Montana Cooperative Fishery Research Unit

2014 Briefing Booklet

MONTANA COOPERATIVE
FISHERY RESEARCH UNIT

Coordinating Committee Meeting
Bozeman, Montana
9 April 2014

Personnel and Cooperators

Coordinating Committee Members

U.S. Geological Survey
Joe Margraf, Supervisor
Cooperative Research Units
1135 Park Ave. Unit 904
Pagosa Springs, CO 81147

Montana Fish, Wildlife and Parks
Bruce Rich, Fisheries Bureau Chief
P.O. Box 200701
Helena, MT 59620

Montana State University
Renee Reijo Pera
Vice President of Research
and Economic Development
MSU - Montana Hall
Bozeman, MT 59717

U.S. Fish and Wildlife Service
Noreen Walsh, Regional Director
Mountain-Prairie Region
U.S. Fish and Wildlife Service
P.O. Box 25486, DFC
Denver, CO 80225

Cooperative Unit Staff

Alexander Zale
    Unit Leader and Professor
Christopher Guy
    Assistant Unit Leader and Associate Professor
Lynn DiGennaro
    Program Coordinator, MSU Department of Ecology
Robert Bramblett
    Assistant Research Professor
Hilary Treanor
    Research Associate
Peter Brown
    Post-Doctoral Researcher
Michael Duncan
    Research Scientist

Cooperators and Collaborators

Montana State University Department of Ecology
    David Roberts
    Wyatt Cross
    Andrea Litt
    Jay Rotella

Montana State University Department of Land Resources & Environmental Sciences
    James W. Bauder

Montana State University College of Letters and Science
    Nicol Rae, Dean

Montana State University Department of Mathematical Sciences
- Megan Higgs

Montana Fish, Wildlife and Parks
- Caryn Amacher
- Mike Backes
- Allison Begley
- Caleb Bollman
- Grant Grisak
- Lauri Hanauska-Brown
- Heath Headley
- Travis Horton
- Matt Jaeger
- Casey Jensen
- George Liknes
- Travis Lohrenz
- Lee Nelson
- Jason Rhoten
- Bruce Rich
- Vic Riggs
- Leo Rosenthal
- Mike Ruggles
- Brad Schmitz
- Don Skaar
- Anne Tews
- Joel Tohtz
- Karen Zackheim

USGS Northern Rocky Mountain Science Center
- Robert Al-Chokhachy
- Robert Gresswell
- Jeffrey Kershner
- Clint Muhlfeld

U.S. Fish and Wildlife Service
- Kyle Cutting
- Jo Ann Dullum
- Jackie Fox
- Wade Fredenberg
- George Jordan
- Kevin Kappenman
- Robert Muth
- Greg Watson
- Molly Webb

Blackfeet Community College
- Keith Tatsey

Bureau of Land Management
- John Carlson
- Jake Chaffin
- Jody Peters

Bureau of Reclamation
- Justin Kucera
- David Trimpe

DTM Consulting
- Tony Thatcher

LP Consulting, LLC
- Larry Peterman

Madison River Foundation

Michigan State University
- Michael Jones

Montana Natural Resource Damage Program
- Doug Martin

National Park Service
- Patricia Bigelow
- Chris Downs
- Todd Koel

PPL Montana
- Steve Leathe
- Brent Mabbott

Rocky Mountain Cooperative Ecosystem Studies Unit
- Lisa Gerloff
- Kathy Tonnessen

Simms Fishing Products
- Luke Boswell
- Rich Hohne

Turneffe Atoll Trust
- Craig Hayes

U.S. Army Corps of Engineers
- Tiffany Vanosdall

USGS Montana Water Science Center
Rod Caldwell
Kathy Chase
Sean Lawlor

University of Belize, Environmental Research Institute
Leandra Cho-Ricketts

University of California, Davis
Serge Doroshov
Bernard May

Washington Department of Fish and Wildlife
Brad Cady
Brad James

Western Regional Aquaculture Center
Graham Young

Westscape Native Plants Nursery
Robert Dunn
Laura Smith

Wildlife Conservation Society
Brad Shepard

Wyoming Game and Fish Department
Paul Gerrity
Mark Smith

Current Graduate Students Advised by Unit Faculty

Alex Anderson	M.S.
Jan Boyer	M.S.
Mike Duncan	Ph.D.
Carter Fredenberg	M.S.
Ben Galloway	M.S.
Andrew Gilham	M.S.
Jeffrey Glaid	M.S.
Sean Lewandoski	M.S.
Austin McCullough	M.S.
Ann Marie Reinhold	Ph.D.
David Ritter	M.S.
John Syslo	Ph.D.
Brian Tornabene	M.S.
Brittany Trushel	Ph.D.
Patrick Uthe	M.S.

Current Graduate Students Advised by Cooperating Faculty

Eric Scholl	Ph.D.
Shane Vatland	Ph.D.

Research Technicians 2013

Cam Clevidence	Patrick Luckenbill	Mike Schilz
Leif Halvorson	Nathan Marotz	Britton Tew
Greg Hill	Colter Mumford	Ben Triano
Luke Holmquist	Samuel Pannoni	Brian Van Ee
Austin Lawrence	Nick Pinkham	Maggie Zee
	Janette Rounds	

Graduate Students Receiving Degrees in 2013

Ben Galloway graduated with a M.S. in Fish and Wildlife Management and is working for the Oregon Department of Fish and Wildlife as a Columbia River Fisheries Sampler in Portland, Oregon.

2013 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 will be 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.

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.

Project Duration

December 2009 – August 2014

Funding

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

Hailstone National Wildlife Refuge, located about 3.5 miles northeast of Rapelje, Montana, 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. Hailstone Refuge is in open shortgrass prairie country dominated by rocky outcroppings, small grassy hills, and a large alkaline playa, a remnant of dewatering the Refuge impoundment in 2011-2012. From about 1935 until 2008, the major water body of Hailstone National Wildlife Refuge, an impoundment formed by a CCC-constructed rock × earthen dam, sporadically filled with rainfall, runoff, and snowmelt laden with geologically sourced dissolved salts—mostly sodium bicarbonate, sulfate and chloride. Dewatering left behind a salt-encrusted basin, devoid of much vegetation. Not only was the impoundment a hazardous environment for waterfowl, but in addition, the basin became a source of significant blowing salt dust and fine soil particles and air quality deterioration following dewatering. In concert with the dewatering effort, the project reported here 1) completed a detailed characterization of plant communities existing and adaptable to the expanding area of formerly shoreline and 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) implemented, initially on a trial basis and in October 2013, a large scale, bioremediation effort and proactive management strategies that have facilitated establishment of sustainable plant communities that are both stabilizing salt-rich land surfaces subject to wind scouring and sequestering/volatilizing soil-borne selenium, and 4) established large-scale field plantings of desirable native plant species that will serve as prototype settings and seed sources for sustained self-seeding and exposed soil revegetation. The project initially established, on a trial basis, expansive areas of sustainable, salt-tolerant plant communities across the recently exposed lake-bottom sediments and exposed shorelines. Tasks completed during this reporting period included 1) assessment of 2011-2012 planting trials, 2) identification of successfully established native plant species resulting from prior year plantings, 3) determination of effective land surface manipulations to be used in conjunction with future seeding efforts, and 4) large scale planting-revegetation of about 6 acres of exposed shoreline and lakebed sediments, incorporating diverse species selections, mechanical surface manipulations,

and multiple planting techniques. This project will conclude with final surface seed planting and seeding success evaluations in 2013.

Total Project Cost		$411,484.40
Beginning Balance – January 2013		$148,648.86
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 25,749.44	
Contracted Services	$ 54,640.49	
Supplies	$ 2,160.09	
Communications	$ 321.02	
Travel	$ 3,133.33	
IDCs @ 15%	$ 12,900.56	
Total Spent		$ 98,904.93
Balance		$ 52,263.55
Waived IDCs		$ 24,941.27

A proposal to conduct an integrated analysis of Red Rock Creek and Upper Red Rock Lake historical Arctic grayling data

Investigator
Megan Higgs
Assistant Professor, MSU

Graduate Student
Terrill Paterson, M.S.

Project Duration
June 2013 – July 2014

Collaborators
Matt Jaeger, Montana Fish, Wildlife and Parks
Kyle Cutting, Jeff Warren
Red Rock Lakes National Wildlife Refuge, U.S. Fish and Wildlife Service
Glenn Boltz, retired
U.S. Fish and Wildlife Service

Funding
USGS/FWS Science Support Partnership (SSP) and Quick Response Program (QRP), USGS RWO 69, MSU index 4W4448

Concerns about declining abundance and low survival rates of the last remaining native population of adfluvial Arctic grayling in the lower 48 states at Red Rock Lakes National Wildlife Refuge motivated a long-term monitoring effort (1975 to present). The species is currently under review for a potential listing under the Endangered Species Act. That decision requires estimates of abundance and survival. The 38-year legacy data set from the monitoring effort was used to produce minimum abundance estimates based on counts, and both abundance and apparent survival estimates based on mark-recapture methods intermittently applied over the years. The sampling design of the monitoring effort necessitated simulations to partially understand the degree of bias in abundance estimates resulting from spatially restricted sampling during electrofishing. Estimated abundances in the system range from a few hundred individuals (1995: 121; 100 to 152) to over a thousand (2013: 1,145; 1,085 to 1,215). Estimated apparent survival was 0.41 (0.24 to 0.66) during 1993 to 1996 and 0.63 (0.53 to 0.74) during 2010 to 2013. Simulations suggest that abundance estimates are positively biased and highly variable with low detection and spatially restricted sampling.

Total Project Cost		$ 17,248.00
Beginning Balance – June 2013		$ 17,248.00
Expenditures – June 2013 - December 2013		
Salaries and Benefits	$ 11,788.22	
Supplies	$ 1,433.98	
Travel	$ 742.52	
IDCs @ 15%	$ 2,094.72	
Total Spent		$ 16,059.44
Balance		$ 1,188.56
Waived IDCs		$ 4,049.77

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
T. David Ritter, M.S.

Project Duration
July 2009 – June 2014

Collaborators
Grant Grisak
Montana Fish, Wildlife and Parks
George Liknes
U.S. Forest Service

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 climate change adaptation management strategies and tactics. Our goal was 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 was on the lower reaches of Tenderfoot Creek, a largely undeveloped major tributary to the Smith River. A PIT-tag detection network of five fixed stations monitored the seasonal movements of 355 rainbow trout, 287 mountain whitefish, 66 brown trout, and 55 brook trout in the lower 13.6 km of Tenderfoot Creek. Abundances were estimated by depletion electrofishing, mark-recapture, and snorkeling. Densities of brown trout were high in study segments with deep pools. Two groups of brown trout were identified based on movement patterns: Tenderfoot Creek residents and Smith River migrants. Tenderfoot Creek residents had a wider size distribution but a smaller range of movement. Among-station movement of brown trout was limited to spawning migrations by Smith River migrants. Brown trout redds numbered 69 in 2011 and 90 in 2012. Mountain whitefish abundance was highest within 3 km of the confluence with the Smith River. Among-station movement of mountain whitefish included upstream migrations before spring runoff and in October and downstream migrations in early September. About 10,000 whitefish spawned in the lowest 3 km of Tenderfoot Creek in October of 2012. Rainbow trout abundance increased with distance from the confluence with the Smith River. Among-station movement of rainbow trout was common and increased during upstream spawning migrations in early spring. Among-station movement of brook trout was rare. Brook trout spawning was restricted to tributaries and side channels. Densities of age-0 brook trout were highest near springs and tributaries. Tenderfoot Creek is heavily used by Smith River fishes for spawning; maintaining its connectivity is therefore vital. Conversely, no tagged fish were directly observed using Tenderfoot Creek as a thermal refuge during summer, but such use may occur at the confluence with the Smith River; we will examine this possibility in 2014.

Total Project Cost		$145,003.00
Beginning Balance - January 2013		$ 50,797.04
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 16,566.91	
Contracted Services	$ -0-	
Supplies	$ 2,775.53	
Communications	$ -0-	
Travel	$ 624.62	
Rent	$ -0-	
Repairs Maintenance	$ 177.67	
Tuition	$ 1,599.00	
Total Spent		$ 21,743.73
Balance		$ 29,053.31
Waived IDCs		$ 9,567.24

Effects of abiotic and biotic factors on life history characteristics and vital rates of Yellowstone cutthroat trout in a headwater basin

Investigators

Robert Al-Chokhachy
USGS Northern Rocky Mountain Science Center
Alexander Zale
Unit Leader, MTCFRU

Collaborators

Jeffrey Kershner, USGS, Northern Rocky Mountain Science Center
Rob Gipson, Wyoming Game and Fish Department

Graduate Student

Patrick Uthe, M.S.

Project Duration

March 2012 - June 2014

Funding

U.S. Geological Survey, Priority Ecosystems Science Program, RWO 67**,** MSU indexes 4W3919, 4W4253 4W4532

Habitat degradation and introduction of non-native salmonids have caused substantial declines in abundance and distribution of Yellowstone cutthroat trout. Additionally, global climate change is expected to exacerbate current threats through changes to thermal regimes, hydrology, stream productivity, and distributions of non-native species. Understanding how factors such as climate and local stressors (e.g., non-native species) interact to affect Yellowstone cutthroat trout is critical for developing management strategies to enhance future persistence. However, research investigating relationships among these factors and life history characteristics and vital rates of Yellowstone cutthroat trout is lacking. We therefore examined the effects of stream temperature, streamflow, food availability, and presence of non-native brook trout on life history characteristics of Yellowstone cutthroat trout in three tributaries in Wyoming. We used passive integrated transponder (PIT) tags and a combination of stationary and mobile PIT tag antennae within a capture-recapture framework to monitor growth, movement, and survival of Yellowstone cutthroat trout and brook trout. Since 2011, we have tagged 1,160 trout (975 Yellowstone cutthroat trout and 185 brook trout) and relocated 778 fish (650 Yellowstone cutthroat trout and 128 brook trout) at least once; 1,809 unique relocations of tagged trout occurred during the course of this study. Significant differences in summer growth rates of 26 brook trout and 75 Yellowstone cutthroat trout existed between species as well as among Yellowstone cutthroat trout populations. Streamflow and stream temperature had strong and interactive effects on Yellowstone cutthroat trout growth. At all temperatures within the range observed throughout the study, higher streamflow was associated with higher growth rates. Increased accumulation of degree days above 3°C throughout the growing season was associated with decreased growth rates. The effect of streamflow was greater at lower accumulations of degree days. No significant differences existed in survival among streams. In all streams, monthly survival rates were not significantly different during the winters of 2011 and 2012, and the summer of 2012. Monthly survival rates during the summer of 2013 were significantly lower than during other time intervals in each stream. Frequencies and timings of movements differed considerably across streams and seasons. The range of movement in Rock Creek declined after high flows subsided in July, but trout in Leidy and Grouse Creeks continued to exhibit a high

range of mobility throughout the summer and autumn. Yellowstone cutthroat trout were more mobile than brook trout except during autumn when spawning migrations by brook trout occurred. Consideration of intra-basin variability in life history characteristics may aid restoration and conservation planning efforts related to current and future climate-driven stream changes.

Total Project Cost		$ 83,034.00
Beginning Balance – January 2013		$ 34,360.30
Additional Funding – 2013		$ 18,280.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 23,449.14	
Supplies	$ 2,410.26	
Communications	$ -0-	
Travel	$ 5,914.98	
Tuition	$ 4,797.00	
IDCs @ 15% 4W3919	$ 4,660.08	
IDCs @ 0% 4W4253, 4W4532	$ -0-	
Total Spent		$ 41,231.46
Balance		$ 11,408.84
Waived IDCs 4W3919		$ 9,009.54
Waived IDCs 4W4253		$ 1,081.96
Waived IDCs 4W4532		$ 1,339.80
Waived IDCs TOTAL		$ 12,782.72

Grazing effects on stream fish assemblages on Blackfeet Nation lands

Investigators

Alexander Zale
Unit Leader, MTCFRU
Bradley Shepard
Western Conservation Society

Collaborators

Robert Bramblett, MSU
Andrea Litt, MSU
Keith Tatsey, Blackfeet Community College

Graduate Student

Andrew Gilham, M.S.

Funding

Wildlife Conservation Society
MSU index 423187

Project Duration

June 2012 – December 2014

We are evaluating conditions in streams with various levels of livestock grazing in ten headwater streams within, and adjacent to, lands of the Blackfeet Nation located on the East Front of the Rocky Mountains near Glacier National Park. This research is a cooperative effort between the Wildlife Conservation Society, the U.S. Fish and Wildlife Service, Blackfeet Fish and Wildlife Department, the Montana Cooperative Fisheries Research Unit, and the Blackfeet Community College. Originally, we planned to compare grazing effects of domestic cattle and bison on stream morphology and fish abundance; however, we found no comparable streams where bison grazing and cattle grazing occurred on the reservation in 2012. Consequently, we are assessing effects of cattle and horse grazing on fish assemblages in streams where future bison reintroduction is proposed. Fish species compositions, abundances and biomasses of trout species, and habitat conditions were estimated in two 4,150-m long sample sections in each of ten streams. Study streams were all 1st and 2nd order headwater streams, but differed in grazing intensities, basin areas, and summer discharges. Scat surveys were used to quantify relative grazing use. All streams were sampled with backpack electrofishing gear. Habitat condition of stream channels (wetted width, average depth, thalweg depth), instream cover (proportion undercut and large woody debris), streambed composition (size class distribution), and riparian vegetation (proportion open vegetation, proportion dense woody vegetation, and livestock use) were assessed at each sample site. Three streams had little to no obvious grazing effects whereas the other seven had varying levels of effects. Scat counts (grazing intensity) were positively correlated with proportion open riparian vegetation ($P < 0.0001$). Scat counts were also positively correlated with proportion fine sediment ($P = 0.0028$). Estimated fish biomass (g/m^2) was negatively correlated with proportion fine sediment ($P = 0.007$). Riparian vegetation strongly influenced grazing intensity, and increased grazing intensity caused an increase in fine sediment input. Proportion fine sediment was the strongest predictor of fish biomass.

Total Project Cost		$ 43,646.76
Beginning Balance – January 2013		$ 27,014.05
Additional funding 2013		$ 4,542.60
STIP interest 2013		$ 40.37
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 12,345.55	
Supplies	$ 298.20	
Travel	$ 263.42	
Tuition	$ 1,066.00	
Total Spent		$ 13,973.17
Balance		$ 17,623.85

Assessment of population and assemblage level effects of the Exxon oil spill on Yellowstone River fishes

Investigators

Alexander Zale
Unit Leader, MTCFRU
Robert Bramblett
Assistant Research Professor
Michael Duncan, MTCFRU
Ann Marie Reinhold, MTCFRU

Collaborators

Larry Peterman, LP Consulting, LLC
Doug Martin, Natural Resource Damage Program

Project Duration

June 2012 – June 2013
Completed

Funding

Montana Natural Resource Damage Program
MSU index 4W4011

Fish sampling (fyke and trammel nets, electrofishing) was conducted on the Yellowstone River from July to October 2012 at sites where samples had been collected prior to 2011. Fish were identified, measured, and examined before being released. All sampling was completed as planned. An interim report was submitted to the Natural Resource Damage Program on 1 January 2013 and a final report was submitted on 1 April 2013. A confidentiality agreement prevents the disclosure of any results without prior written consent of the State of Montana.

Total Project Cost		$ 33,400.00
Beginning Balance – January 2013		$ 12,389.91
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 11,474.67	
Contracted Services	$ -0-	
Supplies	$ 9.70	
Travel	$ 96.04	
Rent	$ -0-	
Repair and Maintenance	$ -0-	
Tuition	$ 791.50	
IDCs @ 0%	$ -0-	
Total Spent		$ 12,371.91
Back to sponsor		$ 18.00
Balance		$ -0-
Waived IDCs		$ 5,443.64

Assessment of population effects of the Exxon oil spill on Yellowstone River softshell turtles

Investigators

Alexander Zale
Unit Leader, MTCFRU
Robert Bramblett
Assistant Research Professor
Michael Duncan, MTCFRU

Collaborators

Larry Peterman, LP consulting, LLC
Doug Martin, Natural Resource Damage Program
Allison Begley, Montana Fish, Wildlife and Parks

Project Duration

June 2012 – June 2013
Completed

Funding

Montana Natural Resource Damage Program
MSU index 4W4088

Turtle sampling with baited traps was conducted on the Yellowstone and Missouri rivers in July and August 2012 at sites where samples had been collected prior to 2011. Captured turtles were measured, weighed, and tagged before being released. All sampling was completed as planned. An interim report was submitted to the Natural Resource Damage Program on 1 January 2013 and a final report was submitted on 1 April 2013. A confidentiality agreement prevents the disclosure of any results without prior written consent of the State of Montana.

Total Project Cost	$ 16,600.00
Beginning Balance – January 2013	$ -0-

Spatial and temporal dynamics of the queen conch stock at Turneffe Atoll, Belize

(aka Turneffe Atoll Trust student support)

Investigators

Alexander Zale
Unit Leader, MTCFRU
Robert Bramblett
Assistant Research Professor

Collaborators

Leandra Cho-Ricketts,
Environmental Research Institute
University of Belize
Craig Hayes, Turneffe Atoll Trust

Graduate Student

Alex Anderson, M.S.

Funding

Turneffe Atoll Trust
MSU index 423192

Project Duration

August 2012 – December 2014

In support of sustainable management of the Turneffe Atoll Marine Reserve (TAMR), we are assessing the current status of the atoll's queen conch population and developing analytical techniques for monitoring its response to management. Our specific objectives are to 1) produce a baseline assessment of current conch distribution, abundance, and size structure at TAMR, and 2) develop a monitoring plan to detect specified levels of change in conch stock abundance. Quantification of the spatial variability in conch abundances will allow completion of a statistical power analysis to determine the location and number of transect samples needed to monitor future conch population dynamics at TAMR. Conch were sampled from May through August and in December 2013 and January 2014 at sites selected using a stratified-random design.

Conch were counted along four parallel 50 m long × 4 m wide transects at each site by two scuba divers following the Long-term Atoll Monitoring Program (LAMP) protocol. A total of 213 sites was sampled among the five geozones: North 81, Northeast 30, Southeast 25, Southwest 44, and Northwest 33. The distribution among habitat types was bare sand 6, sand and sparse algae 22, sparse seagrass 31, medium seagrass 52, dense seagrass 49, sparse patch reef 8, sparse massive coral 9, dense massive coral 23, and spur and groove 13. A total of 2,383 conch of various sizes was sampled. Densities varied greatly within and among habitat types and geozones; highest densities were in the North, followed by the Southwest, Northeast, Southeast and Northwest. The most conch found at a site was 383, but many sites (87) had no conch. Conch were sampled at depths of 0 to 23.5 m (0 to 77 feet). The largest conch was 10.4 inches long. The greatest lip thickness was 28.3 mm. Although sample sites were stratified among habitat types based on existing GIS shapefiles, significant discrepancies existed between expected and observed habitat types. Video imagery collected during the transects is currently being examined to correct discrepancies. Upon completion of this process, geozone and habitat specific conch densities will be calculated and expanded to estimate abundance of the TAMR conch stock. Variability in densities will be used to calculate needed sample sizes. This work will be completed in 2014.

Total Project Cost		$ 46,211.00
Beginning Balance – January 2013		$ 10,631.68
Additional funding 2013		$ 27,896.00
STIP interest - 2013		$ 15.47
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 17,663.91	
Supplies	$ 11.07	
Travel	$ 987.65	
Tuition	$ 1,925.85	
Total Spent		$ 20,588.48
Balance		$ 17,954.67

Evaluation of a technique for determining how different glove fabrics vary in their propensity to remove mucus from fish

Investigators

Molly Webb,
BFTC, USFWS
Christopher Guy
Assistant Unit Leader, MTCFRU
Alexander Zale
Unit Leader, MTCFRU

Collaborators

Luke Boswell and Rich Hohne
Simms Fishing Products

Project Duration

June 2013 – December 2014

Catch-and-release angling provides enhanced recreational opportunities because individual fish can be caught (or at least fished for) multiple times, assuming that mortality associated with being caught is not excessive. Factors affecting catch-and-release survival include intrinsic factors (age, sex, maturity, condition, and size), water quality, temperature, degree of exhaustion, duration of air exposure, susceptibility to predation and disease, hooking injury, and handling. Conventional wisdom suggests that handling fish with bare, wetted hands is best for fish because it is thought to minimize removal of mucus. However, anglers (and fisheries workers both in the field and in aquacultural settings) often prefer to wear gloves during inclement weather and to get a better grip on fish. The effect of gloves, or bare hands for that matter, on fish mucus removal is unknown. Only two studies have addressed mucus removal at all, and these were both evaluations of the effects of angling landing nets. In both cases, evaluation of mucus removal was qualitative. Moreover, no studies have explicitly examined the role of mucus removal on fish health or mortality but abrasion and mucus removal magnified the risk of fungal infection in one of the landing-net studies. Mucus is thought to protect fish through resistance to abrasion, predator evasion (slipperiness), and especially pathogen and contaminant defense. It also regulates water absorption and enhances swimming efficiency, and has a variety of specialized species-specific functions associated with feeding, reproduction, and communication.

In this pilot study, we evaluated a technique for determining how different glove fabrics vary in their propensity to remove mucus from fish. The technique involved two-step anesthesia to avoid use of nets to handle fish and thereby remove mucus, and use of a swiping apparatus to consistently test the propensity of different glove fabrics to remove mucus from fish. The two-step anesthesia worked well, but amounts of mucus removed by the swiping apparatus were too small to measure accurately when dried. Future modifications will include increasing the swatch size and area of coverage to remove more mucus. If the technique works, we will pursue funding to conduct a more definitive study. Findings would guide glove material selection and development of handling techniques to enhance health and survival of handled fish in both recreational and workplace situations.

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.

Collaborator

Chris Downs
National Park Service

Funding

USGS RWO 64
National Park Service
MSU index 4W3190

Project Duration

May 2010 - December 2012
Completed

Translocations are becoming an important tool for conservation and recovery of native fishes. However, many translocations have been unsuccessful likely due to inadequate feasibility assessments of abiotic and biotic factors influencing translocation success prior to implementation. This study provides a framework developed to assess the feasibility of translocating threatened bull trout into novel stream and lake systems in Glacier National Park, Montana (GNP). Populations of bull trout in GNP are at risk of extirpation in several lakes due to the establishment of nonnative invasive lake trout. Drainage-specific translocations of extant bull trout populations have been proposed as a possible management solution to these declines, but the suitability of translocation sites is unknown. This study evaluated the suitability of spawning, rearing, foraging, and overwintering habitats in three isolated headwater stream and lake systems (Logging, Camas, and Lincoln sites) to determine their suitability for bull trout translocation. A scoring framework was developed to compare the suitability of proposed translocation sites based on three major components: potential for the recipient habitat to support a translocation; potential for the translocation to negatively impact native aquatic biota; and ability of within-drainage donor populations to support a translocation. Scoring criteria were developed based on abiotic and biotic characteristics known to influence translocation success, including water temperature, habitat quantity and quality, habitat complexity, species composition, and the possibility of conducting within-drainage translocation. Based on the framework, the Camas site is the most suitable for translocation because it contains physical and biological conditions comparable to other systems supporting bull trout. The Logging site is the second most suitable site for translocation, whereas the Lincoln site is least suitable because it contains a minimal amount of stream habitat (< 300 m) and nonnative brook trout. These results will be used to prioritize and plan potential translocation strategies for imperiled bull trout populations in GNP and provide a framework for evaluating the feasibility of conducting translocations elsewhere.

Total Project Cost	$ 66,163.00
Beginning Balance – January 2013	$ -0-

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.

Collaborator

Chris Downs
National Park Service

Funding

through USGS Northern Rocky Mountain Science Center

Project Duration

January 2011- December 2013

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 (GNP) 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, to conserve threatened bull trout populations in western GNP, in 2009 the U.S. Geological Survey and the National Park Service began a four-year experimental research project to assess the feasibility of suppressing lake trout in Quartz Lake. To identify the timing and location of spawning, adult lake trout were surgically implanted with acoustic transmitters and released each year. Two spawning areas have been identified and harvest during spawning has been highly successful. For example, 91% of acoustic tagged adults have been recaptured and 341 adult lake trout have been removed. Furthermore, adult biomass removed (kg/ha/yr) decreased from 1.23 in 2009 to 0.37 in 2013. In addition, 4,700 juvenile lake trout have been removed prior to their maturation and eventual contribution to the next cohort of the population. Bull trout redd counts have remained stable from 2009 through 2013. Although further data analyses and modeling are needed, these results suggest that suppression efforts are negatively influencing the lake trout population in this remote backcountry lake.

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

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Collaborators
Todd Koel and Patricia Bigelow
National Park Service

Graduate Student
John Syslo, Ph.D.

Project Duration
February 2010 - June 2014

Funding
USGS RWO 63
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.

Statistical catch at age and matrix population models are used to assess the efficacy of the lake trout suppression program and quantify targets for exploitation and fishing effort. A large increase in fishing effort in 2013 resulted in high lake trout mortality and likely suppressed lake trout population growth. In 2013, fishing effort was 63,000 100-m net nights which exceed the recommended target of 45,000 100-m net nights. The fishing effort in 2013 resulted in an instantaneous fishing mortality of 1.24 (1.01-1.48; 95% CI) and a population growth rate of 0.58 (0.43-0.75). Thus, lake trout abundance is predicted to decline if the amount of fishing effort in 2013 is maintained.

Total Project Cost		$102,770.00
Beginning Balance – January 2013		$ 35,174.03
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 19,165.71	
Contracted Services	$ 135.00	
Supplies	$ 169.16	
Travel	$ 2,001.80	
Rent	$ 235.20	
Tuition	$ 1,599.00	
IDCs @ 15%	$ 3,495.81	
Total Spent		$ 26,801.68
Balance		$ 8,372.35
Waived IDCs		$ 6,758.70

Annual evaluation and development of benchmarks for lake trout suppression in Yellowstone Lake

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Graduate Student
John Syslo, Ph.D.

Funding
National Park Service, CESU
MSU index 4W4470

Project Duration
July 2013 – June 2018

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.

Statistical catch at age and matrix population models are used to assess the efficacy of the lake trout suppression program and quantify targets for exploitation and fishing effort. A large increase in fishing effort in 2013 resulted in high lake trout mortality and likely suppressed lake trout population growth. In 2013, fishing effort was 63,000 100-m net nights which exceed the recommended target of 45,000 100-m net nights. The fishing effort in 2013 resulted in an instantaneous fishing mortality of 1.24 (1.01-1.48; 95% CI) and a population growth rate of 0.58 (0.43-0.75). Thus, lake trout abundance is predicted to decline if the amount of fishing effort in 2013 is maintained.

Total Project Cost		$ 85,165.00
Beginning Balance – July 2013		$ 85,165.00
Expenditures – July 2013 - December 2013		
Salaries and Benefits	$ -0-	
Supplies	$ -0-	
Travel	$ -0-	
IDCs @ 15%	$ -0-	
Total Spent		$ -0-
Balance		$ 85,165.00
Waived IDCs		$ -0-

Estimate density of lake trout vulnerable to capture in trap nets using mark-recapture methods appropriate to sampling design

Investigators

Jay Rotella
MSU Professor
Christopher Guy
Assistant Unit Leader, MTCFRU

Collaborators

Todd Koel, National Park Service
Pat Bigelow, National Park Service

Project Duration

June 2012 – December 2015

Funding

National Park Service, CESU
MSU index 4W4058

Non-native species of fish threaten native fishes throughout North America. In Yellowstone National Park (YNP), introduced populations of invasive lake trout increasingly threaten Yellowstone cutthroat trout. Prior to the recent invasion of non-native lake trout, the streams around Yellowstone Lake contained thousands more Yellowstone cutthroat trout than present. These declines are directly attributed to the invasion and establishment of introduced lake trout. In response, the YNP initiated a project to suppress lake trout. To date, results seem promising but underscore the urgency to continue suppression to prevent continued loss of remaining native fish populations and evaluate the success of the suppression of lake trout. Success of the suppression effort is often measured by exploitation rate. Currently, several methods are used to estimate the exploitation rate, but a more direct measure is calculated from population abundance, which has not been estimated for lake trout in Yellowstone Lake.

Thus, this research project will estimate the population abundance of lake trout vulnerable to trap nets in Yellowstone Lake. A Lincoln-Petersen estimator for mark-recapture data or a modification of that method that allows one to incorporate length of fish as a covariate that might be related to capture probability will be used to estimate abundance. All modeling efforts will employ rigorous methods of estimation, evaluation of competing models, and model selection methods currently available in software such as Program MARK, WinBUGS, and other related packages designed for the analysis of the data type that will be generated in this project. Once an estimate is obtained then exploitation for similar sized fish can be calculated as the quotient of the number harvested and the population estimate. This estimate can be compared to other independent exploitation estimates to build multiple lines of evidence for evaluating the success of the suppression program.

Use of mobile electrofishing to induce mortality in lake trout embryos in Swan Lake

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Post-Doctoral Researcher
Peter Brown

Collaborators
Leo Rosenthal
Joel Tohtz
Montana Fish, Wildlife and Parks

Project Duration
July 2011 – June 2014

Funding
Montana Fish, Wildlife and Parks
MSU index 4W3625, 4W4157
4W4530

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 in Swan Lake, which targets juvenile and adult lake trout. Targeting lake trout embryos may be a complementary and effective method for suppressing lake trout. Exposure of fish embryos to voltage gradients in the upper range of those produced by electrofishing equipment has been shown to result in mortality. However equipment does not exist to increase mortality of embryos. We tested a grid of electrodes electrified for 60s with 15 amps of direct current at 1000V. Embryos were pre-positioned in spawning areas, electrodes were lowered from a pontoon boat and electrified using standard electrofishing equipment. Embryo mortality was 100.00% (±0.00%) at the surface of the substrate, 99% (±2%) in embryos buried 5 cm deep, 99% (±1%) mortality in embryos buried 10 cm deep, and 98% (±3%) mortality in embryos buried 20 cm deep. Average mortality in the control (embryos placed in spawning areas but not exposed to electricity) was 8% (±5%). Mortality in treatment groups differed significantly from the control (Kruskal–Wallis statistic, $H = 63.6$, df = 4, $P = <0.001$). These results suggest that a portable grid of electrodes is effective in causing high mortality of lake trout embryos. The equipment should be used to supplement ongoing gillnetting operations for overall population suppression, and could be used thereafter for continued population suppression. Modifications to the electrode array, or to the electric waveforms used, could make the array effective in causing high mortality of larval and juvenile life stages.

Total Project Cost		$255,046.00
Beginning Balance – January 2013		$ 47,052.40
Additional Funding – 2013		$ 78,246.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 66,679.89	
Contracted Services	$ 36.56	
Supplies	$ 11,068.85	
Communications	$ 68.43	
Travel	$ 4,887.05	
Rent	$ 775.00	
Repair and Maintenance	$ 1,075.88	
Equipment	$ -0-	
IDCs @ 0%	$ -0-	
Total Spent		$ 84,591.66
Balance		$ 40,706.74
Waived IDCs		$ 37,220.33

Electroshocking to induce mortality of lake trout embryos in Yellowstone Lake

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Post-Doctoral Researcher
Peter Brown

Funding
National Park Service, CESU
MSU index 4W4471

Project Duration
July 2013 – June 2015

Suppression of nonnative Lake Trout is critical to the conservation of Yellowstone Cutthroat Trout in Yellowstone Lake. A large component of the gillnetting effort targets spawning Lake Trout. Targeting Lake Trout embryos on spawning areas may be a complementary and effective method for suppressing Lake Trout. Exposure of fish embryos to voltage gradients in the upper range of those produced by electrofishing equipment has been shown to result in mortality. However, equipment does not exist to increase mortality of embryos. We planned to test an electrode array for embryo suppression during 2013, Federal government shutdown and Yellowstone National Park closures precluded these efforts and forced combination of this project with research on Swan Lake. We tested a grid of electrodes electrified for 60s with 15 amps of direct current at 1000V. Embryos were pre-positioned in spawning areas, electrodes were lowered from a pontoon boat and electrified using standard electrofishing equipment. Embryo mortality was 100.00% (±0.00%) at the surface of the substrate, 99% (±2%) in embryos buried 5 cm deep, 99% (±1%) mortality in embryos buried 10 cm deep, and 98% (±3%) mortality in embryos buried 20 cm deep. Average mortality in the control (embryos placed in spawning areas but not exposed to electricity) was 8% (±5%). Mortality in treatment groups differed significantly from the control (Kruskal–Wallis statistic, $H = 63.6$, df = 4, $P = <0.001$). These results suggest that a portable grid of electrodes is effective in causing high mortality of Lake Trout embryos. The equipment should be used to supplement ongoing gillnetting operations for overall population suppression, and could be used thereafter for continued population suppression. Modifications to the electrode array, or to the electric waveforms used, could make the array effective in causing high mortality of larval and juvenile life stages.

Total Project Cost		$ 39,147.00
Beginning Balance – July 2013		$ 39,147.00
Expenditures – July 2013 - December 2013		
Salaries and Benefits	$ 9,358.66	
Contracted Services	$ 62.50	
Supplies	$ 3,185.02	
Travel	$ 2,313.00	
Rent	$ 410.00	
Repair & Maintenance	$ 34.97	
IDCs @ 17.5%	$ 2,688.72	
Total Spent		$ 18,052.87
Balance		$ 21,094.13
Waived IDCs		$ 4,071.50

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, Kevin Kappenman
U.S. Fish and Wildlife Service
Bozeman Fish Technology Center

Research Associate

Hilary Treanor

Collaborators

William Gardner, Anne Tews
Montana Fish, Wildlife and Parks

Funding

Montana Fish, Wildlife and Parks,
MSU index 4W1928

Project Duration

January 2008 – April 2013
Completed

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 of the species.

Through a combination of field observations and laboratory experiments, we tested the hypothesis that abiotic conditions upriver of the dam are the mechanism for the lack of recruitment in pallid sturgeon, an iconic large-river endangered species. Here we show for the first time that anoxic upriver habitat in reservoirs (i.e., the transition zone between the river and reservoir) is responsible for the lack of recruitment in pallid sturgeon. The anoxic condition in the transition zone is a function of reduced river velocities and the concentration of fine particulate organic material with high microbial respiration. As predicted, the river was oxic at all sampling locations. Our results indicate reservoirs are an ecological sink for pallid sturgeon.

Total Project Cost		$272,937.00
Beginning Balance - January 2013		$ 8,395.39
Expenditures - January 2013 - June 2013		
Salaries and Benefits	$ 7,192.54	
Contracted Services	$ -0-	
Supplies	$ 1,202.85	
Communications	$ -0-	
Travel	$ -0-	
Maintenance	$ -0-	
IDCs @ 0%	$ -0-	
Total Spent		$ 8,395.39
Balance		$ -0-
Waived IDCs		$ 3,693.97

Density of pallid sturgeon and food web dynamics in the Missouri River: Inferences regarding carrying capacity and density-dependent response of pallid sturgeon to the contemporary stocking protocol

Investigators

Christopher Guy
Assistant Unit Leader, MTCFRU
Wyatt Cross
Assistant Professor, Ecology
Jay Rotella
Professor, Ecology

Graduate Students

Eric Scholl, Ph.D.
Brittany Trushel, Ph.D.

Collaborators

Lee Nelson
Montana Fish, Wildlife and Parks

Funding

Montana Fish, Wildlife and Parks
MSU index 4W4311

Project Duration

January 2013 – December 2017

Pallid sturgeon have been stocked annually in the Missouri River below Ft. Peck Reservoir and the Yellowstone River since 1998. Survival estimates for hatchery-reared pallid sturgeon are relatively high. Thus, there is growing concern among biologist that they have stocked too many pallid sturgeon; therefore, negatively influencing growth and survival of conspecifics and allospecifics. The effects of hatchery-reared pallid sturgeon on food-web dynamics is unknown. The objectives of this study are to: 1) estimate density and standing stock of the pallid sturgeon population, 2) estimate survival rate of the hatchery-reared pallid sturgeon, 3) compare density estimates to estimates of hatchery-reared pallid sturgeon at large from survival estimates and stocking history, 4) estimate production of the prey base (i.e., invertebrates and small-bodied fishes), 5) assess the potential of food limitation for hatchery-reared pallid sturgeon, 6) use population and production models to estimate carrying capacity, and 7) compare estimated carrying capacity to estimated historical abundance. Capture-recapture models will be used to estimate abundance of pallid sturgeon. In addition, density of macroinvertebrates and prey fishes will be estimated to determine supply. Diets of the most abundant fish species in each trophic guild will be evaluated to measure demand. These data will be used to create quantitative food-webs and assess the supply and demand of resources. These results will be used to better manage pallid sturgeon by informing future stocking recommendations.

Total Project Cost		$ 115,990.00
Beginning Balance - January 2013		$ 49,504.00
Additional Funding 2013		$ 66,486.00
Expenditures - January 2013 - December 2013		
Salaries and Benefits	$ 59,656.30	
Contracted Services	$ 120.00	
Supplies	$ 12,567.00	
Communications	$ 17.21	
Travel	$ 8,159.43	
Rent	$ 5,450.00	
Maintenance	$ 1,622.30	
Tuition	$ 9,388.10	
IDCs @ 0%	$ -0-	
Total Spent		$ 96,980.34
Balance		$ 19,009.66
Waived IDCs		$ 42,671.35

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 – July 2014

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. Shovelnose sturgeon spawning ecology was studied in an artificial river at the Bozeman Fish Technology Center from 2011 – 2013. Spawning trials performed in 2011 focused on developing methodology and describing the spawning behaviors of shovelnose sturgeon. Observations of spawning behavioral characteristics and ecology included a spawning duration that varied from 3 to 18 h (defined as the shortest and longest periods from first oviposit to final oviposit for an individual female), a 2-3 second spawning bout or coupling, approximately 50 individual spawning bouts or couplings for a female, and thousands of eggs released per spawning bout. The observed courtship and mating behaviors of shovelnose sturgeon included polyandrous and polygynous mating and a single couple per spawning bout. Additionally, shovelnose sturgeon were observed to spawn over gravel (2 - 64 mm) and cobble substrate (65 - 256 mm), spawned in close proximity to the substrate (0 - 18 cm), and the majority of eggs released by a female attached to the substrate a few meters downstream of the spawning site. Spawning trials performed in 2012 and 2013 examined microhabitat characteristics (water velocity and substrate) connected to spawning site selection. Preliminary analysis showed shovelnose sturgeon spawning site selection was influenced by water velocity. Water velocities available in the living stream were characterized for each individual trial. Manly Selection ratios and chi-squared log likelihood selection ratios indicates that shovelnose sturgeon did not select velocities in proportion to availability. Spawning trials performed in 2012 and 2013 provided indications that substrate along with specific flow velocity influenced site selection. Spawning trials planned for 2014 will continue to characterize the water velocities and substrates connected to shovelnose sturgeon spawning site selection. Understanding the behavioral and environmental ecology of sturgeon spawning reproduction will help river managers determine how controlled flow regimes might be best used (e.g. timing and magnitude) to promote spawning and recruitment.

Total Project Cost		$107,840.00
Beginning Balance – January 2013		$ 7,116.79
Additional funding – 2013		$ 34,383.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 14,975.44	
Contracted Services	$ -0-	
Supplies	$ 6,487.22	
Travel	$ 79.31	
IDCs @ 15%	$ 3,231.30	
Total Spent		$ 24,773.27
Balance		$ 16,726.52
Waived IDCs		$ 6,247.17

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

Investigators

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

Collaborators

Brad Cady, Brad James
Washington Department of Fish and Wildlife

Project Duration

October 2006 – September 2013

Funding

Oregon Department of Fish and Wildlife, MSU indexes 4W1587, 4W1960, 4W2412, 4W2965, 4W3495, 4W4289, 4W4725

During 1 April through 31 December 2012, Montana State University/U.S. Fish and Wildlife Service researchers collected gonadal biopsies from adult white sturgeon in Bonneville Reservoir with Washington Department of Fish and Wildlife. The objective of this research is to describe the maturation cycle in wild white sturgeon above Bonneville Dam and compare the reproductive cycle in that population to that below Bonneville Dam. This was the first year in this study area. The white sturgeon were caught by set-line (n=79). Gonadal tissue was collected by biopsy, and the gonad samples were processed histologically. In 2012, a total of 93 fish were handled during the season (June-August), 79 of which were new fish to the study, and 14 of which were handled twice or more in the season (i.e. within season recapture). A total of 79 gonad samples were collected for histological analysis from white sturgeon in Bonneville Reservoir. Of the 79 gonad samples, 43 were collected from females, 32 were collected from males, and 4 samples did not contain germ cells. The reproductive structure of the adult white sturgeon population in Bonneville Reservoir was determined using the 2012 data. Of the females (n=43), 68% were pre-vitellogenic (Stages 1 and 2), 28% were vitellogenic (Stages 3 and 4), 2% were post-vitellogenic or ripe (Stage 5), 0% were postovulatory (Stage 7), and 2% were undergoing follicular atresia (Stage 8). Of the males (n=32), 78% were pre-meiotic (Stage 2), 6% were mid-spermatogenic (Stage 3 and 4), 0% were spermiating (Stage 5), and 16% were post-spermiation (Stage 6). There were proportionally less than half of the actively reproducing females (post-vitellogenic or ripe, post-ovulatory, and undergoing follicular atresia) in Bonneville Reservoir (4%) compared to below Bonneville Dam where approximately 10% of the adult females were reproducing or undergoing follicular atresia every year. Proportionally, the number of reproducing males (spermiating or post-spermiation) was similar in Bonneville Reservoir (16%) compared to below Bonneville Dam (18%). The sex ratio of the adult white sturgeon population in Bonneville Reservoir using the 2012 data was 1:1.2 males to females.

Total Project Cost		$ 68,042.00
Beginning Balance - January 2013		$ 3,499.71
Additional Funding – 2013		$ 11,295.00
Expenditures - January 2013 - December 2013		
Salaries and Benefits	$ 1,205.54	
Supplies	$ 1,224.82	
Communication	$ -0-	
Contracted Services	$ -0-	
Travel	$ -0-	
Rent	$ -0-	
IDCs @ 44%	$ 1,069.35	
Total Spent		$ 3,499.71
Back to Sponsor (closed 4W3495)		$ -0-
Balance		$ 11,295.00
Waived IDCs		$ -0-

Environmental and endogenous factors affecting egg quality and caviar yield in farmed sturgeon

Investigators

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

Funding

Western Regional Aquaculture Center, MSU index 4W3678
4W3927, 4W4360

Project Duration

June 2011 – August 2015

Several families of the captive broodstock of pallid sturgeon are experiencing high levels of accumulation of gonadal fat that impairs reproductive performance. Sturgeon farmers in California and Idaho also observe highly variable roe yield in mature sturgeon associated with accumulation of fat in the ovaries. Environmental, genetic, and developmental factors can all affect gonadal fat accumulation, but the role of these factors is not well understood. Understanding these effects is essential for conservation propagation of endangered sturgeons and sustained production of high quality sturgeon caviar. The aquaculture farms in California and Idaho are used to conduct a collaborative study, with participation of four states and four sturgeon farms, aimed to investigate these effects on the ovarian adiposity, roe yield, and caviar quality in farmed sturgeon. To date, we have demonstrated the impact of diet on gonadal adiposity. We are currently describing the mechanism of fat accumulation during gametogenesis and will complete the studies focusing on how genetic relatedness affects gonadal fat accumulation within the next year. These results will be directly applicable to sturgeon conservation propagation programs to understand the influence of culture conditions, genetics, and developmental factors on the reproductive performance of captive populations.

Total Project Cost		$ 68,247.00
Beginning Balance - January 2013		$ 28,964.78
Additional Funding – 2013		$ 33,920.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 8,013.76	
Contracted Services	$ 45.00	
Supplies	$ 6,903.48	
Travel	$ -0-	
IDCs @ 0%	$ -0-	
Total Spent		$ 14,962.24
Balance		$ 47,922.54
Waived IDCs		$ 6,583.39

Assessment of carbon dioxide (CO_2) to enhance winter kill in natural rearing ponds used for fish production in the north central region

Investigators

Christopher Guy
Assistant Unit Leader, MTCFRU
Molly Webb
U.S. Fish and Wildlife Service
Michael Jones
Michigan State University

Research Associate

Hilary Treanor

Funding

North Central Regional Aquaculture Center, Michigan State University
MSU index 4W4260

Project Duration

October 2012 – December 2013
Completed

In most natural waters, aquatic organisms are exposed to relatively low concentrations of dissolved carbon dioxide (CO_2). During the middle part of the 20th Century, concerns over the introduction and fate of organic pollution in surface water led to observations and experiments documenting stress and mortality of freshwater fishes exposed to elevated levels of free CO_2. Experimental CO_2 introductions are now being considered as a tool for suppression and manipulation of aquatic species in a variety of field and aquaculture settings. Trials were conducted to determine the lethal concentration (LC_{100}) for fingerlings of three fish species (rainbow trout, common carp, and channel catfish) important to the aquaculture industry and often identified as aquatic invasive species. Fish were exposed to six concentrations of CO_2 for a period of 24 h, and mortality was recorded at the end of each exposure. Rainbow trout experienced 100% mortality when exposed to 225 mg CO_2/L, while common carp and channel catfish experienced 100% mortality at the 495 mg CO_2/L treatment level. We also wanted to determine whether our LC_{100} values could be affected by the rate at which the test tanks were brought to concentration. Using rainbow trout, tanks were raised to concentration over the course of four time periods and then held fish at the empirically-derived LC_{100} (i.e., 225 mg CO_2/L) for 24 h. The rate of CO_2 application did not affect the 24 h LC_{100}. The results demonstrate that CO_2 can be used to induce mortality in multiple species of fish in a laboratory setting.

Total Project Cost		$ 38,250.00
Beginning Balance – January 2013		$ 36,319.33
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 35,194.49	
Contracted Services	$ 180.00	
Supplies	$ 944.82	
Travel	$ -0-	
IDCs @ 0%	$ -0-	
Total Spent		$ 36,319.31
Balance		$ .02
Waived IDCs		$ 15,980.50

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, M.S.

Project Duration
July 2011 – June 2015

Collaborators
Mark Smith
Paul Gerrity
Wyoming Game and Fish Department

Funding
Wyoming Game and Fish Department
MSU index 4W3554

In the Wind River drainage, burbot are a popular sport fish and an important cultural resource for the Eastern Shoshone and Northern Arapahoe tribes. However, there is concern that overexploitation may be limiting these populations. To address this issue, we estimated exploitation by tagging 1041 burbot in Bull Lake and 476 burbot in the Torrey Creek drainage with Carlin-type tags from 2011 through 2013. We also estimated tag loss (20% for the 2011 cohort and 4% for the 2012 cohort) and tag reporting (16%) to minimize bias in our exploitation estimates. In Bull Lake, annual exploitation was 11% (95% CI: 4–19%); in the Torrey Creek drainage, exploitation was 2% (95% CI: 0–16%). Mean exploitation estimates are low; however, the upper ends of both confidence intervals approach values that merit concern. Using population size-structure and parameter estimates, including exploitation, natural mortality, abundance, and growth rate, we constructed a stage-structured model to investigate the effects of varying exploitation rates on the Bull Lake and Torrey Creek drainage burbot populations. The model delineates threshold levels of exploitation that will cause fishery metrics (e.g., biomass of all harvested fish or biomass of trophy sized harvested fish) to fall below acceptable levels—allowing for more informed management decisions with regard to harvest regulations for burbot.

Total Project Cost		$140,250.00
Beginning Balance – January 2013		$ 18,522.59
Additional Funding – 2013		$ 45,970.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 20,284.51	
Contracted Services	$ 27.00	
Supplies	$ 2,241.05	
Communication	$ -0-	
Travel	$ 3,229.63	
Rent	$ -0-	
Repair and Maintenance	$ 257.59	
Tuition	$ 2,398.50	
Participant Support	$ 1,740.00	
IDCs @ 15%	$ 6,035.69	
Total Spent		$ 36,213.97
Balance		$ 28,278.62
Waived IDCs		$ 8,751.70

Spawning characteristics and early life history of mountain whitefish in the Madison River, Montana

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Collaborators
Travis Horton
Montana Fish, Wildlife and Parks

Graduate Student
Jan Boyer, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W3860

Project Duration
January 2012 – January 2015

Mountain whitefish were historically common throughout much of the Intermountain West. However, within the last decade mountain whitefish have exhibited population-level declines in some rivers. In the Madison River, Montana anecdotal evidence indicates mountain whitefish abundance has declined and the population is skewed toward larger individuals, which is typically symptomatic of recruitment problems. Spawning success and early-life history influence numbers of juveniles recruited into a population, so our objectives are to describe the spatial and temporal extent of spawning, determine fecundity, spawning periodicity, and age-at-maturity, identify effective sampling methods for age-0 fish, and describe the spatial distribution of age-0 fish. We implanted radio tags in mature mountain whitefish (n = 138) and relocated tagged fish in autumn 2012 and 2013. Timing of spawning was determined from spawning status of captured females (n = 49) and from density of eggs collected on egg mats. Gonad samples and otoliths were collected from fish sampled in October 2012 (n = 147) in order to examine age at maturity and spawning periodicity, and whole ovaries were collected and used to estimate fecundity for a subsample of females (n = 28). Four sampling gears were tested in May 2013 to compare their effectiveness at sampling age-0 mountain whitefish. Gonad samples suggested that this was an annual spawning population. Fecundity was estimated to be 18,221 eggs per kg body weight. In 2013, the spawning window was 19 October 2013 to 10 November 2013. Mean daily water temperatures during peak spawning varied from 1.5ºC to 8.5ºC. Mean weekly movement varied as a function of spawning behavior. For example, mean pre-spawning weekly movement was 1.9 km (90% CI = 1.7 to 2.2 km) and during spawning was 10.2 km (90% CI = 9.5 to 11.1 km). During spawning, 28% of the tagged fish were observed in an area accounting for 5% of study site length, near Varney Bridge. Our preliminary results suggest that mountain whitefish are successfully spawning in the Madison River, and fecundity and spawning periodicity are similar to other populations.

Total Project Cost		$116,472.00
Beginning Balance – January 2013		$ 9,083.90
Additional Funding 2013		$ 56,906.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 21,908.98	
Contracted Services	$ 1,230.09	
Supplies	$ 27,434.64	
Communications	$ 124.07	
Travel	$ 6,148.86	
Rent	$ 1,675.00	
Repair and Maintenance	$ -0-	
Tuition	$ 3,997.50	
IDCs @ 0%	$ -0-	
Total Spent		$ 62,519.14
Balance		$ 3,470.76
Waived IDCs		$ 27,508.42

Evaluation of management actions in the Big Hole River basin on Arctic grayling relative abundance

Investigator
Christopher Guy
Assistant Unit Leader, MTCFRU

Collaborators
Travis Horton
Montana Fish, Wildlife and Parks

Graduate Student
Austin McCullough, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 423194

Project Duration
August 2012 – December 2014

Arctic grayling currently occupy less than five percent of the native range in Montana and recently the species was listed as a candidate species. Of the five known remaining native populations, the Big Hole River population is the only strictly fluvial population, which was historically the dominant life-history form. Monitoring data from the 1980s to early 2000s indicated abundance and distribution of Arctic grayling were in decline in the upper watershed. Thus, in 2006, Montana Fish, Wildlife & Parks initiated the "Candidate Conservation Agreement with Assurances for Fluvial Arctic Grayling in the upper Big Hole River (Big Hole CCAA)" program with the U.S. Fish and Wildlife Service to secure and enhance the population. Through the Big Hole CCAA, individual conservation plans are developed for voluntarily enrolled non-Federal properties to address limiting factors for Arctic grayling. In return, landowners are assured no further regulatory requirements than those detailed in their conservation plan should Arctic grayling be listed as threatened or endangered.

Since the inception of the Big Hole CCAA program, 14 conservation plans, encompassing 57,000 acres, have been completed to improve conditions for Arctic grayling. Conservation plans address limiting factors for Arctic grayling, which are thought to be degraded riparian and in-stream habitat, adverse stream-flow conditions, barriers to fish migration, and entrainment of individuals in irrigation ditches. Through the Big Hole CCAA, over 300 projects have been completed to address limiting factors, which have previously included stream restoration, native riparian vegetation supplementation, riparian and pasture fence construction, irrigation structure replacement/improvement, modifying irrigation structures to allow year-round fish migration, screening fish from irrigation ditches, and providing off-stream livestock water sources. Additionally, conservation plans develop grazing management plans for livestock in riparian areas and stream-flow agreements, whereby landowners agree to reduce irrigation water diversion when Big Hole River flows reach minimum target levels. To evaluate Arctic grayling population response to management actions, annual sampling is conducted to document relative abundance (fish/mile) of age-1 and older individuals captured within 10 index reaches. Arctic grayling relative abundance has increased from 2006 (0.3 fish/mile) through 2012 (3.2/mile). Big Hole CCAA management actions have presumably contributed to the increase in relative abundance; however, the effect of each management action is unclear. A better understanding of the relationship between management action and Arctic grayling response would provide natural resource agencies with information to implement projects that provide the most benefit.

Therefore, the goal of this project is to evaluate the effects of each management action on Arctic grayling relative abundance.

Total Project Cost		$ 10,398.00
Beginning Balance – January 2013		$ 902.07
Additional Funding 2013		$ 7,898.00
STIP interest – 2013		$ 3.55
Expenditures – January 2013 - December 2013		
Travel	$ -0-	
Communication	$ -0-	
Tuition	$ 3,464.50	
Total Spent		$ 3,464.50
Balance		$ 5,339.12

Evaluation of juvenile bull trout outmigration in Thompson Falls Reservoir

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Lee Nelson
Montana Fish, Wildlife and Parks

Graduate Student
Jeffrey Glaid

Funding
Montana Fish, Wildlife and Parks
MSU index 4W4708

Project Duration
November 2013 – December 2016

Habitat fragmentation caused by dams is known to adversely affect the distribution and connectivity of fish populations. In 2008, the U.S. Fish and Wildlife Service concluded that the PPL Montana Thompson Falls Project was adversely affecting bull trout. Understanding the effects of Thompson Falls Reservoir on the out-migration behavior and survival of juvenile bull trout could lead to the development of new operation procedures for the Thompson Falls Dam to maximize the survival of out-migrating bull trout. The objectives of this study are to estimate travel time, describe travel route, estimate survival rate, and describe habitat use of out-migrating juvenile bull trout in and around Thompson Falls Reservoir. In order to accomplish these objectives, out-migrating juvenile bull trout will be captured in October and September using directional weir traps placed in Fish Trap Creek and the West Fork of the Thompson River. Thirty juvenile bull trout ($\geq$ 45 g) will be surgically implanted each year with Lotek MAP coded acoustic transmitters and monitored throughout the fall and early winter using a combination of stationary hydrophone receivers and mobile tracking.

Total Project Cost		$ 44,924.00
Beginning Balance – November 2013		$ 44,924.00
Expenditures – November 2013 - December 2013		
Salaries and Benefits	$ -0-	
Contracted Services	$ -0-	
Supplies	$ -0-	
Communications	$ -0-	
Travel	$ -0-	
Tuition	$ -0-	
Total Spent		$ -0-
Balance		$ 44,924.00
Waived IDCs		$ -0-

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

Graduate Student

Ann Marie Reinhold, Ph.D.

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

Project Duration

January 2008 – December 2013

Funding

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

The Yellowstone River remains the longest undammed river in the conterminous United States. However, anthropogenic structures, such as bank stabilization and dikes, have been constructed on the Yellowstone River for more than 50 years. These anthropogenic structures have altered fish habitat, but the responses of Yellowstone River fish to these habitat alterations were unknown at the onset of this study. Therefore, we sampled Yellowstone River fish from Laurel to Sidney, Montana, and quantified the responses of fish assemblages to anthropogenic habitat alterations. We quantified a net loss of large side channels from the 1950s to 2001 that directly correlated to dike frequency. We sampled fish in shallow, slow-current velocity habitats in main channels and side channels during runoff and base flow and quantified habitat-use differences between channel types. More fish used side channels than main channels and fish assemblage structure (i.e., proportional fish assemblage compositions) differed between channel types during runoff when much of the main channel habitat may have been unsuitable for fish. Side-channel current velocities were slower than main-channel current velocities at the sampling locations during runoff and not during base flow and shallow, slow current-velocity habitat patches were larger in side channels than main channels during runoff; this may explain why fish were concentrated in side channels during runoff and not during base flow. We sampled fish in bank-stabilized and reference river bends during base flow and determined that fish assemblage structures of small-bodied and large-bodied fish captured in shoreline habitats differed as a function of bank stabilization. The assemblage structure of large-bodied fish captured in thalweg habitats differed as a function of bank stabilization in alluvial river bends, but not in bluff river bends. Changes to assemblage structures associated with bank stabilization differed consistently from, and often opposed, changes to assemblage structures associated with the presence of side channels. The strength of the relationships between assemblage structures and bank stabilization depended on the spatial scale that bank stabilization was measured, with coarse spatial scales explaining assemblage structure best. Depth differences between stabilized and reference pools explained, in part, shifts in assemblage structure associated with bank stabilization.

Total Project Cost		$ 466,242.68
Beginning Balance - January 2013		$ 73,067.85
Expenditures - January 2013 - December 2013		
Salaries and Benefits	$ 47,480.44	
Contracted Services	$ 1,168.28	
Supplies	$ 3,128.67	
Communications	$ 386.37	
Travel	$ 759.29	
Rent	$ -0-	
Maintenance	$ -0-	
Tuition	$ 3,198.00	
IDCs @ 15%	$ 8,418.16	
Total Spent		$ 64,539.21
Balance		$ 8,528.64
Waived IDCs		$ 16,275.10

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

Investigators

Robert Bramblett
Assistant Research Professor
Alexander Zale
Unit Leader, MTCFRU

Collaborators

Jo Ann Dullum
U.S. 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 indexes 4W2596, 4W4273 4W4356

Little information exists about the ecology of spiny softshell turtles in large rivers and in Montana where they are at the northern (45–47° N) and western extent of their natural range, disjunct from downstream populations, and a State species of concern. We described spatial and temporal patterns in movements, habitats and nesting ecology of spiny softshell turtles in relation to natural and anthropogenic factors and identified fundamental habitat areas in the Missouri River in east-central Montana from August 2009 through July 2012. Movement rates of females were greater than those of males and movement rates and trends of both sexes varied among seasons, peaked in summer, and were minimal in winter. Median home range sizes were not significantly different between sexes, varied among seasons, were larger than reported elsewhere (linear 7 km; areal 1 km^2), and were highly variable among individuals (linear 0.9–87.0 km; areal 0.1–17.0 km^2). Turtles aggregated and showed interannual fidelity to active and overwintering-period habitats that were distinct and could be separated by long distances (median 3.4 km, range 0.02–23.27 km). Turtles preferred tributaries or reaches with islands in the spring and summer, outside bends in the winter, and fine substrates in both periods. Microhabitat characteristics at turtle locations varied among months; shallow, slow velocity, near-shore areas were inhabited from May through September whereas deeper areas, with moderate water velocities, and which were located furthest from shore were inhabited from October through April. Preservation and protection of areas inhabited during major portions of the life cycle (lateral habitats and hibernacula) from anthropogenic disturbance may facilitate continued existence of spiny softshell turtles in the Missouri River in Montana.

We located 25 nests in 2011 and 97 in 2012. Nesting followed annual peak river stage, and mostly occurred in the afternoon when temperatures were 25–30° C and no humans were present. Nesting and emergence occurred 20 and 24 d later in 2011 than in 2012, but incubation periods between years were similar. Longitudinal distribution of nests was more restricted in 2011 than

in 2012 and nest distribution was more similar to the distribution of islands in 2012. Nearly all nests were in mixed-gravel substrates, only 3% were in pure sand, and vegetative cover at nest sites was sparse. Median distance of nests to the water's edge was 10.6 m and median bank elevation was 0.7 m; microhabitat characteristics of nests during the emergence period were typically greater than those during the nesting period. Habitat characteristics at basking sites were closer to shore and lower elevation than at nesting. Proportion of nests found on island and mainland habitats were similar in 2011, but 90% of nests were on islands in 2012. Predation occurred on 46 nests; mainland nests incurred three times higher predation rates than island nests. Only 36% of nests were successful in 2011, but 60% were successful in 2012.

Substrate temperatures in simulated nests during the incubation period differed little between depths, but were about 4° C higher in mixed gravel than in sand substrates. Potential freezing episodes penetrated to 20 cm, occurred at all depths and varied among them, duration was generally longer in sand substrates, and minimum temperatures were generally cooler in mixed gravel substrates.

Flooding in 2011 probably decreased nesting effort and success by reducing nesting habitat availability and delaying the onset of nesting, thereby prematurely ending incubation. However, flood events maintain and create nesting habitats by clearing vegetation and depositing substrates. Premature termination of incubation and the ostensible inability of *Apalone spinifera* hatchlings to overwintering in the nest suggest that the northern range of this species is probably limited by successful incubation and emergence before winter each year.

Total Project Cost		$280,472.63
Beginning Balance - January 2013		$ 23,832.55
Additional Funding - 2013		$ 17,478.77
Expenditures - January 2013 - December 2013		
Salaries and benefits	$ 31,755.18	
Contracted Services	$ 43.31	
Supplies	$ -0-	
Communications	$ 15.43	
Travel	$ 1,184.74	
Rent	$ -0-	
Maintenance	$ -0-	
Tuition	$ -0-	
IDCs @ 0% 4W2596	$ -0-	
IDCs @ 17.5% 4W4273	$ 3,890.59	
IDCs @ 15% 4W4356	$ 861.35	
Total Spent		$ 37,750.60
Balance		$ 3,560.72
Waived IDCs 4W2596		$ 2,210.74
Waived IDCs 4W4273		$ 5,891.43
Waived IDCs 4W4356		$ 1,665.30
Waived IDCs TOTAL		$ 9,767.47

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

Collaborators

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

Project Duration

September 2011 – September 2013

Funding

U.S. Geological Survey, CESU
MSU index 4W3769, 4W4344

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. The goal of this study is to predict the effects of climate change on the hydrology and fish assemblages of northern Great Plains streams. Predicted changes in precipitation and air temperature will be linked to changes in streamflow and in turn, fish assemblages by using empirically derived relations between streamflow and fish assemblages as follows: (1) simulate baseline daily streamflows at about 1,500 fish sample sites in eastern Montana using the Precipitation-Runoff Modeling System (PRMS) and existing precipitation, temperature, and basin characteristics; (2) model relations between streamflow characteristics and baseline fish assemblage structures at these fish sample sites; (3) use PRMS to simulate future daily streamflows at the fish sample sites using projected precipitation and temperature output from a regional climate model; and (4) model future fish assemblage structures based on streamflow projections. Index of Biotic Integrity scores will be calculated for the 1,500 fish sample sites to identify areas of primary conservation concern and compare them to the areas that are most likely to change. Results will be presented at workshops with fishery and land managers to help them understand and plan for potential effects of climate change on the hydrology and fish assemblages of northern Great Plains streams.

Total Project Cost		$210,537.00
Beginning Balance – January 2013		$ 46,196.05
Additional Funding – 2013		$109,123.00
Expenditures – January 2013 - December 2013		
Salaries and Benefits	$ 36,233.80	
Contracted Services	$ 16,870.00	
Supplies	$ -0-	
Travel	$ 787.25	
IDCs @ 17.5%	$ 9,430.94	
Total Spent		$ 63,321.99
Balance		$ 91,997.06
Waived IDCs		$ 14,281.13

Taxonomic and ecological services

Investigator
Robert Bramblett
Assistant Research Professor

Funding
USGS Water Science Center
MSU Index 433295

Project Duration
Ongoing

Dr. Bramblett taught laboratory and field identification of small fishes for the Water Science Center in Helena.

Beginning Balance - January 2013		$ 7,515.28
Additional Funding - 2013		$ 5,000.00
Expenditures - January 2013 - December 2013		
Salary and Benefits	$ -0-	
Supplies	$ 1,226.99	
Communications	$ -0-	
Travel	$ 144.00	
Administrative fee @ 4%	$ 54.84	
Total Spent		$ 1,425.83
Balance		$ 11,089.45

MTCFRU Sales and Service Account
MSU Index 433309

This account manages non-grant work that the Montana Cooperative Fishery Research Unit performs in association with cooperators and collaborators.

Fort Peck water chemistry analysis

Investigators

Alexander Zale, Unit Leader
Robert Bramblett, Assistant Research Professor
Michael Duncan, Research Scientist

Collaborator

Heath Headley, Montana Fish, Wildlife and Parks

Funding

$10,700.00 MT FWP

Montana Fish, Wildlife & Parks annually stock millions of walleye fry and fingerlings into Fort Peck Reservoir (H. Headley, FWP, personal communication). However, the contribution of those stocked fish to the fishery remains poorly understood. There is also a lack of knowledge pertaining to important nursery areas and general movements of walleye in the reservoir and its tributaries. Given suitable water chemistry variability among areas of interest (i.e., Fort Peck Reservoir, its tributaries, and hatcheries), otolith microchemistry analysis should provide the information needed to quantify the proportion of stocked and wild walleye in the fishery as well as identify movements and habitat use of walleye in the reservoir and its tributaries. The objectives of this study are to 1) determine the proportion of stocked and wild walleye that compose the Fort Peck Reservoir fishery, 2) determine interannual variability of stocked and wild walleye recruitment, and 3) identify walleye spawning and nursery habitats in Fort Peck and its tributaries. Ratios of $^{87}Sr:^{86}Sr$ ranged from 0.70848 to 0.70975 among sampling locations. The Musselshell River had the lowest $^{87}Sr:^{86}Sr$ ratio, the Missouri River had the highest, and Fort Peck Reservoir and hatchery samples were intermediate. Ratios of Sr:Ca ranged from 4.26 to 9.98 mmol:mol. The Missouri River had the lowest Sr:Ca ratio, the Musselshell River had the highest, and Fort Peck and hatchery samples were intermediate. Ratios of Ba:Ca (mmol:mol), Mg:Ca (mol:mol), and Mn:Ca (mmol:mol) also varied among locations. Despite its variability among sampling locations, manganese was excluded from further analyses due to its low concentrations, which approached the detection limits of the instruments. We used discriminant function analysis to assign water chemistries to individual sampling locations with little error when incorporating elemental and isotopic ratios. Despite sufficient variability in water chemistry, the isotopic and elemental concentrations were not high enough to use a laser spot small enough (< 10 µm) to reliably identify hatchery-reared fry. Improper group assignment was limited to Bone Trail and Rock Creek samples. Isoscapes of $^{87}Sr:^{86}Sr$ and Sr:Ca provided sufficient variability to characterize the water chemistry of water sampling locations when excluding hatcheries from analyses and combining several neighboring reservoir locations. After we assess the otolith microchemistry results, we will complete a preliminary report that includes research recommendations based on the water chemistry and otolith profiles.

Hebgen Lake otolith microchemistry analysis

Investigators

Alexander Zale, Unit Leader
Robert Bramblett, Assistant Research Professor
Michael Duncan, Research Scientist

Collaborator

Travis Lohrenz, Montana Fish Wildlife and Parks

Funding

$7,099 Madison River Foundation

The contribution of stocked rainbow trout to the Hebgen Lake fishery in southwest Montana remains poorly understood. Otolith microchemistry analysis has repeatedly proven to be a reliable technique for identifying hatchery-reared fish. Given suitable water chemistry variability among Hebgen Lake, its tributaries, and the hatchery, otolith microchemistry analysis should provide the information needed to quantify the proportion of stocked and wild rainbow trout in the fishery. The objectives of this study are to 1) determine the proportion of stocked and wild rainbow trout that compose the Hebgen Reservoir fishery, 2) determine interannual variability of stocked and wild rainbow trout recruitment, and 3) identify rainbow trout spawning and nursery habitats in Hebgen Reservoir and its tributaries. We are still waiting for the results of elemental and isotopic water chemistry analyses to determine the feasibility of the project. We will complete a preliminary report that will provide research recommendations based on the water chemistry results.

Beginning Balance - January 2013		$ 1,956.12
Additional Funding – 2013		$ 17,799.00
Expenditures - January 2013 - December 2013		
Salary and Benefits	$ 108.03	
Contracted Services	$ 3,925.00	
Supplies	$ 238.77	
Communications	$ 10.68	
Travel	$ 1,501.08	
Administrative fee @ 4%	$ 231.34	
Total Spent		$ 6,014.90
Balance		$ 13,740.22

Montana Cooperative Fishery Research Unit Vehicle Account

Administrator
Alexander V. Zale
Unit Leader, MTCFRU

Funding
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 - January 2013		$ 68,645.41
Expenditures - January 2013 - December 2013		
Repairs and Maintenance	$ 8,831.39	
Fuel	$ 15,062.20	
Insurance	$ 3,717.24	
Travel Trailer	$ 19,600.00	
Administrative Assessment Fee @ 4%	$ 1,888.48	
Total Spent		$ 49,099.31
Total Revenue Reimbursed		$ 33,461.09
Balance		$ 53,007.19

Montana Cooperative Fishery Research Unit Watercraft Account

Administrator
Alexander V. Zale
Unit Leader, MTCFRU

Funding
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 - January 2013		$ 20,400.72
Expenditures - January 2013 - December 2013		
Supplies	$ 1,956.97	
Equipment	$ -0-	
Maintenance	$ 3,551.89	
Administrative Assessment Fee @ 4%	$ 220.36	
Total Spent		$ 5,729.22
Total Revenue Reimbursed		$ 5,850.00
Balance		$ 20,521.50

Montana Cooperative Fishery Research Unit Operations Account

Administrator
Alexander V. Zale
Unit Leader, MTCFRU

Funding
Yearly: $12,000 from MSU VP Research
MSU index 436899

Beginning Balance - January 2013		$ 13,515.80
Expenditures - January 2013 - December 2013		
Salary and Benefits	$ -0-	
Communications	$ 1,162.05	
Contracted Services	$ 3,030.21	
Supplies	$ 940.44	
Travel, training	$ 95.35	
Rent (Storage Unit)	$ 6,684.00	
Maintenance	$ -0-	
Administrative Assessment Fee @ 4%	$ -0-	
Total Spent		$ 11,912.05
Total Revenue from VPR		$ 12,000.00
Balance		$ 13,603.75

Monetary Equivalence for MSU Services and Facilities
January 2013 - December 2013

Accountant salary and benefits	$ 46,567.33
Office space	
Staff - 515 sq. ft. @ $13/sq. ft.	$ 6,695.00
Students - 742 sq. ft. @ $13/sq. ft.	$ 9,646.00
Laboratory space - 40% of 942 sq. ft. @ $16/sq. ft.	$ 6,028.80
Storage space	
AJMJ cages (2) - 71.5 sq. ft. @ $3.24/ sq. ft.	$ 231.66
Museum facilities - 12.5% of 936 sq. ft. @ $16/ sq. ft.	$ 1,872.00
Library @ 0.8% of total expenditures ($881,240)	$ 7,049.92
Utilities - General @ 12% of total expenditures ($881,240)	$105,748.80
Unit Operations Account	$ 12,000.00
Waived IDCs	$256,595.37
Total	**$452,434.88**

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

Investigator
Alexander V. Zale
Unit Leader, MTCFRU

Funding
Montana Fish, Wildlife and Parks
MSU index 428513

Beginning Balance - January 2013		$ 25,420.16
Additional Funding – July 2013		$ 30,000.00
Expenditures - January 2013 - December 2013		
Salaries and Benefits	$ -0-	
Communication (Telephone/postage)	$ 151.66	
Contracted Services	$ 6,169.49	
Travel	$ 5,063.50	
Supplies	$ 2,132.51	
Repairs and Maintenance	$ -0-	
Equipment	$ -0-	
Tuition	$ 799.50	
Total Spent		$ 14,316.66
Balance		$ 41,103.50

Federal Budget
January 2013 - December 2013

Salaries and Benefits	$313,179.00
Supplies	$ 8,002.73
Total	**$321,181.73**

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 21,492

2009 Chevrolet HHR (red)
Property No. 433291 – Serial No. 3GNBAADB4AS513678
Acquisition value $18,720.00
Mileage 18,414

2005 Chevrolet Silverado 2500, 4x4 crew cab (green)
Property No. 430750 - Serial No. 1GCHK23G15F926039 (2005)
Acquisition value $22,948.21
Mileage 84,527

2002 Chevrolet 4x4 Suburban (white)
Property No. 261052 - Serial No. 3GNGK26U52G249012
Acquisition value $31,988
Mileage 114,255

1999 Chevrolet 3/4-ton 4x4 pickup truck (white)
Property No. 252537 -- Serial No. 1GCGK24R9XF049122
Acquisition value $21,009
Mileage 154,235

1989 Chevrolet 4x4 Suburban (tan)
Property No. 261114 - Serial No. 1GNGV26K2KF176088
Acquisition value $15,766
Mileage 152,380

Leica M165 C Stereomicroscope System
Serial No. 10450035
Leica DFC450 Digital Camera
Serial No. 12730411
Acquisition value $20,936

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 31,233

2005 GMC Sierra 2500 crew cab truck (green)
Property No. 132353
Serial No. 1GTHK23G65F944780
Acquisition Value $24,463.00 (2005)
Mileage 101,047

2001 GMC 1/2 ton 4x4 extended cab truck (green)
Property No. 132228
Serial No. 2GTEK19T911227311
Acquisition Value $15,255.00 (2005)
Mileage 153,091

1999 Ford F250 4x4 crew cab (blue)
Property No. 125014
Serial No. 1FTNW21S8XEA98840
Acquisition Value $11,002 (2005)
Mileage 175,251

1999 Chevrolet 1/2 ton 4x4 extended cab truck (white)
Property No. 132229
Serial No. 2GCEK19T8X1144560
Acquisition Value $12,459.00 (2005)
Mileage 201,079

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 18’ 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)

2013 Jayco Jay Flight 26BH Travel Trailer
Serial No. 1UJBJ0BP4D77R0223
Acquisition value $19,600 (2013)

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)