does not necessarily correlate with higher caviar yields. However, using oocyte PI even though weakly correlated to caviar yield to determine the time to harvest fish did result in a 2% increase in yield in both California and Idaho, a significant gain. Adiposity of the sturgeon ovary appeared to be a major factor that negatively affected caviar yield, particularly in larger, faster growing fish. It should be noted that this analysis does not invalidate the importance of detecting maturity stage by non-invasive methods. Using the same percent of salt throughout the processing season has resulted in some egg batches becoming too salty or not salty enough. The variable saltiness is hypothesized to be associated with variation in egg maturity (PI) among females. If females could be harvested at more homogenous PIs then the standardized percent of salt used would result in less variation in quality of the caviar in terms of saltiness.

Total Project Cost		$129,571.00
Beginning Balance - July 2010		$ 28,009.64
Additional Funding – 2011		$ 34,148.00
Expenditures – July 2010 - December 2011		
Salaries and Benefits	$ 54,600.75	
Communication	$ -0-	
Contracted Services	$ 97.00	
Supplies	$ 2,060.11	
Travel	$ 3,140.40	
IDCs @ 0%	$ -0-	
Total Spent		$ 59,898.26
Back to Sponsor (4W3084)		$ 46.01
Balance		$ 2,213.37
Waived IDCs		$ 25,456.76

Exploitation, Abundance and Large-Scale Movements of Burbot in the Upper Wind River Drainage

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Graduate Student
Sean Lewandoski

Project Duration
July 2011 – June 2015

Collaborators
David Zafft
Paul Gerrity
Wyoming Game and Fish Department

Funding
Wyoming Game and Fish Department
MSU index 4W3554

Management of burbot stocks is poorly understood given the lack of biological information for the species. However, burbot are beginning to receive more attention from natural resource agencies because of information regarding their population declines, particularly at the southern extent of their range. In Wyoming, much of the work conducted on burbot has been in the Wind/Bighorn River drainage. Interestingly, burbot in the Wind/Bighorn River drainage represent the most southwest portion of the species natural range. Burbot are an important sportfish in the Wind/Bighorn River drainage, are a native species of special concern (classified as an NSS3), and an important cultural resource to the Eastern Shoshone and Northern Arapahoe tribes.

Understanding the mechanisms that influence burbot in the Wind/Bighorn River drainage will assist in making sound management decisions to maintain sustainable populations. Much of the research conducted on burbot in the Wind/Bighorn River drainage has suggested that the cumulative effects of high exploitation and entrainment probably have the largest effect on burbot populations in the drainage. However, the exact mechanism for the decline in burbot is not well understood. Thus, this project is designed to evaluate the extent of exploitation within the upper Wind River drainage. The specific objective is to estimate exploitation, abundance, population growth rate, and develop deterministic population models to guide management of burbot populations in the upper Wind River drainage.

Total Project Cost		$154,899.00
Beginning Balance – June 2011		$ 68,740.00
Expenditures – June 2011 - December 2011		
Salaries and Benefits	$ 12,345.76	
Contracted Services	$ 534.50	
Supplies	$ 7,365.65	
Communication	$ 9.90	
Travel	$ 5,570.47	
Rent	$ 2,550.00	
Repair and Maintenance	$ 23.30	
Tuition	$ 1,523.10	
IDCs @ 15%	$ 5,984.55	
Total Spent		$ 34,907.23
Balance		$ 32,832.77
Waived IDCs		$ 7,953.74

Distribution, habitats, and tributary linkages of small and non-game fishes in the lower Yellowstone River

Investigators
Robert Bramblett
Assistant Research Professor
Alexander Zale
Unit Leader, MTCFRU

Collaborator
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Tyler Haddix
Montana Fish, Wildlife and Parks
Ryan Wilson
U.S. Fish Wildlife Service

Graduate Student
Michael Duncan, Ph.D.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W1855

Project Duration
October 2007 – June 2012

The Yellowstone River is the longest undammed river in the contiguous United States. Biologists have concentrated most of their efforts on the game and larger nongame species within the river, and we still lack a basic understanding of small and nongame fishes in the mainstem Yellowstone River. Two of these species, the sturgeon chub *Macrhybopsis gelida* and sicklefin chub *M. meeki* are species of special concern within Montana and potentially important prey items for the endangered pallid sturgeon.

The objectives of this project are to determine the composition, distribution, abundance, and habitat requirements of native and non-game fishes in the lower Yellowstone River, quantify landscape-level linkages between tributary streams and the lower Yellowstone River, and determine the differences in the lower Yellowstone and Missouri river fish assemblages.

Nearly 100 sites were sampled using mini-fyke nets, seines, and otter trawls. We have captured 46 fish species, totaling over 150,000 individual fish. The catch was dominated by western silvery minnow *Hybognathus argyritis*, emerald shiner *Notropis atherinoides*, sand shiner *N. stramineus*, flathead chub *Platygobio gracilis*, and longnose dace *Rhinichthys cataractae*. The range of sturgeon chub in the Yellowstone River appears to be restricted to reaches below the confluence of the Tongue River whereas the range of the sicklefin chub abruptly ends at the Intake diversion dam.

To quantify linkages between tributary streams and the lower Yellowstone River, we compared $^{87}Sr:^{86}Sr$ otolith profiles from western silvery minnows, flathead chubs, and sand shiners to the water chemistry of the lower Yellowstone River and its tributaries. We found that 69% of fish collected in the Yellowstone River were migrants between the Yellowstone River and its tributaries. All of the fish collected in the Powder River were migrants whereas about 50% of the fish collected in smaller tributaries were residents. Between 10-20% of each species moved between at least two tributaries. These findings indicate that connectivity between large rivers and tributaries is critical to maintain populations of small fish species in both large river and tributary habitats.

The lower Yellowstone and Missouri rivers probably had similar fish assemblages prior to the damming of the Missouri River by the Fort Peck dam. We compared fish assemblages in the Yellowstone River with those in the Missouri River using data collected by Montana Fish, Wildlife & Parks and U.S. Fish and Wildlife Service personnel. We collected 80,937 fish in the Yellowstone River (n = 49 sampling reaches) whereas only 36,244 fish were captured in the Missouri River (n = 93 reaches) from 2008 to 2010. Mean catch per unit effort was greater in the Yellowstone River (224 fish/net night) than in the Missouri River (49 fish/net night). Much of the difference was the result of nets with large numbers of native cyprinids in Yellowstone River samples, which were not common in Missouri River samples. Although twice as many Missouri River reaches were sampled, both native and nonnative species richness were greater in the Yellowstone River. However, nonnative fish made up only 1.1% of the total catch in the Yellowstone River as opposed to 4.4% in the Missouri River. We also observed higher relative abundances of degradation-tolerant and coldwater species in the Missouri River. Our results indicate that naturally-functioning rivers may sustain higher species richness and densities of both native and nonnative fish, whereas altered rivers may sustain lower overall densities of all fish, but higher relative abundances of nonnative fish.

Total Project Cost		$302,926.00
Beginning Balance - July 2010		$123,397.20
Additional Funding – June 2011		$ 6,000.00
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 82,664.43	
Contracted Services	$ 20,885.26	
Supplies	$ 3,746.53	
Communications	$ 330.73	
Travel	$ 4,373.44	
Rent	$ -0-	
Maintenance	$ 3,593.96	
Tuition	$ 4,424.70	
IDCs @ 0%	$ -0-	
Total Spent		$120,019.05
Balance		$ 9,378.15
Waived IDCs		$ 51,008.10

Anthropogenic habitat change effects on fish assemblages of the middle and lower Yellowstone River

Investigators
Robert Bramblett
Assistant Research Professor
Alexander Zale
Unit Leader, MTCFRU

Collaborators
George Jordan
U.S. Fish and Wildlife Service
Matt Jaeger
Montana Fish, Wildlife and Parks
Sean Lawlor, U.S. Geological Survey
Tony Thatcher, DTM Consulting

Graduate Student
Ann Marie Reinhold

Funding
U.S. Army Corps of Engineers
USGS RWO 56, MSU index
4W1987, 4W2650

Project Duration
January 2008 – December 2013

Although the Yellowstone River remains the largest undammed river in the continental United States, it is nonetheless exposed to a number of anthropogenic stressors such as bank stabilization. The purpose of this study is to evaluate the effects of bank stabilization on the river morphology, fish habitats, and fish assemblages within the transition and warmwater fish zones of the Yellowstone River. We are evaluating these effects using three study components.

1. Comparing fish assemblages in river bends that have been modified by bank stabilization structures to fish assemblages in unmodified river bends. Bank stabilization causes changes in the local geomorphology of the river that may translate into changes in fish habitat suitability and changes in the fish assemblage. We are comparing fish assemblages in unmodified river bends to assemblages in stabilized river bends. To account for natural variability, we stratified river bends by longitudinal position, regional and local geomorphology, and pool type. From 2009 to 2012, thirty-two river bends were sampled with boat electrofishing, trammel nets, minifyke nets, and bag seines and eight river bends were sampled with otter trawls. In total, 149,129 fish representing 46 species and 16 families were captured. The most common were cyprinids (116,498), catostomids (28,131), centrarchids (1,497), and ictalurids (1,230). In addition to the fish sampling, an Acoustic Doppler Current Profiler survey was conducted on the thirty-two river bends to inform how fish habitats have changed in response to bank stabilization and to provide a plausible mechanism for potential differences between the fish assemblages in unmodified and stabilized river bends. Sampling for this objective is complete and data analyses are underway.

2. Assessing the importance of secondary seasonal channels and shallow slow-velocity habitats as early summer fish habitat. Bank stabilization causes a local channelization of the river that disconnects the river from its floodplain. One result of this channelization is decreased secondary seasonal channel formation, connectivity, and inundation. We are sampling these habitats and the shallow slow-velocity habitat in the contiguous mainstem at thirty-two river bends using mini fyke nets during both the rising and falling limbs of runoff to assess their importance for fish at this time. We have collected 50,729 fish representing 39 species and 12 families from twenty river bends during runoff 2010 and 2011. We have captured both large and

small fish, piscivores, omnivores, and invertivores, as well as 13 species of spawning fish, indicating that the structure and function of fish assemblages in shallow slow velocity habitats during runoff are complex. Preliminary analysis indicates that fish catch per unit effort is significantly higher in secondary seasonal channels than in the mainstem, indicating that seasonally inundated channels provide important habitat for fish. In 2012, twelve river bends will be sampled during both the rising and falling limbs of runoff.

3. Quantifying habitat use of Yellowstone River fishes and linking this information to anthropogenic changes in habitats. We are analyzing the temporal changes that have occurred in river geomorphology and fish habitat in response to bank stabilization to infer the cumulative effects of channel alteration on Yellowstone River fish assemblages. We mapped fisheries habitat units from aerial photographs taken in the 1950s and 2001 using GIS. We are assessing the structural changes to the fish assemblages of the modified habitats by applying current fisheries data from unmodified habitats that represent conditions prior to channel alteration. These data analyses are currently underway.

Total Project Cost		$ 353,954.94
Beginning Balance - July 2010		$ 107,533.52
Additional Funding – 2011		$ 99,239.94
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 76,766.10	
Contracted Services	$ 18,974.01	
Supplies	$ 16,827.10	
Communications	$ 96.03	
Travel	$ 16,079.89	
Rent	$ 8,975.00	
Maintenance	$ 5,404.11	
Tuition	$ 3,699.30	
IDCs @ 15%	$ 22,023.27	
Total Spent		$ 168,844.81
Balance		$ 37,928.65
Waived IDCs		$ 40,375.92

Habitats and movements of spiny softshells in the Missouri River in Montana

Investigators
Robert Bramblett
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Unit Leader, MTCFRU

Collaborators
Jo Ann Dullum
US Fish and Wildlife Service
Steve Leathe
PPL Montana
Lauri Hanuska-Brown
Montana Fish, Wildlife, and Parks

Graduate Student
Brian Tornabene, M.S.

Project Duration
August 2009 - December 2013

Funding
US Fish and Wildlife Service, PPL Montana, US Bureau of Land Management, Montana Fish, Wildlife, and Parks, Bureau of Reclamation
MSU index 4W2596

Little is known about the populations of spiny softshells *Apalone spinifera hartwegi* in Montana, where they are a state Species of Concern, a Tier 1 Species with greatest conservation need, and a Bureau of Land Management Sensitive Species. The spiny softshell populations upstream of Ft. Peck Dam are isolated from other Montana populations and are therefore at risk of extirpation. Although dam operations affect riverine and riparian habitats, the relationships between hydrograph and use of habitats for nesting, feeding, basking, and overwintering by spiny softshell are not known.

Our overall goal is to document how human activities and natural factors affect spiny softshell habitat use, movements, nesting behavior and site selection, and overwintering locations in a 50-mile reach of the Missouri River from Judith Landing on the Upper Missouri Breaks National Monument downstream to the Fred Robinson Bridge on the Charles M. Russell National Wildlife Refuge. This reach spans a gradient of spiny softshell catch per unit effort ranging from 16.7 turtles per trap night in the upstream part of the reach to 0.3 turtles per trap night near the downstream end.

We captured 57 spiny softshell turtles using hoop nets and fitted them with radio transmitters since August 2009. Additionally, a total of over 25 trips and 1,000 relocations have been made and habitat was characterized at over 450 locations since 2009. Furthermore, habitat was characterized at over 75 basking locations since 2010.

Preliminary data analysis indicated that turtles used main channel habitats during most of the year. However, habitats along the river margins (i.e., creeks, ephemeral side channels, and floodplains) were used more than main channel habitats during the ascending limb and peak of the hydrograph. Accordingly, basking habitats were most often on main channel shorelines or tributary mudflats composed of silt or sand substrates in sparsely vegetated areas. Movement rates and ranges of activity varied widely among individual turtles. Turtle home ranges ranged from 0.8 to 55.6 river miles with an average of 10.5 river miles from 2010-2011. However, most turtles had a home range of about 2 to 4 river-miles and little difference between male and female turtle home ranges was observed.

We observed that turtles aggregated during the overwintering periods from 2009 through 2011. In 2009 and 2010, more than 50% of the relocated turtles were found in aggregations with other turtles. However, in 2011 only 32% of relocated turtles were found in aggregations. Overwintering sites were typically about 2 m deep, with moderate current velocity (i.e., 0.3 to 1.0 m/sec), and about 14 m from shore. Substrate in overwintering sites varied, but sand and silt were often the dominant substrate. This population of turtles used the same locations across years and individual turtles may show fidelity to sites across years.

Aggregation and fidelity to overwintering sites may be related to the ice dynamics and scour in certain reaches of the river, forcing turtles to seek out refuges from moving ice flows. We are investigating this by monitoring overwintering sites suspected to have increased ice activity throughout the winter. The frequency and duration of ice jams at these sites are being monitored with scout cameras programmed to take pictures at daily intervals from November to April 2010 and 2011.

Total Project Cost		$222,207.86
Beginning Balance - July 2010		$ 67,594.23
Additional Funding - January 2011		$ 49,360.86
Expenditures - July 2010 - December 2011		
Salaries and benefits	$ 57,621.98	
Contracted Services	$ 100.00	
Supplies	$ 12,984.24	
Communications	$ 23.79	
Travel	$ 9,143.22	
Rent	$ 4,950.00	
Maintenance	$ 561.88	
Tuition	$ 6,466.50	
IDCs @ 0%	$ -0-	
Total Spent		$ 91,851.61
Balance		$ 25,103.48
Waived IDCs		$ 39,036.93

Predicting effects of climate change on native fishes in northern Great Plains streams

Investigators
Robert Bramblett
Assistant Research Professor
Alexander V. Zale
Unit Leader, MTCFRU
Dave Roberts
MSU Department of Ecology

Collaborator
Robert Gresswell
USGS Northern Rocky Mountain Science Center
Kathy Chase and Rod Caldwell
USGS Montana Water Science Center

Project Duration
September 2011 – September 2012

Funding
U.S. Geological Survey, CESU
MSU index 4W3528

The fish assemblages of Great Plains streams may be perceived as "living on the edge," because water quantity and water quality are often precariously close to ecological tolerance limits. At the same time, prairie streams provide critical "green lines" of habitat, in a sea of semi-arid prairies for both aquatic and terrestrial wildlife. For example, in Montana, prairie streams are a stronghold of native biodiversity that support 25 native fish species, 14 amphibian and reptile species, and more than 130 bird species. It appears, however, that changes in water quantity and quality associated with global climate change may substantially alter these networks of biodiversity. Our goal is to predict the effects of climate change on the hydrology and biota of northern Great Plains streams. We propose to link predicted changes in precipitation and air temperature to changes in water quantity in streams, and in turn, fish assemblages. Our approach will involve predicting changes in hydrology, water quality, and fish assemblage structure in a large portion of the Northern Great Plains.

The common factor that links hydrology, water quality, and fish assemblages is watershed area. Larger catchments have greater quantities and durations of flows, and also support more speciose fish assemblages. Because watershed area links hydrology to biology, we can use watershed area to characterize current hydrological and biological conditions, as well as predict changes under projected climate change conditions. First, we will construct watershed models for two stream networks in Montana that link duration and magnitude of flows, groundwater levels, and water quality to watershed area based on empirical observations under current climate conditions. We will also develop a regional model of fish assemblage structure as a function of watershed area using a database of over 1,600 fish collections from Montana prairie streams. The linked watershed and fish assemblage models will serve as a baseline of current conditions. Next, we will predict how hydrology and fish assemblages will change using projected changes in precipitation and temperature from an ensemble of general circulation models (GCMs) as inputs to the watershed models. Finally, we will use projected climate-related changes in hydrological and water quality parameters to predict changes on fish assemblage dynamics across a hierarchical spatial scale from individual pools to small tributaries to large prairie streams. We will identify the areas with the highest biological integrity by calculating Index of Biotic Integrity (IBI) values for the 1,600 samples in our regional fish database. This will allow us to identify areas of primary conservation concern and compare them to the areas that are most likely to undergo changes.

Total Project Cost		$ 35,921.00
Beginning Balance – September 2011		$ 35,921.00
Expenditures – September 2011 - December 2011		
Salaries and Benefits	$ -0-	
Supplies	$ 3.99	
Travel	$ 1,533.38	
IDCs @ 0%	$ 269.02	
Total Spent		$ 1,806.39
Balance		$ 34,114.61
Waived IDCs		$ 384.47

Taxonomic and ecological services

Investigator	**Undergraduate Researchers**
Molly Webb	Luke Holmquist
BFTC	Beca Gunderson
Duration	**Funding**
Ongoing	U.S. Fish Wildlife Service

We started a new program in 2011 for Montana State University undergraduate students to work on research projects at the Bozeman Fish Technology Center. We provide temporary student services to the BFTC and our students gain valuable research experience.

Beginning Balance - July 2010		$ 7,509.74
Additional Funding – 2011		$ 8,836.96
Expenditures - July 2010 - December 2011		
Salary and Benefits	$ 9,347.43	
Supplies	$ -0-	
Communications	$ -0-	
Travel	$ -0-	
Administrative fee @ 4%	$ 373.87	
Total Spent		$ 9,721.30
Balance		$ 6,625.40

MTCFRU Sales and Service Account

Investigator	**Duration**
Alexander Zale Unit Leader, MTCFRU	Ongoing

We coordinated a two-day regional Fish Screen Workshop in June 2011. It was funded by the Bureau of Reclamation, Natural Resources Conservation Service, U.S. Forest Service, and Trout Unlimited.

Beginning Balance - July 2010		$ 730.34
Additional Funding – 2011		$ 5,800.00
Expenditures - July 2010 - December 2011		
Salary and Benefits	$ 1,365.36	
Contracted Services	$ 2,400.00	
Supplies	$ 367.87	
Travel	$ 100.94	
Software/Training	$ 291.82	
Administrative fee @ 4%	$ 181.03	
Total Spent		$ 4,707.02
Balance		$ 1,823.32

Montana Cooperative Fishery Research Unit Vehicle Account

Administrator	**Funding**
Alexander V. Zale Unit Leader, MTCFRU	Designated Account - projects are charged mileage based on project use. MSU index 433099

The purpose of the Unit vehicle account is to cover all expenses related to Unit vehicles, which includes replacement, repairs and maintenance, insurance, and fuel.

Beginning Balance - July 2010		$ 45,856.67
Expenditures - July 2010 - December 2011		
Repairs and Maintenance	$ 12,341.59	
Fuel	$ 30,620.67	
Insurance	$ 7,587.12	
Administrative Assessment Fee @ 4%	$ 2,022.01	
Total Spent		$ 52,571.39
Total Revenue Reimbursed		$ 60,893.19
Balance		$ 54,178.47

Montana Cooperative Fishery Research Unit Watercraft Account

Administrator	**Funding**
Alexander V. Zale Unit Leader, MTCFRU	Designated Account – projects are charged a daily fee when using boats. MSU index 433301

The purpose of the Unit watercraft account is to cover expensive repairs and replacement of Unit research vessels.

Beginning Balance - July 2010		$ 12,400.10
Expenditures - July 2010 - December 2011		
Insurance	$ -0-	
Supplies	$ -0-	
Equipment	$10,000.00	
Maintenance	$ 4,402.18	
Administrative Assessment Fee @ 4%	$ 576.08	
Total Spent		$ 14,978.26
Total Revenue Reimbursed		$ 16,325.00
Balance		$ 13,746.84

Montana Cooperative Fishery Research Unit Operations Account

Administrator	**Funding**
Alexander V. Zale	Yearly: $12,000 from MSU VP Research
Unit Leader, MTCFRU	MSU index 436899

Beginning Balance - July 2010		$ 11,057.69
Expenditures - July 2010 - December 2011		
Salary and Benefits	$ -0-	
Communications	$ 1,443.83	
Contracted Services	$ 2,631.88	
Supplies	$ 1,588.49	
Travel	$ -0-	
Rent (Storage Unit)	$ 9,973.00	
Maintenance	$ 3,500.00	
Administrative Assessment Fee @ 4%	$ 625.55	
Total Spent		$ 19,762.75
Total Revenue from VPR		$ 24,000.00
Balance		$ 15,294.94

Monetary Equivalence for MSU Services and Facilities
July 2010 - December 2011

Accountant salary and benefits	$ 63,497.00
Office space	
Staff - 515 sq. ft. @ $13/sq. ft.	$ 10,042.50
Students - 742 sq. ft. @ $13/sq. ft.	$ 14,469.00
Laboratory space - 40% of 942 sq. ft. @ $16/sq. ft.	$ 9,043.20
Storage space	
AJMJ cages (2) - 71.5 sq. ft. @ $3.24/ sq. ft.	$ 347.49
Museum facilities - 12.5% of 936 sq. ft. @ $16/ sq. ft.	$ 2,808.00
Library @ 0.8% of total expenditures ($1,023,569)	$ 8,188.55
Utilities - General @ 12% of total expenditures ($1,023,569)	$122,828.28
Unit Operations Account	$ 24,000.00
Waived IDCs	$319,097.30
Total	**$574,321.32**

Montana Fish, Wildlife and Parks Annual Contribution
Montana Cooperative Fishery Research Unit Operations

Investigator	Funding
Alexander V. Zale	Montana Fish, Wildlife and Parks
Unit Leader, MTCFRU	MSU index 428513

Beginning Balance - July 2010		$ 46,882.75
Additional Funding – July 2011		$ 30,000.00
Expenditures - July 2010 - December 2011		
Salaries and Benefits	$ 22,727.59	
Communication (Telephone/postage)	$ 64.38	
Contracted Services	$ 6,911.18	
Travel	$ 7,026.75	
Supplies	$ 8,967.92	
Repairs and Maintenance	$ 917.44	
Equipment	$ 20,080.49	
Tuition	$ 2,418.00	
Total Spent		$ 69,113.75
Balance		$ 7,769.00

A portion of the $69,113.75 spent was for the Yellowstone River Oil Spill research as follows:

Salaries and Benefits	$ 20,304.41
Supplies	$ 7,195.25
Travel	$ 1,434.58
Equipment	$ 20,080.49
Total	$ 49,014.73

Federal Budget
July 2010 - December 2011

Salaries and Benefits	$448,051.79
Supplies	$ 15,476.03
Publications	$ -0-
Working Capital Vehicle Fund	$ 5,000.00
Total	**$468,527.82**

Unit Equipment Inventory (items with acquisition values greater than $5,000)

USGS

2011 Ford F250 4x4 crew cab (green)
Property No. 433429 – Serial No 1FT7W2BTOBEA70586
Acquisition value $ 31,697.00
Mileage 4,285

2009 Chevrolet HHR (red)
Property No. 433291 – Serial No. 3GNBAADB4AS513678
Acquisition value $18,720.00
Mileage 7,782

2005 Chevrolet Silverado 2500, 4x4 crew cab (green)
Property No. 430750 - Serial No. 1GCHK23G15F926039 (2005)
Acquisition value $22,948.21
Mileage 71,279

2002 Chevrolet 4x4 Suburban (white)
Property No. 261052 - Serial No. 3GNGK26U52G249012
Acquisition value $31,988
Mileage 110,286

1999 Chevrolet 3/4-ton 4x4 pickup truck (white)
Property No. 252537 -- Serial No. 1GCGK24R9XF049122
Acquisition value $21,009
Mileage 140,769

1995 Ford Taurus GL station wagon (green)
Property No. 261116 - Serial No. 1FALP57U9SA292782
Acquisition value $15,068
Mileage 95,753

1989 Chevrolet 4x4 Suburban (tan)
Property No. 261114 - Serial No. 1GNGV26K2KF176088
Acquisition value $15,766
Mileage 146,428

1989 Chevrolet 4x4 regular cab pickup (blue)
Property No. 4320218 - Serial No. 1GCFK24K2KZ259793
Acquisition value $1,500
Mileage 157,749

Wooldridge 20' Custom Boat and Trailer with a Honda 200 Four Stroke Motor and Electrofishing combo.
Property No. Boat 4005308 - Serial No. WLG20635I405
Property No. Trailer 430697 - Serial No. 47AVA221250061126
Property No. Motor 4005305 - Serial No. BAEJ-1300065
Property No. Electrofisher Combo 4005309
Acquisition value $50,871.57 (2004)

1990 23' Sea Ark Marine Boat and EZ-Load Trailer with a Zodiac life raft, Mobile Radio, Binoculars, Ross Depthfinder and Hummingbird Fish Finder.
Property No. Boat 632069 - Serial No. SAMA0093J989/FSC 1940
Property No. Trailer 632068 - Serial No. 12EIGN224LLW19678/FSC 2330
Property No. Mobile Radio 632015 - Serial No. 1391568/FSC 5820
Property No. Depthfinder 632014 - Serial No. 1975-201/FSC 6605
Property No. Life Raft 632007 - Serial No. 2845 or 2860/FSC 4220
Property No. Fish Finder 618216 - Serial No. 4765325
Property No. Binoculars 237807 - Serial No. 308594
Acquisition value $42,845.99 (Transferred from USFWS Creston Fish and Wildlife Center June 2006)

Hyde Aluminum Drift Boat
Property No. 3800001 - Serial No. TAD00230D696
Acquisition value $5,262 (1996)

VideoRay Pro3-XE-N ROV System
Property No. 4005775 - Serial No. G09028
Acquisition value $25,424.00 (2009)

Electrofisher SRI Backpack Combo
Serial No. BC-170057
Acquisition value $7,467.59 (2004)

Olympus BX40 microscope
Property No. 6001157 - Serial No. 9810089
Acquisition value $5,601 (1999)

U.S. Army Corps of Engineers

Wooldridge Jet Boat
Serial No. WLG18428K596
Acquisition value $19,447 (1996)

Montana State University

2008 Ford Escape Hybrid 4WD (grey)
Property No. 132775
Serial No. 1FMCU59H78KA13346
Acquisition Value $26,553.65 (2007)
Mileage 23,107

2005 GMC Sierra 2500 crew cab truck (green)
Property No. 132353
Serial No. 1GTHK23G65F944780
Acquisition Value $24,463.00 (2005)
Mileage 80,223

2001 GMC 1/2 ton 4x4 extended cab truck (green)
Property No. 132228
Serial No. 2GTEK19T911227311
Acquisition Value $15,255.00 (2005)
Mileage 135,045

1999 Ford F250 4x4 crew cab (blue)
Property No. 125014
Serial No. 1FTNW21S8XEA98840
Acquisition Value $11,002 (2005)
Mileage 171,380

1999 Chevrolet 1/2 ton 4x4 extended cab truck (white)
Property No. 132229
Serial No. 2GCEK19T8X1144560
Acquisition Value $12,459.00 (2005)
Mileage 188,129

2012 Wooldridge 18’ Custom Boat with a Mercury 150 Optimax motor
Serial No. WLG18379H112
Mercury Serial No. 1B881822
EZ Loader trailer Serial No. 1ZEAAAMC5CA001832
Acquisition Value $36,080.50 (2011)

BRP Evinrude 200 hp (for 1996 Wooldridge boat)
Serial No. 05257091
Acquisition value $10,444.00 (2009)

2008 Crestliner 16’ Boat
Serial No. CRC36198J708
90 hp Evinrude engine, Serial No. 05265364
19’ Shorelander trailer VIN No. IMDAPLP188A402650
Acquisition value $16,107.00 (2009)

2008 18' Wooldridge Custom Boat
Serial No. WLG18099B808
150 hp Yamaha engine Serial No. 63PL1070949
EZ Loader Trailer Serial No. 1ZEADAMB08A152874
Acquisition value $32,182 (2008)
Smith-Root Electrofisher
Serial No. 11363T
Acquisition value $14,074 (2007)

2008 Workskiff Custom Boat
Serial No. MGN19S06D808
135 hp Honda engine Serial No. BARJ-1301242
EZ Loader Trailer Serial No. 1ZEADMPK28A158379
Acquisition value $36,615 (2008)

HT 2000 Backpack Electrofisher
Serial No. B068MK4
Acquisition value $6,162 (2006)

Electrofisher Backpack
Property No. 131644
Serial No. C00162
Acquisition value $5,792 (2003)

Acoustic Doppler Current Profiler
Property No. 133442
Serial No. StreamPro930
Acquisition value $16,975 (2009)

YSI Water Quality Monitor
Serial No. 08F100275, 08F100274, 08E100745
Acquisition value $15,923 (2008)

SRX 400A Datalogging Coded Series Receivers with W31 CT Firmware (two)
Property No. 132057
Serial No. 11826A
Acquisition value $7,950 (2004)
Property No. 132058
Serial No. 11827A
Acquisition value $7,950 (2004)