Montana Cooperative Fishery Research Unit

2018 Briefing Booklet

MONTANA COOPERATIVE
FISHERY RESEARCH UNIT

Coordinating Committee Meeting
Helena, Montana
18 April 2018

Personnel and Cooperators

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Graduate Students Advised by Unit Faculty

Tanner Cox	M.S.
Kyle Crapster	M.S.
Colleen Detjens	M.S.
Mike Duncan	Ph.D.
Adeline Dutton	M.S.
Haley Glassic	Ph.D.
Jeffrey Glaid	M.S.
Luke Holmquist	M.S.
Daniel Kaus	M.S.
Michael Lance	M.S.
Jason Marsh	M.S.
Paige Maskill	M.S.
Austin McCullough	M.S.
Lauren McGarvey	M.S.
Alex Poole	M.S.
Andriana Puchany	M.S.
Allison Stringer	M.S.
Nathan Thomas	M.S.
Nicholas Voss	M.S.
Jacob Williams	M.S.

Graduate Students Advised by Cooperating Faculty

Kathleen Carroll	Ph.D.
Brent Cascaddan	M.S.
Michael Forzley	M.S.
Shannon Hilty	M.S.
Megan Milligan	Ph.D.
Eric Scholl	Ph.D.
Benjamin Triano	M.S.
Skyler Vold	M.S.

Graduate Students Receiving Degrees

Adeline Dutton graduated with a M.S. in Fish and Wildlife Management and is working for Wisconsin Department of Natural Resources as a Senior Fisheries Biologist.

Jeffrey Glaid graduated with a M.S. in Fish and Wildlife Management and is working for Wyoming Game and Fish as a Fisheries Biologist.

Luke Holmquist graduated with a M.S. in Fish and Wildlife Management and is working for U.S. Geological Survey as a Research Technician.

Austin McCullough graduated with a M.S. in Fish and Wildlife Management and is working for Montana Fish, Wildlife and Parks as a Fisheries Biologist.

Nathan Thomas graduated with a M.S. in Fish and Wildlife Management and is working for National Park Service as a Fisheries Research Technician.

Research Technicians

Keenan Blackbird
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Evan Moran
Ticha Padgett-Stewart
Chris Smith
Ben Turnock
Charles White
Madeleine Whitman
Charlie Williams

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.

Seasonal movements of rainbow trout, brown trout, and mountain whitefish in the Smith River, Montana

Investigator
Alexander Zale
Unit Leader

Graduate Student
Michael Lance, M.S.

Duration
January 2015 – December 2018

Collaborators
Grant Grisak, Jason Mullen
Montana Fish, Wildlife and Parks
Tom McMahon, MSU
Robert Al-Chokhachy, USGS
Northern Rocky Mountain Science Center

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5241

We investigated fish movement in the Smith River, an un-fragmented watershed in central Montana. We tracked the movements of over 7,500 fish of multiple species to determine biological, spatial, and temporal patterns of movement. Movement varied by species with Mountain Whitefish (*Prosopium williamsoni*) being the most likely to move 0.5 km or more after being tagged. Brook Trout (*Salvelinus fontinalis*) moved the least, usually less than 0.5 km. The median home range of all species was ≤ 10 km, but some individuals had home ranges up to 182 km. Movement was greatest among fish tagged in the middle portions of the Smith River, with decreased amounts of movement by fish in tributaries, the Smith River headwaters, and the Smith River near its confluence with the Missouri River. Movement was strongly associated with species-specific spawning periods. Movement was also related to water temperatures, with the most movement occurring near species-specific thermal optimums (13-15 °C). Fish displayed complex movement behaviors that varied by species, and movements of fish connected distant portions of the watershed. The diversity of movement expressed by fish in the Smith River probably helps to increase resilience of the Smith River fish assemblage to localized environmental disturbances. Consideration of differences in movements among species, locations, and seasons may enhance management actions to protect critical movement corridors during periods of high movement activity.

Total Project Cost		$ 150,922.00
Beginning Balance – January 2017		63,567.65
Expenditures – January 2017 - December 2017		
Salaries and Benefits	26,193.21	
Contracted Services	1,434.14	
Supplies	2,937.54	
Communications	7.15	
Travel	6,938.93	
Rent	1,300.00	
Repairs and Maintenance	0	
Tuition	5,167.55	
Total Spent		43,978.52
Balance		19,589.13
Waived IDCs		19,350.55

Effect of water chemistry and pressure on lake trout embryos

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

Graduate Student
Alex Poole, M.S.

Collaborator
Todd Koel
Yellowstone National Park

Funding
National Park Service, CESU
MSU index 4W5648

Duration
September 2015 – August 2019

Introduced Lake Trout threaten native Yellowstone Cutthroat Trout in Yellowstone Lake, Yellowstone National Park. Gill nets have been used to suppress subadult and adult Lake Trout since 1995. Because survival of embryonic and larval life history stages can have profound effects on population dynamics of Lake Trout, suppression at those stages, especially if used in concert with intensive gill netting of older fish, could enhance suppression efforts. We therefore conducted controlled laboratory and field experiments to systematically evaluate the effects of a variety of candidate chemical physical, and biological suppression methods on different developmental stages of Lake Trout embryos and larvae. Methods that significantly increased mortality in laboratory experiments included liquid and powdered rotenone applications, fish carcass and carcass analog exposures, and sediment deposition. Sodium chloride, calcium carbonate, and gelatin applications were not effective. Controlled field experiments evaluated the effect of ground Lake Trout carcass application and sediment deposition on Lake Trout embryonic mortality. Ground carcasses at 14 and 28 kg/m^2 caused 100% mortality down to 20 cm and at 7 kg/m^2 caused 64% (23.2 SE) mortality at the substrate surface and 99% (0.67 SE) mortality at 20 cm in the substrate. Sediment deposition was not effective at increasing Lake Trout embryonic mortality in field experiments. These results suggest, if implemented on a large scale, ground Lake Trout carcass application may be an effective additional suppression method. Field evaluations of liquid and powdered rotenone and carcass analogs are warranted to determine potential efficacy in Yellowstone Lake and other waters in the western United States where Lake Trout suppression is desirable.

Total Project Cost		$ 90,017.00
Beginning Balance – January 2017		56,772.63
Expenditures – January 2017 - December 2017		
Salaries and Benefits	19,367.92	
Contracted Services	0	
Supplies	2,164.30	
Communications	0	
Travel	656.37	
Rent	0	
Repairs and Maintenance	0	
Tuition	3,008.30	
IDCs @ 17.5%	4,409.39	
Total Spent		29,606.28
Balance		27,166.35
Waived IDCs		6,677.24

Environmental DNA as a means to estimate relative abundance of Yellowstone cutthroat trout spawning in tributaries to Yellowstone Lake

Investigator
Alexander Zale
Unit Leader

Graduate Student
Colleen Detjens, M.S.

Duration
January 2016 – December 2020

Collaborators
Todd Koel
Yellowstone National Park
Andrea Litt
Assistant Professor MSU
Mike Schwartz
U.S. Forest Service

Funding
National Park Service
MSU index 4W4525 (Institute on Ecosystems)

The population of Yellowstone cutthroat trout in Yellowstone Lake is one of the largest genetically pure populations within the species' native range and is therefore a conservation priority. The population has been stressed by several factors over the years, including whirling disease and drought. However, the most serious threat is illegally introduced lake trout. First detected in 1994, lake trout have continued to pose a threat to native cutthroat trout through competition and predation. As a result of these threats, particularly in response to the introduction of lake trout, fisheries managers in Yellowstone National Park have invested a sizable amount of effort and funds in the recovery of the Yellowstone cutthroat trout population. In addition to the efforts aimed at removing lake trout, park biologists are also concerned with assessing the recovery of Yellowstone cutthroat trout based on a series of metrics that define desired conditions for Yellowstone Lake. One such metric is the assessment of cutthroat trout spawning in tributary streams.

Environmental DNA (eDNA) has recently garnered significant attention for its potential in assisting fisheries monitoring programs. The method, which involves collecting a water sample and testing for specific species presence or absence, has proven successful in many instances. Furthermore, several studies have suggested that relative abundance may be inferred from eDNA concentrations. We aim to provide a better understanding of the relationship between eDNA concentrations and fish abundance, specifically as it relates to spawning Yellowstone Cutthroat Trout in Yellowstone Lake tributaries. Repeated sampling of 6 or 7 tributaries will occur from April through October. Samples will be collected at several locations in each tributary and analyzed using qPCR. Visual surveys will be conducted in conjunction with water sample collection. A sonar fish counter located on a large tributary and an electronic counter on two smaller tributaries will also be used to compare to eDNA amounts.

Samples were collected from six tributaries in 2016 and five tributaries in 2017. Electronic counter tubes were installed on two tributaries in 2017, but as a result of high water and technical difficulties a complete count was not obtained. Samples are currently being analyzed at the Rocky Mountain Research Station in Missoula, MT. Further sampling will occur during the 2018 field season and will be directed by the analysis results of the previously collected samples.

Assessing limiting factors precluding re-establishment of Arctic Grayling in Elk Springs Creek

Investigator
Alexander Zale
Unit Leader

Graduate Student
Jason Marsh, M.S.

Collaborators
George Jordan, Bill West, and Jeff Warren
U.S. Fish and Wildlife Service
Matt Jaeger
Montana Fish, Wildlife and Parks

Duration
March 2015 – September 2018

Funding
U.S. Fish and Wildlife Service
(no MSU involvement)

Habitat fragmentation can have significant effects on migratory fish populations. Arctic Grayling (*Thymallus arcticus*) spawned in 11 tributaries of Upper Red Rock Lake in southwest Montana in the early 1900s but now persist in only Red Rock Creek. Elk Springs Creek, a spring-fed tributary to Upper Red Rock Lake, historically had a large Arctic Grayling spawning presence. Grayling were so abundant that the U.S. Bureau of Fisheries operated a spawning station near the springheads from 1898 to 1910 for the collection of grayling gametes. However, operation ceased after an unsuccessful egg take in 1910 that coincided with the diversion of water from Elk Springs Creek into low-gradient marsh habitat (Swan Lake) by duck hunters. Swan Lake may be inhospitable to upstream-migrating Arctic Grayling spawning adults and downstream-migrating juveniles. Managers have recently attempted to restore a spawning run using remote site incubators (RSIs) with little to no success. We are using passive integrated transponder (PIT) tags to determine movements of Arctic Grayling in Elk Springs Creek before and after reconnection of the stream to Upper Red Rock Lake. The specific study objectives are to 1) determine how seasonal temperature and dissolved oxygen concentration trends affect movements of Arctic Grayling in Elk Springs Creek and its tributaries before and after Swan Lake is bypassed, and 2) determine abundances of Arctic Grayling in Elk Springs Creek and its tributaries before and after Swan Lake is bypassed.

Fifty-six Arctic Grayling have been PIT tagged in Elk Springs Creek and its tributaries since investigations began in spring 2015: 34 in 2015, 6 in 2016, and 16 in 2017. Two juvenile Arctic Grayling migrated through Swan Lake in spring 2016 before Swan Lake was bypassed in fall 2016. Five juvenile Arctic Grayling migrated through Swan Lake in spring 2017. One adult Arctic Grayling PIT tagged in spring 2015 migrated upstream through the reclaimed channel that bypasses Swan Lake in spring 2017. Additionally, one adult Arctic Grayling was captured near the headwaters of Elk Springs Creek during spring electrofishing surveys in 2017 and was subsequently detected emigrating from Elk Springs Creek to Upper Red Rock Lake two weeks after capture. Moreover, this is the first time adult Arctic Grayling have been documented in Elk Springs Creek since investigations began in spring 2015.

Identifying the threats of smallmouth bass to Yellowstone cutthroat trout in the Yellowstone River

Investigators

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

Graduate Student

Nick Voss, M.S.

Duration

April 2016 – May 2019

Collaborators

Mike Ruggles, David Schmetterling, Scott Opitz, Jason Rhoten
Montana Fish, Wildlife and Parks

Funding

Northern Rocky Mountain Science Center, USGS RWO 72, MSU index 4W5971

Non-native smallmouth bass (*Micropterus dolomieu*) have demonstrated considerable range expansion from their initial stocking locations in the Yellowstone River near Miles City, Montana (river km 293); adult smallmouth bass are now sympatric with wild and native trout near Livingston, Montana (river km 797), and potentially as far upstream as Emigrant, Montana (river km 844). In other western waters, introduced smallmouth bass demonstrated pronounced effects on juvenile salmonids and other resident fish species. Information about their current and potential distribution, habitat associations, and ecological interactions is needed to identify the threat severity of smallmouth bass to other fishes in the Yellowstone River.

We used trap netting to determine the upstream extent and habitat associations of juvenile smallmouth bass, as the presence of this life stage is indicative of habitats that are suitable for establishment by the species. We sampled Yellowstone River side-channel habitats for juvenile smallmouth bass from the Clarks Fork Yellowstone River confluence (river km 610) to the Shields River confluence (river km 785) in August and September 2016, and from the Huntley Diversion (river km 566) to the Pine Creek confluence (river km 818) in August and September 2017. We documented juvenile smallmouth bass as far upstream as Big Timber (river km 732) in 2016 and Reed Point (river km 700) in 2017, suggesting a discrepancy between the upstream extent of adult distribution and that of successful reproduction. We documented juvenile smallmouth bass in every sampled side channel below the Clarks Fork Yellowstone River confluence in both years, and only sporadically above it. Analyses relating their presence to habitat covariates are still pending. Next steps include repeated sampling in 2018 to quantify longitudinal patterns in diet, consumption, and summer growth. We will use these results to inform a bioenergetics model that will estimate juvenile summer growth potential based on temperature data. Such estimates will allow us to predict

size-selective juvenile winter mortality, which has been shown to limit distribution in other northern systems, across a broad longitudinal extent of the Yellowstone River.

Total Project Cost		$ 74,258.00
Beginning Balance – January 2017		23,268.97
Additional Funding – 2017		40,000.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	11,096.31	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	868.43	
Rent	0	
Repairs and Maintenance	0	
Tuition	2,587.75	
IDCs @ 15%	2,182.85	
Total Spent		16,735.34
Balance		46,533.63
Waived IDCs		4,220.22

Linkages between unpaved road sediment production and instream sediment and the interactions between habitat, native trout eDNA, and abundance.

Investigators
Alexander Zale
Unit Leader
Robert Al-Chokhachy
USGS NOROCK

Graduate Student
Kyle Crapster, M.S.

Duration
August 2016 – September 2019

Collaborators
Adam Sepulveda, USGS
Ladd Knotek, MTFWP
Tom Black, Charles Luce, Shane Hendrickson, Michael Young
USDA Forest Service

Funding
USDA Forest Service , CESU
MSU index 4W6280
RWO 73 4W6610

Native trout populations are becoming increasingly vulnerable to interactions between large-scale natural and anthropogenic disturbances. To focus conservation efforts on mitigating these emergent threats, we must understanding the implications of climate and land management on aquatic habitats and the linkage of habitat to populations at multiple scales. One such anthropogenic disturbance tied to land management is road networks. For example, the U.S. Forest Service road network exceeds over 600,000 kilometers and serves as a primary sediment contributor to streams. However, road sediment contributions and subsequent habitat degradation are dependent on the extent of an unpaved road network and its context within the landscape (Al-Chokhachy et al. 2016). Mechanistic models for estimating road sediment production are currently being refined but lack validation from in-stream sediment monitoring. Our first objective is to improve our understanding of linkages between roads and instream sediment. We selected five road-stream connection points from two drainages in northwest Montana. Within these drainages, road sediment delivery from individual road-stream connection points was estimated using Geomorphic Road Analysis and Inventory Package (GRAIP) models. We then collected various measures of in-stream suspended sediment concentrations (SSC), turbidity, and continuous stage. Sampling extended from March into November to capture variability of road sediment delivery across seasons. Results from the first sampling season were inconclusive; no discernable relationships among discharge, estimates of road sediment production, and measures of SSC were observed.

An addition challenge in understanding biological effects of large scale disturbances such as road networks is monitoring fish populations at corresponding scales. Rapid and cost-effective tools that allow managers to effectively scale up population abundance estimates are therefore needed. Whereas environmental DNA (eDNA) has the potential to assess fish abundances, considerable variability exists in the relationship between eDNA concentration and fish abundance. To address this limitation, we initiated a study investigating how habitat and environmental attributes

influence the relationship between eDNA concentrations and fish abundances. We simultaneously quantified eDNA concentrations and abundances of westslope cutthroat (*Onchorhynchus clarki lewisi*) and bull trout (*Salvelinus confluentis*) in four tributaries to the Clearwater River. In addition, we concomitantly collected habitat and environmental attributes potentially influencing eDNA production, persistence, and transportation. Large variability was present among replicate eDNA samples and in their relationship with fish abundance. Furthermore, several habitat variables moderated the relationship between eDNA concentrations and relative abundance, but varied between species.

Total Project Cost 4W6610 RWO 73		$ 27,238.00
Beginning Balance – March 2017		27,238.00
Expenditures – March 2017 - December 2017		
Salaries and Benefits	14,700.95	
Contracted Services	0	
Supplies	133.98	
Communications	0	
Travel	6,461.04	
Tuition	2,389.25	
Repairs and Maintenance	0	
IDCs @ 15%	3,552.78	
Total Spent		27,238.00
Balance		0
Waived IDCs		6,868.71

Total Project Cost 4W6280		$ 55,009.74
Beginning Balance – January 2017		46,635.58
Expenditures – January 2017 - December 2017		
Salaries and Benefits	7,677.52	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	652.35	
Tuition	2,761.65	
Repairs and Maintenance	0	
IDCs @ 17.5%	1,941.02	
Total Spent		13,032.54
Balance		33,603.04
Waived IDCs		2,939.25

Assess the recovery of westslope cutthroat trout and Arctic grayling in restoration areas

Investigator
Alexander Zale
Unit Leader

Graduate Student
Andriana Puchany, M.S.

Duration
September 2017 – June 2021

Collaborators
Todd Koel
Yellowstone National Park
Bradley Shepard
B.B. Shepard and Associates

Funding
National Park Service
MSU index 4W6811

Native populations of Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* and Arctic Grayling *Thymallus arcticus* in Yellowstone National Park were reduced or eliminated through competition, predation, and hybridization with nonnative fishes that were historically stocked by managers, ostensibly to enhance sportfishing. National Park Service (NPS) fisheries managers carried out conservation actions aimed at restoring Westslope Cutthroat Trout (WCT) and Arctic Grayling populations in two watersheds in Yellowstone National Park, including East Fork Specimen Creek in the Gallatin River drainage and Grayling Creek in the Madison River drainage. Conservation actions included 1) building barriers impassable to upstream fish movement to isolate watersheds; 2) applying rotenone, a lethal fish toxicant, to eliminate all fish from the watersheds above the barriers; and 3) reintroducing native fish to the isolated watersheds.

NPS fisheries managers plan to continue restoration efforts of WCT and Arctic Grayling in additional park watersheds, but first want to understand how past conservation efforts performed to guide future restoration actions. Therefore, the goal of this research project is to assess the recovery and status of the reintroduced populations of WCT and Arctic Grayling in East Fork Specimen and Grayling creeks. Our specific objectives are to 1) assess population abundance, size structure, condition, individual growth, and reproductive success of WCT and Arctic Grayling; 2) determine the spatial distributions of restored WCT and Arctic Grayling in relation to the reintroduction sites; 3) determine how population size structure and condition of recovering WCT in East Fork Specimen Creek compare to those of the hybridized WCT population they replaced; and 4) estimate the genetic population structure of recovering Westslope Cutthroat Trout relative to the contributions of the various WCT donor sources (Last Chance, Geode, and Muskrat creeks, and Sun Ranch Hatchery). Attainment of these objectives will provide NPS fisheries managers with information needed to better manage these populations and to guide future restoration efforts elsewhere in the Park.

Total Project Cost		$ 125,357.00
Beginning Balance – September 2017		125,357.00
Expenditures – September 2017 - December 2017		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
IDCs @ 17.5%	0	
Total Spent		0
Balance		125,357.00
Waived IDCs		0

Annual evaluation and development of benchmarks for Lake Trout suppression in Yellowstone Lake

Investigators
Christopher Guy
Assistant Unit Leader
John Syslo, Post Doc
Travis Brenden Research Associate

Collaborator
Todd Koel
Yellowstone National Park

Funding
National Park Service, CESU
MSU index 4W4470

Duration
July 2013 – June 2018

Introduced Lake Trout threaten to extirpate native Yellowstone Cutthroat Trout, an important 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 Yellowstone 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. The abundance of Lake Trout age 2 and greater increased from approximately 80,000 (69,000 -90,000; 95% CI) fish in 1998 to 953,000 (839,000-1,057,000; 95% CI) fish in 2012. Large increases in fishing effort from 2012 through 2017 resulted in high fishing mortality and likely prevented Lake Trout abundance from continuing to increase. From 2014 through 2016, fishing effort was about 75,000 100-m net nights, which exceeded the recommended target of 45,000 100-m net nights. In 2017, the fishing effort increased to 90,000 100-m net nights. The fishing effort in 2017 resulted in an instantaneous fishing mortality rate of 1.43 (1.06-1.79; 95% CI). Lake Trout abundance is predicted to decline if the high level of fishing effort implemented from 2014 to 2017 is maintained. At a fishing effort level of 75,000 100-m net nights, population projections indicate an overall population growth rate of 0.63 (0.55-0.75).

Total Project Cost		$ 85,165.00
Beginning Balance – January 2017		31,305.85
Expenditures – January 2017 - December 2017		
Salaries and Benefits	9,096.27	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
IDCs @ 15%	1,591.82	
Total Spent		10,688.09
Balance		20,617.76
Waived IDCs		2,637.92

Mobile tracking of Lake Trout in Yellowstone Lake

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel, Pat Bigelow
Yellowstone National Park

Graduate Student
Jacob Williams, M.S.

Funding
National Park Service, CESU
MSU index 4W5738

Duration
September 2015 – August 2019

Suppression of Lake Trout in Yellowstone Lake is a high priority for Yellowstone National Park. Nearly two million dollars are spent on suppression annually and this effort is projected to continue for the foreseeable future. Gillnetting in Yellowstone Lake has removed over two million Lake Trout since suppression began in 1995. Targeting known spawning locations has resulted in the highest numbers of adult Lake Trout removed. Historically, it was believed that Lake Trout spawned at three locations in the West Thumb. Recently, nine additional spawning sites have been confirmed. The discovery of additional spawning areas has demonstrated the lack of our understanding regarding Lake Trout spawning locations. Insight into the movement, staging, and spawning habits of Lake Trout will be useful in the current suppression efforts and will also provide information for novel suppression methods. The specific objectives of the study are: 1) identify spawning locations, 2) identify movement corridors and seasonal aggregation patterns, and 3) evaluate the efficacy of targeting tagged Lake Trout to increase catch rates. Lake Trout (N = 469) were surgically implanted with acoustic transmitters from 2015 through 2017. Tracking resulted in 1,995 detections of 254 individual Lake Trout in 2016 and 2,685 detections of 379 individuals in 2017. Kernel density estimation was used to analyze Lake Trout locations and twelve additional putative Lake Trout spawning sites were identified throughout Yellowstone Lake with the highest concentrations of Lake Trout in the West Thumb. Contract netting crews targeted 34 aggregations of Lake Trout during the summer (June-August). Targeted areas had higher catch rates than random sites—indicating targeting known locations of acoustically tagged Lake Trout is an effective strategy for increasing the efficacy of Lake Trout suppression.

Total Project Cost		$ 90,017.00
Beginning Balance – January 2017		61,370.47
Expenditures – January 2017 - December 2017		
Salaries and Benefits	18,771.20	
Contracted Services	0	
Supplies	95.63	
Communications	0	
Travel	2,323.02	
Rent	0	
Repairs and Maintenance	0	
Tuition	4,559.75	
IDCs @ 17.5%	4,506.16	
Total Spent		30,255.76
Balance		31,114.71
Waived IDCs		6,823.64

Novel methods to induce mortality of Lake Trout embryos in Yellowstone Lake

Investigator
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Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Graduate Student
Nathan Thomas, M.S.

Funding
National Park Service, CESU
MSU index 4W4973

Duration
July 2014 – January 2018
Completed

Non-native Lake Trout threaten to extirpate native Yellowstone Cutthroat Trout in Yellowstone Lake, Yellowstone National Park. Suppression of Lake Trout in Yellowstone Lake has been ongoing since 1995, primarily by gillnetting. Unfortunately, bycatch of Yellowstone Cutthroat Trout is associated with this removal method, which targets adult and subadult Lake Trout. Alternative methods effective at causing mortality in early life stages of Lake Trout could be used simultaneously with gillnetting to improve suppression effectiveness. The vulnerability of salmonid embryos suggests increasing Lake Trout embryo mortality is feasible and because population growth rates are sensitive to age-0 survival an effective embryo suppression method could have population-level effects. Thus, the primary objective of this study was to evaluate the efficacy of methods to increase mortality of Lake Trout embryos. *In situ* experiments tested the effect of dredging, electroshocking, tarping, and Lake Trout carcass deposition on embryo mortality. Tarping and dredging were not effective at increasing embryo mortality. Electroshocking caused 92% mortality of embryos at the substrate surface, but only 38% at 20 cm depth in the substrate. Lake Trout carcass deposition caused 99% mortality of embryos at the surface and at 20 cm in the substrate. Anoxic conditions at the carcass sites may be the mechanism for the high embryo mortality. Embryo suppression methods are unlikely to replace traditional Lake Trout suppression methods. However, the success of Lake Trout carcass deposition shows potential for the development of an effective alternative suppression method that could be implemented on a large scale.

Total Project Cost		$ 172,082.00
Beginning Balance – January 2017		8,821.82
Additional Funding -- 2017		43,230.00
Expenditures – January 2017 - January 2018		
Salaries and Benefits	32,443.79	
Contracted Services	714.96	
Supplies	1,912.75	
Communications	282.41	
Travel	2,632.97	
Rent	4,800.00	
Repairs and Maintenance	177.00	
Tuition	1,331.30	
IDCs @ 17.5%	7,756.64	
Total Spent		52,051.82
Balance		0
Waived IDCs		11,738.22

Lake Trout suppression and the ecological consequences in Yellowstone Lake

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Graduate Student
Haley Glassic, Ph.D.

Funding
National Park Service
MSU index 4W6204

Duration
September 2016 – August 2021

Invasive species introductions cause reductions in populations of native species and are associated with negative environmental and economic effects. Suppression techniques including chemical, mechanical, and biological controls are commonly used to manage invasive species. Understanding the ecosystem-level influence of suppression techniques selected by natural resource agencies is essential for establishment of successful mitigation against invasive species and assisting native populations in an altered ecosystem. Invasive Lake Trout within Yellowstone Lake, Yellowstone National Park, Wyoming have greatly reduced the abundance of native Yellowstone Cutthroat Trout and disrupted the ecosystem through food-web alteration. Commercial gill-netters are contracted by the National Park Service to remove juvenile and adult Lake Trout, and a portion of the Lake Trout carcasses collected are subsequently placed on Lake Trout spawning sites to suppress embryo development. The novel concentration of nutrients from Lake Trout carcasses could further influence the adult stages of Lake Trout and Yellowstone Cutthroat Trout by providing concentrated areas of prey not historically available. The proposed study will evaluate the effects of Lake Trout carcass deposition in the aquatic food web of Yellowstone Lake to better understand the influence of Lake Trout carcass deposition lake-wide.

Total Project Cost		$ 183,300.00
Beginning Balance – September 2017		183,300.00
Expenditures – September 2017 - December 2017		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Total Spent		0
Balance		183,300.00
Waived IDCs		0

Reproductive readiness and behavioral ecology of wild hatchery-reared Pallid Sturgeon in the Missouri River above Fort Peck Reservoir, Montana

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
David Trimpe
U.S. Bureau of Reclamation

Graduate Student
Luke Holmquist, M.S.

Funding
Bureau of Reclamation
MSU index 4W4723

Duration
January 2014 – June 2017
Completed

Pallid sturgeon are an endangered species indigenous to the warm, turbid waters of the Yellowstone, Missouri, and Mississippi rivers. Population declines observed in pallid sturgeon are a function of habitat alteration and fragmentation from the construction and operation of dams on the large rivers they inhabit. The Pallid Sturgeon population in the upper Missouri River, upstream of Fort Peck Reservoir, has experienced a substantial decline such that only a few (< 50) wild fish remain in the population. To augment the declining population, stocking of age-1 hatchery-origin (HO) pallid sturgeon produced from wild broodstock began in 1998 (i.e., 1997 year-class) to prevent extirpation of the species in the upper Missouri River. The objectives of this study are: 1) determine age and size of HO Pallid Sturgeon at first sexual maturity, 2) determine the spawning periodicity of HO Pallid Sturgeon, 3) determine if reproductively active (RA) HO Pallid Sturgeon use habitat and move similarly to RA wild-born adult Pallid Sturgeon, 4) determine if experimental discharge releases from upstream reservoirs provide a cue for RA Pallid Sturgeon to migrate further upstream during spawning migrations, and 5) assess spawning success of female Pallid Sturgeon. To accomplish these objectives, radio-tagged Pallid Sturgeon were captured in the early-spring and assigned to reproductive classifications based on sex (determined using sex-steroid concentrations) and origin of the fish (hatchery or wild). During the presumed spawning season, weekly locations were obtained for each individual and habitat-use were recorded at each location. The youngest RA male HO Pallid Sturgeon captured was 14.5 years old and the youngest female was 18. Hatchery-origin males were observed having annual (N=3) and biennial (N=2) reproductive cycles. Mean total movement distances (± SE) during the spawning season were greater for both RA male classifications than for unconfirmed sex HO fish. Mean total movement distances were 104.5 km (18.9) for RA wild males, 116.0 km (18.1) for RA 1997-year class males, and 20.6 km (3.0) for unconfirmed sex 1997-year class fish. The timing of peak spring discharge was eight days earlier and 79 m^3/s less in 2016 compared to 2015, but total movement (km), maximum upstream location (rkm), median location (rkm), and home range size (km) during the presumed spawning season did not differ between the two years. In 2016, a RA HO female was

recaptured in the upper Missouri River approximately 15 km upstream of the confluence with the Marias River, representing the most upstream RA fish observed in this study. A successful spawning event at this location would provide the necessary distance from the reservoir transition zone to accommodate extended larval drift, but no spawning event took place. Interestingly, all five females (two wild and three HO) tracked from 2014 and 2016 went atretic. These preliminary results indicate that RA HO Pallid Sturgeon have similar behavior to wild Pallid Sturgeon in this reach of the Missouri River, but exhibit an alarmingly high incidence of follicular atresia.

Total Project Cost		$ 288,031.28
Beginning Balance – January 2017		30,452.79
Expenditures – January 2017 - June 2017		
Salaries and Benefits	9,220.38	
Contracted Services	3,679.90	
Supplies	7,765.40	
Communications	22.00	
Travel	1,421.53	
Rent	0	
Repairs and Maintenance	<.52>	
Tuition	2,802.30	
IDCs @ 17.5%	4,359.46	
Total Spent		29,270.45
Balance returned to sponsor		1,182.34
Waived IDCs		6.601.41

Spawning readiness, spawning locations and habitat use of pallid sturgeon in the Missouri River above Fort Peck

Investigators
Christopher Guy
Assistant Unit Leader
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US Fish and Wildlife Service

Graduate Student
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Collaborator
Anne Tews
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6930

Duration
September 2017 – June 2020

All reproductively active female Pallid Sturgeon monitored from 2014 through 2016 in the Missouri River above Fort Peck Reservoir, MT underwent follicular atresia. Hatchery-origin Pallid Sturgeon that underwent follicular atresia may have experienced a spawning “dummy run” that would affect first-time reproductively active female Pallid Sturgeon. Successful recruitment of Pallid Sturgeon is further hindered by inadequate drift distance resulting in mortality of larval Pallid Sturgeon that settle in anoxic conditions found at the headwaters of Fort Peck Reservoir. Recruitment failure continues to prevent Pallid Sturgeon recovery in the upper Missouri River. Thus, knowledge of spawning site selection and reproductive health of Pallid Sturgeon are important to conservation of the species. The objectives of this study are: 1) describe age at first maturity for hatchery-origin Pallid Sturgeon; 2) describe the spawning periodicity of hatchery-origin Pallid Sturgeon; 3) compare movement rates of reproductively active Pallid Sturgeon to those of non-reproductively active Pallid Sturgeon, atretic Pallid Sturgeon, and Pallid Sturgeon in other studies; 4) identify where Pallid Sturgeon spawning occurs in the Missouri River above Fort Peck Reservoir; 5) compare habitat characteristics at aggregation and spawning sites to habitat characteristics elsewhere in the study area and in other study areas; and 6) determine if a spawning “dummy run” contributes to follicular atresia of hatchery-origin Pallid Sturgeon.

Total Project Cost		$ 27,984.00
Beginning Balance – September 2017		27,984.00
Expenditures – September 2017 - December 2017		
Salaries and Benefits	3,064.52	
Contracted Services	0	
Supplies	1,800.48	
Communications	0	
Travel	0	
Tuition	1,965.35	
Repairs and Maintenance	0	
Total Spent		6,830.35
Balance		21,153.65
Waived IDCs		3,005.35

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
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Assistant Unit Leader
Wyatt Cross
Associate Professor, Ecology, MSU
Jay Rotella
Professor, Ecology, MSU

Graduate Students
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Adeline Dutton, M.S.

Collaborator
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Funding
Montana Fish, Wildlife and Parks
MSU index 4W4311

Duration
January 2013 – December 2017

Completed

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: 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., macroinvertebrates), 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.

Diets of Pallid Sturgeon and Shovelnose Sturgeon varied longitudinally in the Missouri River from segment 2 near Fort Peck Dam to segment 4 below the confluence with the Yellowstone River. Diet overlap between Pallid Sturgeon and Shovelnose Sturgeon was highest in segments 2 and 3 of the Missouri River. Pianka's index of diet overlap (± SE) was 0.81 (0.12) in segment 2 and 0.96 (0.05) in segment 3. Diet overlap was low in segment 4 of the Missouri River and both segments of the Yellowstone River. Non-tanypodinae Chironomidae was the most frequently consumed benthic macroinvertebrate by Pallid Sturgeon and Shovelnose Sturgeon in segments 2, 3, and 4 of the Missouri River and segment 2 of the Yellowstone River. In segment 1 of the Yellowstone River, Shovelnose Sturgeon fed primarily on *Cheumatopsyche* spp. and *Hydropsyche* spp. Gape size was slightly (< 9 mm) different between Pallid Sturgeon and Shovelnose Sturgeon suggesting it was not the mechanism for the shift to piscivory in Pallid Sturgeon. These results provided a foundation for future research efforts in the

Missouri River and Yellowstone River. In addition, these results also provided necessary consumption data to develop bioenergetics models.

Macroinvertebrate assemblage structure, abundance, biomass, and secondary production differ throughout study reaches in the Missouri and Yellowstone rivers, with high estimates of assemblage abundance, biomass, and secondary production directly downstream of Fort Peck Dam. Furthermore, in reaches that are predominantly sand, small habitat patches (i.e., rock habitat, large woody debris, off-channel backwaters) support diverse communities of macroinvertebrates with high secondary production estimates, suggesting that these habitats may be resource “hot-spots” for invertivores. These data suggest that estimates of resource availability may be strongly tied to distinct habitat types and larger areas within the river.

Total Project Cost		$ 487,126.00
Beginning Balance – January 2017		61,846.79
Expenditures – January 2017 - December 2017		
Salaries and Benefits	46,214.88	
Contracted Services	541.12	
Supplies	253.76	
Communications	84.08	
Travel	8,870.40	
Rent	0	
Repairs and Maintenance	23.60	
Tuition	5,858.95	
Total Spent		61,846.79
Balance		0
Waived IDCs		24,634.65

Relations among Arctic Grayling, non-native salmonids, and abiotic conditions in the Big Hole Watershed, Montana

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Travis Horton
Montana Fish, Wildlife and Parks

Graduate Student
Austin McCullough, M.S.

Funding
Montana Fish, Wildlife and Parks
Student Support Project
MSU index 423194

Duration
August 2012 – January 2018
Completed

Arctic Grayling in Montana have experienced declines in abundance and distribution over the last century, which contributed to the species being designated as a Species of Concern and petitioned for protection under the Endangered Species Act. Conservation of Arctic Grayling in the Big Hole River watershed was based on presumed environmental influences. Interactions with nonnative species, increasing stream water temperatures, drought, and habitat alterations are suggested to influence Arctic Grayling abundances, although sparse quantitative information exists to support these hypotheses. The objective of this study was to evaluate the influence of these biotic and abiotic factors on Arctic Grayling abundances using data collected in the Big Hole River drainage from 1983 through 2015. Arctic Grayling and nonnative salmonids were sampled at 32 sites, stream temperature data were collected at 33 sites, stream discharge data were collected at 21 sites, and habitat data were collected at 441 sites. Ordinary least squares and quantile ($\tau = 0.90$) regression analyses were used to evaluate the relationships among Arctic Grayling catch per unit effort (CPUE), nonnative salmonids CPUE, stream temperature, stream discharge, and habitat condition. The strongest univariate relationship was a positive correlation between CPUE of Arctic Grayling ≥ age 1 and Brook Trout CPUE ($r = 0.55$, $N = 77$), which was contrary to the *a priori* predicted relationship. Multivariate analyses suggested that high water temperatures and low discharges during drought conditions have the greatest limiting influences on the CPUE of Arctic Grayling ≥ age 1; whereas, Brown Trout CPUE, low water temperatures, and high maximum discharges were suggested as having the greatest limiting influences on age-0 Arctic Grayling CPUE. These findings support current management to increase discharge during drought conditions and further explore relationships between Arctic Grayling CPUE, habitat conditions, and Brown Trout CPUE.

Total Project Cost		$ 12,508.00
Beginning Balance – January 2017		866.47
Additional Funding -- 2017		2,110.00
STIP interest 2017		7.32
Expenditures – January 2017 - January 2018		
Salaries and Benefits	0	
Contracted Services	41.70	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	1,950.60	
Total Spent		1,992.30
Balance		991.49
Waived IDCs		876.61

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, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W4708

Duration
November 2013 – June 2017
Completed

Bull Trout populations in the Thompson River drainage have declined over the past century. Declines have been attributed to habitat fragmentation, habitat degradation, and non-native species. Out-migration characteristics (e.g., temporal and spatial origins, abiotic cues, and movement) of subadult Bull Trout (100 – 300 mm TL) were evaluated throughout the drainage to increase our understanding of local populations and better inform conservation efforts. In autumn 2014, 53 subadult Bull Trout were tagged with passive integrated transponder (PIT) tags; 29 were also surgically implanted with acoustic transmitters. Minimal Bull Trout out-migration (*N* = 7) was observed in 2014. In summer 2015, 566 subadult Bull Trout were PIT-tagged in Fishtrap Creek and West Fork Thompson River drainages (Thompson River tributaries). Stream-width PIT antennas were used to monitor out-migration at the confluences of the Thompson River tributaries and at the mouth of the Thompson River. Out-migrating Bull Trout (*N* = 135) were sampled using directional weir traps at the tributary confluences, PIT-tagged, and implanted with acoustic- (*N* = 29) or radio-tags (*N* = 14) in autumn 2015. From July through December 2015, 10.1% of all PIT-tagged Bull Trout out-migrated from the Thompson River tributaries (11.4% of fish in the Fishtrap Creek drainage [*N* = 420] and 6.2% of fish in West Fork Thompson River [*N* = 146]), with peak out-migration occurring in late October. Highest predicted probabilities of Bull Trout out-migration occurred at lengths of 179 mm in Fishtrap Creek (30.4%) and 165 mm in West Fork Thompson River (29.3%). Only 13.5% of all Bull Trout that entered the Thompson River (*N* = 192) entered Thompson Falls Reservoir, with peak out-migration occurring in December. Median daily water temperature, minimum daily atmospheric pressure, and lunar illumination were weakly associated with an increase in the number of out-migrants. Radio-tagged out-migrants were randomly distributed throughout the Thompson River and exhibited long periods of site fidelity between intermittent downstream movements. Bull Trout demonstrated low out-migration rates in the Thompson River drainage and prolonged habitation of the mainstem Thompson River, which was contrary to the *a priori* hypothesis of clustered out-migration by subadult Bull Trout.

Total Project Cost		$ 117,106.00
Beginning Balance – January 2017		16,247.88
Expenditures – January 2017 - December 2017		
Salaries and Benefits	11,693.61	
Contracted Services	29.80	
Supplies	2,577.87	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	1,946.60	
Total Spent		16,247.88
Balance		0
Waived IDCs		7,149.07

Walleye suppression in Buffalo Bill Reservoir

Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Daniel Kaus, M.S.

Duration
July 2015 – June 2018

Collaborators
Mark Smith, Jason Burckhardt, Travis Neebling
Wyoming Game and Fish Department

Funding
Wyoming Game and Fish Department
MSU index 4W5474

Buffalo Bill Reservoir, WY is managed as a wild Rainbow Trout and Cutthroat Trout fishery. Non-native Walleye were discovered in 2008, and spring sampling of Walleye indicate natural recruitment and a rapidly expanding population. Walleye pose a predation threat to the wild trout population in Buffalo Bill Reservoir. The Wyoming Game and Fish Department (WGFD) is interested in suppressing the Walleye population using removal with electrofishing and gillnetting during the Walleye spawning period. In addition, the WGFD is interested in estimating angler exploitation to evaluate the effect of a mandatory Walleye harvest regulation on Walleye population suppression. The purpose of this study was to evaluate the population demographics of Walleye in Buffalo Bill Reservoir. Age-structured population models were used to estimate the Walleye population growth rate for scenarios with and without Walleye removal. To inform the population models we estimated age-specific fecundity, probability of maturity, natural mortality, and fishing mortality. Asymptotic mean population growth rate was estimated as 1.22 (95% CI of 1.05 to 1.37) for a no suppression scenario, 1.18 (95% CI of 1.04 to 1.32) for an electrofishing exploitation scenario, 1.04 (95% CI of 0.878 to 1.19) for a gillnet exploitation scenario, 0.91 (95% CI of 0.605 to 1.359) for an angler exploitation scenario, and 0.81 (95% CI of 0.66 to 0.96) for a combined angler and gillnet exploitation scenario. Results from this study will be used to inform cost-effective management decisions regarding the future of the recreational fishery in Buffalo Bill Reservoir.

Total Project Cost		$ 132,401.00
Beginning Balance – January 2017		53,090.32
Additional Funding – 2017		22,274.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	23,947.96	
Contracted Services	77.41	
Supplies	1706.73	
Communications	0	
Travel	5,770.99	
Rent	800.00	
Repairs and Maintenance	10.00	
Tuition	3870.00	
IDCs @ 20%	7,236.66	
Total Spent		43,419.75
Balance		31,944.57
Waived IDCs		7,960.28

Lake Roosevelt Burbot maturation study

Investigators
Christopher Guy
Assistant Unit Leader

Graduate Student
Lauren McGarvey, M.S.

Duration
December 2016 – October 2018

Collaborators
Confederated Tribes of the Colville Reservation

Funding
Confederated Tribes of the Colville Reservation
Bonneville Power Administration
US Fish Wildlife Service, CESU
MSU index 4W6449

Lake Roosevelt supports the only known population of native Burbot with a stable abundance in Washington state. However, information regarding the reproductive potential of the population, such as spawning periodicity and age at first maturity, is lacking. Burbot do not display sexual dimorphism. Determining sex and stage of maturity currently requires sacrificing the fish. The objectives of this work are to describe gametogenesis and the plasma sex steroid profile and assess non-lethal tools (plasma sex steroids and ultrasound) to assign sex and stage of maturity in adult Burbot from Lake Roosevelt. Paired blood, gonadal ultrasound images, and gonadal tissue were collected monthly from 12 fish (6 females and 6 males) for 12 months. Plasma sex steroids, testosterone, and 17β-estradiol, were measured by radioimmunoassay. Gonadal tissue was processed histologically. Gametogenesis and the plasma sex steroid profile were described over an entire reproductive cycle. Sex was identified with 95% accuracy using ultrasound. The tools assessed in this study will give biologists access to key reproductive indices to further understand the reproductive potential of the Burbot population in Lake Roosevelt.

Total Project Cost		$ 45,579.00
Beginning Balance – December 2017		17,955.00
Additional Funding -- 2017		27,624.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	17,033.28	
Contracted Services	0	
Supplies	2,148.73	
Communications	0	
Travel	2,510.04	
Tuition	3,948.35	
IDCs @ 17.5%	4,487.02	
Total Spent		30,127.42
Balance		15,451.58
Waived IDCs		6,794.71

Reproductive indices of hatchery-origin white sturgeon in the lower Columbia River, Canada

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

Graduate Student
Paige Maskill, M.S.

Collaborators
James Crossman
BC Hydro

Funding
U.S. Fish and Wildlife Service
MSU index 4W6791

Duration
August 2017 – June 2020

Conservation aquaculture has been the main recovery measure since 2001 for endangered White Sturgeon in the lower Columbia River, Canada. Survival of hatchery origin fish has been high, with certain year classes estimated to be in higher abundance than the wild population. Furthermore, disproportionate survival among maternal family groups has led to lower than expected genetic diversity in the hatchery origin population. It is important to determine the proportion of the hatchery-origin population that could be sexually mature and contributing to natural spawning. In order to do this, reproductive indices will need to be determined for the hatchery origin population such as, sex ratio and age at first maturity. There are tools available which can be used to assign sex and stage of maturity to fish that are not sexually dimorphic, such as sturgeons. However, all of these tools have error rates associated with them. The objectives of this proposed work are: 1) determine the accuracy of multiple tools, ultrasound, blood plasma sex steroids, endoscopy, and gonadal biopsy to assign sex and stage of maturity in both hatchery-origin and wild populations, 2) determine if gametogenesis occurs homogenously across the gonadal tissue in male and female hatchery-origin white sturgeon, and 3) determine how age, size, and habitat effect the growth and age at first maturity of hatchery-origin white sturgeon in the lower Columbia River, Canada. Sampling will occur during the spring and fall of 2017 and 2018. To date, it has been determined that the hatchery-origin population has sexually differentiated but are not yet sexually mature. Additionally, it has been determined that an otoscope can be used to assign sex in the field across a variety of sizes and ages within the hatchery-origin population (97% accuracy). Plasma sex steroids can be used as a less invasive tool to determine whether the fish are reproductive or non-reproductive (100% accuracy), based on previously determined sex steroid concentrations.

Total Project Cost		$ 22,653.00
Beginning Balance – August 2017		22,653.00
Expenditures – August 2017 - December 2017		
Salaries and Benefits	6,122.39	
Contracted Services	<55.50>	
Supplies	<12.36>	
Communications	0	
Travel	0	
Tuition	1,937.00	
IDCs @ 17.5%	1,398.52	
Total Spent		9,390.05
Balance		13,262.95
Waived IDCs		2,117.76

Enhancing native aquatic species through the USFWS Propagation Program in Region 6

Investigators

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

Collaborators

Scott Gangl, Patrick Isakson
North Dakota Game, Fish and Parks
Rob Holm, Steve Krentz
U.S. Fish and Wildlife Service

Duration

June 2015 – September 2017
Completed

Funding

US Fish Wildlife Service
USGS RWO 70, MSU index 4W5511

The U.S. Fish and Wildlife Service (USFWS) Fisheries Program and its fish hatchery system were established 130 years ago to address a growing concern over the observed decline in the United States' fishery resources and a lack of information concerning the status of the nation's fisheries. Currently, the National Fish Hatchery System (NFHS) plays a vital role in meeting federal mitigation obligations, restoring and maintaining native fisheries and participating in the recovery of threatened and endangered aquatic species. However, a significant focus still remains on the propagation of non-native species rather than meeting conservation objectives through the USFWS Region 6 (R6) Fisheries and Aquatic Conservation (FAC) Program. The R6 FAC Program actively stocks, manages, and promotes recreational fisheries for native and non-native species, with 9% of the aquatic species in R6 stocked within their native range and 91% stocked outside their native range (native range defined by U.S. Geological Survey Nonindigenous Aquatic Species website nas.er.usgs.gov). Given the R6 is stocking predominately non-native species, there is room for the R6 FAC Program and NFHS to improve their actions in the conservation of threatened and endangered aquatic species and imperiled or declining native species to further align R6 with USFWS national priorities. This project used a decision-support tool (Bayesian Network) to classify and prioritize native aquatic species that could benefit from conservation propagation (species listed as Tier I and II in State Wildlife Action Plans) in Utah, Colorado, Kansas, South Dakota, and North Dakota. Mussels have ranked within the top 10 species in need of propagation along with fishes in each state that included mussels in their analysis.

Total Project Cost		$ 110,613.00
Beginning Balance – January 2017		54,091.71
Expenditures – January 2017 - September 2017		
Salaries and Benefits	25,927.08	
Contracted Services	13,393.74	
Supplies	2,021.47	
Communications	0	
Travel	2,742.98	
Rent	2,948.78	
Tuition	0	
IDCs @ 15%	7,057.66	
Total Spent		54,091.71
Balance		0
Waived IDCs		13,639.87

Native prairie special status fish species inventory

Investigators
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Assistant Research Professor
Alexander Zale
Unit Leader

Graduate Student
Allison Stringer

Duration
July 2014 – June 2019

Collaborators
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Bureau of Land Management
Steve Leathe
NorthWestern Energy

Funding
Bureau of Land Management,
CESU MSU index 4W5002
NorthWestern Energy
MSU index 433295

Northern Pearl Dace *Margariscus nachtriebi*, Northern Redbelly Dace *Chrosomus eos*, and Northern Redbelly Dace × Finescale Dace hybrids *C. eos* × *C. neogaeus* (Northern Redbelly Dace and Northern Redbelly Dace × Finescale Dace hybrids hereafter collectively referred to as chrosomid dace) have undergone range contractions in Montana. Nonnative Northern Pike *Esox lucius* have expanded from stocked reservoirs to prairie streams that are inhabited by native cyprinids. Our objectives were to (1) clarify the probable historical distributions of Northern Pearl Dace and chrosomid dace, (2) establish the current distributions of Northern Pearl Dace and chrosomid dace, and (3) evaluate the extent to which their current distributions may have been influenced by the expansion of non-native predators such as Northern Pike. We collected Northern Pearl Dace at 8 of 80 sites in their historical distribution, which corresponded to an estimated 63.3 to 83.3% reduction in their distribution in Montana. We found almost no overlap between Northern Pearl Dace and influential non-native predators (Northern Pike and non-native trout). We collected chrosomid dace at 43 of 128 sites in their historical distribution, which corresponded to an estimated 28.6% to 69.7% reduction in their distribution in Montana. We found little overlap between chrosomid dace and influential non-native predators. Northern Pike and non-native trout probably contributed to the reduction in Northern Pearl Dace and chrosomid dace distributions, and further expansion of these non-native predators may lead to extirpation of Pearl Dace and substantial declines in chrosomid dace in Montana.

Total Project Cost		$ 172,500.00
Beginning Balance – January 2017		36,802.13
Expenditures – January 2017 - December 2017		
Salaries and Benefits	19,198.58	
Contracted Services	13.62	
Supplies	157.68	
Communications	0	
Travel	2,742.94	
Rent	0	
Repairs and Maintenance	0	
Tuition	1,527.20	
IDCs @ 17.5%	4,136.99	
Total Spent		27,777.01
Balance		9,025.12
Waived IDCs		6,264.61

The spatial and temporal extent of the hypoxic zone in the headwaters of Lake Sakakawea

Investigator
Robert Bramblett
Assistant Research Professor

Collaborator
Joseph Bonneau
U.S. Army Corps of Engineers

Graduate Student
Eric Scholl, Ph.D.

Funding
U.S. Army Corps of Engineers
USGS RWO 71
MSU index 4W5226

Duration
November 2014 – June 2017
Completed

We documented hypoxic sediments in the headwaters of Lake Sakakawea. Hypoxic sediment existed from transition zone between the Missouri River and the reservoir and extended down reservoir for at least 45 km. Hypoxic sediments were associated with declines in current velocity and particle size of sediments and increases in sediment organic matter. Sediment respiration of hypoxic sediments in the transition zone was higher than sediment in the riverine zone. We did not observe a strongly stratified or hypoxic hypolimnion, probably because the headwaters area was too shallow and wind-mixed to stratify thermally. We suspect that larval Pallid Sturgeon arriving in the headwaters lack the swimming ability to remain in the water column or to swim back upstream to avoid hypoxia and succumb to asphyxiation in or on the hypoxic sediments.

Total Project Cost		$ 186,405.66
Beginning Balance – January 2017		35,472.08
Expenditures – January 2017 - August 2017		
Salaries and Benefits	30,763.31	
Contracted Services	38.55	
Supplies	34.88	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
IDCs @ 15%	4,635.34	
Total Spent		35,472.08
Balance		0
Waived IDCs		8,942.65

Statistical analyses to direct conservation and restoration priorities for the Yellowstone cutthroat trout in the context of climate change

Investigator
Bradley Shepard
B.B. Shepard and Associates

Collaborator
Robert Al-Chokhachy
USGS NoRock

Duration
September 2016 – August 2017
Completed

Funding
USGS NoRock
MSU index 4W6272

The Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*; hereafter YCT) is a native trout subspecies that has experienced a reduction in its distribution over the past century because of a multitude of human-related effects. We investigated the potential effects of non-native Brook Trout (*Salvelinus fontinalis*) and climate on the distribution of YCT over time. We used time-series data from the early 1970s to the present to investigate the effects of Brook Trout and climate, and their interaction, on the distribution of YCT. We compiled data on species composition, abundance, and size classes of these two species at fixed sites throughout the Shields River basin and compared these data to similar data from other sites throughout the range of YCT. These data have now been compiled and are currently being analyzed. We have augmented these data with YCT growth data collected during 2011 to 2016.

Total Project Cost		$ 9,100.00
Beginning Balance – September 2017		658.93
Expenditures – January 2017 - October 2017		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	555.34	
Rent	0	
Repairs and Maintenance	0	
IDCs @ 17.5%	103.59	
Total Spent		658.93
Balance		0
Waived IDCs		147.17

Assessing landscape connectivity of Denil fishways for Arctic Grayling in the upper Big Hole River

Investigators
Thomas McMahon
MSU
Kevin Kappenman
U.S. Fish and Wildlife Service

Graduate Student
Benjamin Triano, M.S.

Collaborator
Matt Blank
MSU Engineering and Western Transportation Institute

Funding
U.S. Geological Survey RWO 74
MSU index 4W6821

Duration
August 2017 – March 2019

The upper Big Hole River basin supports one of the last remaining strongholds of fluvial Arctic Grayling in the lower 48 states. Movement is integral for Big Hole River Grayling, which make annual migrations in excess of 100 km to reach critical habitats throughout the basin. Irrigation diversions support agriculture in the valley but fragment the watershed, and can restrict these critical movements. A Candidate Conservation Agreement with Assurances (CCAA) was established in 2006 to secure and enhance this population, and one of the CCAA's main conservation actions was the installation of 63 Denil fish ladders to provide passage over irrigation diversions and increase aquatic connectivity. The evaluation of fishways is necessary to ensure proper function, and to make necessary adjustments to improve their efficiency.

We are using hydraulic models and laboratory and field passage experiments to evaluate the effectiveness of Denil fishways for providing upstream passage for Arctic Grayling and other fishes. In 2017, physical and hydraulic data were collected at 15 study sites, and discharge-rating curves and hydraulic models were built to predict site specific conditions over the range of flows expected annually. Upstream passage of Arctic Grayling and other species will be evaluated in 2018 using Passive Integrated Transponder (PIT) telemetry to test passage over the range of physical and hydraulic conditions seen in 2017. Depth was shown to be an accurate predictor of passage in a recent laboratory study at the Bozeman Fish Technology Center and is highly variable in the Big Hole because of irrigation withdrawals and low summer flows. We will evaluate the effects of depth, slope and submergence of fishways, and velocity and flow conditions on passage. Passage results and hydraulic model predictions will be used to develop site specific "passage windows" describing the ranges of flows at which passage is facilitated or restricted. Results will provide managers with information on the effectiveness of currently installed Denil fishways, as well as design criteria and adaptive management strategies to improve fishway efficiency and benefit both Arctic Grayling and irrigators.

Total Project Cost		$ 47,675.00
Beginning Balance – August 2017		47,675.00
Expenditures – August 2017 - December 2017		
Salaries and Benefits	1,530.60	
Contracted Services	0	
Supplies	1,800.60	
Communications	0	
Travel	95.98	
Rent	1,114.44	
Repairs and Maintenance	0	
Tuition	2,503.75	
IDCs @ 15%	1,056.81	
Total Spent		8,102.18
Balance		39,572.82
Waived IDCs		2,043.16

Carnivore management and elk recruitment in western Montana

Investigators
Robert Garrott
MSU
Jay Rotella
MSU

Graduate Student
Michael Forzley, M.S.

Duration
February 2016 – June 2020

Collaborator
Kelly Proffitt
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5906

The upper Bitterroot Valley experienced long periods of uninterrupted increases in elk abundance in the mid-20th century, followed by increases in large carnivore abundance starting in the late 20th century. These increases in large carnivore abundance coincided with decreases in elk calf recruitment and changes in area elk abundance. In 2011, researchers from Montana Fish, Wildlife and Parks and the University of Montana initiated the Bitterroot Elk Ecology Project to evaluate the factors driving changes in elk populations in the southern Bitterroot.

Our goals are twofold. First, we will assess the effects of mountain lion harvest management on lion densities by comparing densities in treatment and control areas before and after 4 years of increased harvest quotas in the treatment area. We will use DNA-based spatially-explicit capture-recapture models, in conjunction with telemetry information from collared individuals, to estimate densities during each phase. To date, we have estimated mountain lion densities in both the treatment and control areas prior to increased harvest quotas (2012-2013) and in the treatment area after increased quotas (2016-2017). We plan to estimate the densities in the control area during the final 2017-2018 period of the study.

Second, we will evaluate the effects of this increased carnivore harvest on elk calf recruitment in the East Fork and West Fork watersheds of the Bitterroot River. We will use ear-tag radio transmitters to monitor the survival of elk calves for the first year of their life. To date, we have radio-tagged 248 elk calves, and have completed preliminary analysis of summer calf survival in the upper Bitterroot Valley following increased mountain lion harvest. Our first analysis of summer calf survival indicates that no difference in summer survival occurred following increased female mountain lion harvest, but more analyses are necessary to understand possible changes in elk calf survival in the upper Bitterroot. Additionally, we plan to assess the relative effects of winter severity, forage quality, predation risk, and individual characteristics of elk calves such as birth mass and sex on elk calf survival.

Total Project Cost		$ 785,000.00
Beginning Balance – January 2017		353,740.87
Additional Funding – 2017		255,000.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	98,376.38	
Contracted Services	178,568.68	
Supplies	54,625.58	
Communications	513.10	
Travel	319.18	
Rent	0	
Repairs and Maintenance	0	
Tuition	4,290.24	
Total Spent		336,693.16
Balance		272,047.71
Waived IDCs		148,144.99

Elk response to pine beetle outbreak and management responses to that outbreak in the Elkhorn Mountains

Investigator
Robert Garrott
Professor MSU

Collaborators
Kelly Proffitt
Montana Fish Wildlife and Parks

Graduate Student
Brent Cascaddan, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6318

Duration
October 2016 – June 2019

Montana Fish, Wildlife & Parks initiated a study to evaluate the effect of mountain pine beetle (MPB) infestation on elk habitat and elk movements in the Elkhorn Mountains in collaboration with the Elkhorn Working Group, Helena National Forest, Montana State University, and the Montana Department of Military Affairs. Beginning in 1996, a major epidemic of MPB began affecting pine forests in western North America. Currently, western US forests are experiencing a MPB epidemic that is unprecedented in the past 100 years in extent, severity, and duration. During the period from 2000 to 2013, MPB caused tree mortality in 17.5 million acres of pine forest across the western United States. The potential effects of MPB-caused tree mortality on ungulate populations and habitat are relatively unstudied, and the possibility exists for both beneficial changes to ungulate habitat such as increased production of forage (i.e., forage biomass) through the opening of the forest canopy and negative effects such as accelerated phenology of herbaceous plants that may reduce forage quality.

To better understand effects of the beetle epidemic on elk habitat, we are directly evaluating elk nutritional resources within MPB-infested pine forests, with a goal of quantifying the effects of MPB-infestation on elk nutritional resources. This project will also serve to fill the gap in knowledge of how mountain pine beetle affects forest understory and wild ungulates such as elk, and what potential management actions can be taken to produce a desired result. This knowledge is necessary for the decisions wildlife and forest managers need to make for maintaining healthy wildlife populations and habitat.

We have concluded field work including diet sample collections and vegetation monitoring. Estimates from fecal pellet analysis conducted at Washington State University's Wildlife Habitat and Nutrition Laboratory indicated summer diets of elk were composed of 53% graminoids, 31% forbs, and 14% shrubs. The most common summer graminoid forage species detected were *Poa* spp. (12%), *Festuca idahoensis* (10%), and *Festuca campestis* (9%). The most common summer forb forage species was *Lupinus* spp. (17%). *Vaccinium* spp. was the most common summer shrub in the diet. We sampled 168 vegetation sampling plots (summer 2016 = 38 and 2017 = 130) within

three lodgepole pine cover classes (mature uninfested, recent infested < 10 years ago, old infested ≥ 10 years ago). We measured vegetation to estimate percent canopy closure, forage abundance, dominant plant phenology, herbaceous community structure, and herbaceous forage quality in each of the three cover classes. These estimates will allow us to compare the cover classes and make inferences about how elk may be affected by MPB in the Elkhorns. Location data acquired from GPS-collared elk in the Elkhorn study area will also be used to estimate use of cover types and compare recent use to data from a previous elk monitoring study conducted prior to the MPB outbreak, which may provide insight into how elk have altered habitat use post-MPB epidemic.

Total Project Cost		$ 72,759.00
Beginning Balance – January 2017		31,306.00
Additional Funding -- 2017		35,721.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	25,814.51	
Contracted Services	20.00	
Supplies	1,703.94	
Communications	0	
Travel	0	
Tuition	3,726.00	
Repairs and Maintenance	0	
Total Spent		31,264.45
Balance		35,762.55
Waived IDCs		13,756.36

Characterizing foraging areas and maternity roost sites of bat species and evaluating the effects of forest disturbance

Investigator
Andrea Litt
Assistant Professor, MSU

Collaborator
Claire Gower
Montana Fish, Wildlife and Parks

Graduate Student
Shannon Hilty, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6331

Duration
September 2016 – June 2020

Mountain pine beetle (MPB, *Dendroctonus ponderosae*) outbreaks have resulted in large-scale changes in forest structure throughout the western United States. These changes can have large effects on wildlife, but have not been studied in bats. Given that foraging and roosting sites may limit the distribution and abundance of bat populations, we aim to 1) quantify characteristics of these sites in forests during the summer, and 2) evaluate how the availability of these characteristics changes with different intensities of MPB disturbance.

During the summer of 2017, we mist-netted for bats in forests dominated by lodgepole pine (*Pinus contorta*) that exhibited varying degrees of tree mortality due to MPB. Three bat species made up over 75% of captures: hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and little brown myotis *(Myotis lucifugus*). Originally, we intended to tag lactating female little brown myotis to characterize maternity roosts. However, all captures of little brown myotis were male. We attached radio-transmitters to 11 males and located at least 1 roost for 6 individuals (total roosts = 18). All located bats roosted in cracks within rock features even though lodgepole pine snags were abundant and in close proximity to roosting sites. Sixty-one percent of roosts were in talus; 39% were in rock outcrops. Three bats reused a roost at least once, and two bats used multiple roosts within the same rock structure. Our preliminary results suggest that in lodgepole-dominated forests, male little brown myotis choose to roost in rock features over snags, regardless of the severity of MPB disturbance. Although tagged bats did not roost in lodgepole pine, we still do not understand the importance of these forests for bats. As part of the 2018 field season, we aim to better understand this relationship in addition to why we did not catch female bats in these forests.

To characterize foraging by bats, we deployed 38 acoustic detectors in forest stands (15 in lodgepole pine, 12 in lodgepole pine and Douglas fir mixture, and 11 in ponderosa pine) across the Helena Lewis and Clark National Forest with varying degrees of MPB-caused tree mortality between June 3 and August 25. These detectors recorded 902 GB of data resulting in 30,693 sound files, or bat passes. We are currently analyzing these data to understand how bat foraging activity varies with MPB severity. During the summer of 2018, we will resample these detector locations.

Total Project Cost		$ 59,100.00
Beginning Balance – September 2017		24,210.14
Additional Funding -- 2017		34,100.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	17,947.45	
Contracted Services	3,369.48	
Supplies	8,582.06	
Communications	17.98	
Travel	312.92	
Tuition	240.00	
Repairs and Maintenance	46.55	
Total Spent		30,516.44
Balance		27,793.70
Waived IDCs		13,427.23

Bat population monitoring and disease surveillance analysis

Investigator
Andrea Litt
Associate Professor MSU

Research Associate
Wilson Wright, M.S.

Collaborators
Kathi Irvine
U.S. Geological Survey, NRMSC
Emily Almberg, Lauri Hanauska-Brown, Justin Gude
Montana Fish, Wildlife and Parks

Duration
October 2017 – December 2018

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6943, 4W6958

The spread of white-nose syndrome (WNS) across the eastern United States has resulted in population declines of many bat species. WNS has not yet been detected in Montana, or any other western state besides Washington, and we have little information to predict severity of effects of this disease after arrival in this region. Understanding the effects of WNS in western states requires accurate baseline population assessments and continued monitoring after the disease arrives. This study aims to inform surveillance efforts to detect WNS and develop a bat monitoring plan to understand effects of the disease after it arrives in Montana. To assess current bat populations, we analyzed data previously collected by Montana Fish, Wildlife and Parks and its partners. Within an occupancy-model framework, we analyzed acoustic records and mist netting captures of eight bat species to estimate baseline distributions across Montana. For each species, patterns in the probability of occupancy were explained using covariates for forest cover (%), elevation, ruggedness, and average degree days. Estimates from this occupancy model were used to map distributions for each species individually and for species combinations of interest. Additional acoustic data were used to develop a model for overall bat activity. Even after accounting for nightly weather conditions, patterns in overall activity appear highly variable across years and detector locations. These estimates of baseline distribution and activity patterns can used in conjunction and compared to future analyses to better elucidate the effects of WNS when it arrives in Montana.

Based on these models, we will provide guidance on designing future sampling efforts with the goals of detecting arrival and monitoring effects of WNS on bat populations in the state. For early detection of WNS, surveillance efforts can focus on locations with high estimated probabilities of occupancy for susceptible species and consistent bat activity. The baseline estimates can be used to develop a monitoring plan with known power to detect possible changes in distribution or activity or both due to WNS.

Total Project Cost 4W6943		$ 74,815.00
Beginning Balance – October 2017		74,815.00
Expenditures – October 2017 - December 2017		
Salaries and Benefits	5,894.10	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Tuition	0	
Total Spent		5,894.10
Balance		68,920.90
Waived IDCs		2,593.40

Total Project Cost 4W6958		$ 5,185.00
Beginning Balance – October 2017		5,185.00
Expenditures – October 2017 - December 2017		
Salaries and Benefits	5,185.00	
Contracted Services	0	
Supplies	0	
Communications	0	
Total Spent		5,185.00
Balance		0
Waived IDCs		2,281.40

Effects of livestock grazing management on the ecology of sharp-tailed grouse, grassland birds, and their predators in mixed grass prairie habitats of Montana

Investigator
Lance McNew
Assistant Professor

Collaborator
Lorelle Berkeley
Montana Fish, Wildlife and Parks

Graduate Students
Megan Milligan, Ph.D.
Skyler Vold, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5907

Duration
February 2016 – June 2020

Rangelands used for domestic cattle grazing consist of the largest remaining tracts of native grassland that have not otherwise been fragmented by agricultural use or other human development. Grazing is the predominant land use across western North America and livestock grazing directly affects the structure, composition, and productivity of native grasslands. Thus, grazing management within these rangelands has a significant effect on the quality and extent of wildlife habitat. This project aims to evaluate the effects of various grazing systems on the ecology of sharp-tailed grouse (*Tympanuchus phasianellus*), grassland birds, and their predators, by examining the effects of rangeland management practices prescribed by the Montana Upland Game Bird Enhancement Program on private lands in relation to the management systems employed on surrounding lands not enrolled in conservation easements. Specifically, this project will look at the effects of different grazing systems on sharp-tailed grouse nesting ecology, survival, and space use to determine if the management guidelines recommended by Montana Fish, Wildlife and Parks (FWP) are having an effect on grouse populations. This project will also examine the ecological effects of various grazing treatments by examining abundance and space use of the grassland bird and meso-predator assemblages within the study site. We will thereby evaluate whether Montana FWP management guidelines are recommending the grazing system with the greatest benefit to grassland wildlife. Preliminary results suggest that the various grazing treatments are not important predictors of grouse nest survival or nest site selection but that grouse may be selecting for pastures grazed within the rest-rotation system recommended by Montana FWP. Relative to season-long and summer-rotational grazing systems, we observed a lower abundance of a dense-grass obligate, the grasshopper sparrow (*Ammodramus savannarum*), on pastures within rest-rotation grazing systems. Additionally, we found evidence of an interaction between grazing system and rangeland productivity, where areas of high productivity had higher abundance estimates of grasshopper sparrow on pastures employing intensive summer-rotation grazing and lower abundance estimates of grasshopper sparrow on pastures employing rest-rotation grazing or season-long grazing.

Total Project Cost		$ 407,075.00
Beginning Balance – January 2017		155,967.64
Additional Funding – 2017		132,450.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	61,582.80	
Contracted Services	841.88	
Supplies	30,770.76	
Communications	144.51	
Travel	4,814.90	
Rent	5,400.00	
Repairs and Maintenance	3,687.41	
Total Spent		107,242.26
Balance		181,175.38
Waived IDCs		47,186.59

Grouse food insect, pollinator, and dung beetle ecology - grazing

Investigator
Hayes Goosey
Assistant Research Professor

Duration
May 2016 – June 2021

Collaborators
Lorelle Berkeley, John Ensign
Melissa Foster
Montana Fish, Wildlife and Parks
Marni Rolston, MSU Animal and Range Sciences

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6068

Our study sites are in central and eastern Montana near the towns of Roundup and Sidney. At each location, we are examining the effects of livestock grazing on the arthropod assemblage as it relates to sage grouse and sharp-tailed grouse management; however, our primary research objective is investigating, in the larger context, if arthropod assemblage structure is associated with rangeland management. We are investigating two grazing programs: the NRCS Sage Grouse Initiative (SGI) rest-rotational program in central Montana and the Montana Department of Fish, Wildlife and Parks three-pasture rest-rotation program on the Buxbaum ranch in eastern Montana. Our field efforts during 2017 were applied to each research location where we again collected 1) ground dwelling grouse food items, 2) vegetation dwelling food items, 3) rangeland pollinators, and 4) dung beetles. These were collected independently at 72 locations and included 672 samples. These samples will yield about 150,000 specimens for identification.

We are still processing samples and identifying specimens; however, in general we are finding that land use has a significant effect on arthropods as 1) grouse food resources, 2) pollinators, and 3) nutrient recyclers. Our results also suggest that not only does the total abundance of arthropods differ according to land use, but the assemblage of arthropods as functional groups may differ as well, which suggests that the influences of land use on arthropod abundance and diversity are a major component of rangeland health and ultimately wildlife habitat.

Total Project Cost		$ 173,294.00
Beginning Balance – January 2017		11,326.54
Additional Funding – 2017		100,341.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	57,907.58	
Contracted Services	72.80	
Supplies	2,052.12	
Communications	0	
Travel	3,359.43	
Rent	0	
Repairs and Maintenance	284.46	
Total Spent		63,676.39
Balance		47,991.15
Waived IDCs		28,017.61

Wolverine connectivity in Wyoming, Idaho, and Washington

Investigator
Andrew Hansen
Professor

Collaborators
Justin Gude, Robert Inman
Montana Fish, Wildlife and Parks

Graduate Student
Kathleen Carroll, Ph. D.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6410

Duration
November 2016 – June 2018

In the conterminous United States, wolverines (*Gulo gulo*) occupy semi-isolated patches of public lands. Connectivity between these populations is essential to the persistence of this species. However, maintaining habitat connectivity presents several challenges: the scale that the wolverine metapopulation functions over is large, connective habitat is often privately owned, core and connective wolverine habitats may shift in the future because of climate and land-use change, and current models of wolverine connectivity do not account for these changes. To address these issues we modeled changes in wolverine habitat suitability and connectivity under scenarios of climate and land-use change at three time intervals (present, 2030, 2050) to evaluate opportunities for conservation action across Montana, Idaho, Washington, and Wyoming. The project represents the first integrated models capable of projecting snow dynamics, forest cover, and wolverine habitat suitability under IPCC future scenarios and forecasts of human land-use change.

Total Project Cost		$ 112,984.00
Beginning Balance – November 2016		111,252.16
Expenditures – November 2016 - December 2016		
Salaries and Benefits	19,629.99	
Contracted Services	0	
Supplies	1,858.85	
Communications	0	
Travel	357.03	
Tuition	3,218.94	
Repairs and Maintenance	0	
Total Spent		25,064.81
Balance		86,187.35
Waived IDCs		11,028.52

Taxonomic and ecological service project account

Investigator
Robert Bramblett
Assistant Research Professor

Funding
USGS Water Science Center
MSU Index 433295

Duration
Ongoing

Dr. Bramblett provides prairie fish identification services and workshops periodically.

Beginning Balance – January 2017		10,613.19
Additional Funding – 2017		20,000.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	10,869.85	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
Administrative Fee @ 6%	652.19	
Total Spent		11,522.04
Balance		19,091.15

MTCFRU service project account

Investigators

Alexander Zale
Unit Leader
Michael Lance
Graduate Student M.S.

Collaborators

Bradley B. Shepard
B. B. Shepard and Associates
Grant Grisak
Montana Fish, Wildlife and Parks

Duration

Ongoing

Funding

MT Fish, Wildlife and Parks
MSU Index 433309

This account manages non-grant work including consulting for database development and student internships that the Montana Cooperative Fishery Research Unit performs in association with cooperators and collaborators.

Beginning Balance – January 2017		$ 2,488.71
Additional Funding – 2017 Montana Fish, Wildlife and Parks		31,468.00
Expenditures – January 2016 - December 2016		
Salaries and Benefits	16,270.02	
Contracted Services	227.35	
Supplies	53.54	
Communications	248.93	
Travel	724.85	
Rent	400.00	
Repairs and Maintenance	0	
Tuition	0	
Administrative Fee @ 6%	1,075.49	
Total Spent		19,000.18
Balance		14,956.53

MTCFRU Gift Account

Investigators

Alexander Zale
Unit Leader
Jason Marsh
Graduate Student M.S.

Funding

Eccles Foundation
$10,000
MSU Index 423077

Duration

Ongoing

This account manages support from foundations and NGOs for graduate students in the Cooperative Fishery Research Unit program.

Beginning Balance – January 2017		9,072.20
Additional Funding – 2017		0
STIP Interest 2017		58.71
Expenditures – January 2017 - December 2017		
Salaries and Benefits	3,246.01	
Supplies	243.00	
Travel	0	
Repairs and Maintenance	0	
Tuition	2,850.30	
Total Spent		6,339.31
Balance		2,791.60

Montana Cooperative Fishery Research Unit Vehicle Account

Administrator

Alexander Zale
Unit Leader

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 2017		$ 61,708.10
Expenditures – January 2017 - December 2017		
Repairs and Maintenance	3,883.59	
Fuel	7,998.40	
Insurance	2,938.85	
2017 Ford Supercab	26,826.28	
Administrative Assessment Fee @ 6%	2,498.82	
Total Spent		44,145.94
Total Revenue Reimbursed		33,248.58
Balance		50,810.74

Montana Cooperative Fishery Research Unit Watercraft Account

Administrator
Alexander Zale
Unit Leader

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 expenses related to Unit research vessels, including replacement, repairs, and maintenance.

Beginning Balance – January 2017		$ 45,470.23
Expenditures – January 2017 - December 2017		
Repairs and Maintenance	0	
Supplies	0	
Replacement	0	
Administrative Assessment Fee @ 6%	0	
Total Spent		0
Total Revenue Reimbursed		6,000.00
Balance		51,470.23

Montana Cooperative Fishery Research Unit Operations Account

Administrator
Alexander Zale
Unit Leader

Funding
$15,000 yearly from MSU VP for Research and Economic Development
MSU index 436899

Beginning Balance – January 2017		$ 3,334.05
Expenditures – January 2017 - December 2017		
Salaries and Benefits	0	
Contracted Services	3,457.84	
Supplies	618.97	
Communications	926.53	
CCM	390.21	
Rent (storage unit)	7,933.04	
Repairs and Maintenance	0	
Administrative Assessment Fee @ 6%	799.59	
Total Spent		14,126.18
Total Revenue from VPR		10,714.29
Balance		<77.84>

Monetary Equivalence for MSU Services and Facilities
January 2016 - December 2016

Program Coordinator salary and benefits	$ 57,255.61
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 ($1,229,572)	9,836.58
Utilities - General @ 12% of total expenditures ($1,229,572)	147,548.64
Unit Operations Account	10,714.29
Waived IDCs	411,000.44
Total	**660,829.02**

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

Administrator	**Funding**
Alexander Zale	Montana Fish, Wildlife and Parks
Unit Leader	MSU index 4W5335

Beginning Balance – January 2017		$ 42,336.56
Additional Funding – 2017		30,000.00
Expenditures – January 2017 - December 2017		
Salaries and Benefits	6,766.72	
Contracted Services	4,994.41	
Supplies	6,392.57	
Communications	31.46	
Travel	8,392.34	
Rent	251.64	
Repairs and Maintenance	<94.49>	
Tuition	0	
Equipment	<128.83>	
Total Spent		26,605.82
Balance		45,730.74

Federal Budget
January 2015 - December 2015

Salaries and Benefits	$ 374,379.20
Supplies	0
Total	$ 374,379.20

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

USGS

2016 Chevrolet Silverado 2500, 4x4 crew cab (white)
Property No. 434174 – Serial No.1GC1KUE80GF252052
Acquisition value $35,644
Mileage 316

2011 Ford F250 4×4 crew cab (green)
Property No. 433429 – Serial No 1FT7W2BTOBEA70586
Acquisition value $31,697
Mileage 55,265

2009 Chevrolet HHR (red)
Property No. 433291 – Serial No. 3GNBAADB4AS513678
Acquisition value $18,720
Mileage 33,433

2005 Chevrolet Silverado 2500, 4×4 crew cab (green)
Property No. 430750 - Serial No. 1GCHK23G15F926039 (2005)
Acquisition value $22,948
Mileage 119,427

2002 Chevrolet 4×4 Suburban (white)
Property No. 261052 - Serial No. 3GNGK26U52G249012
Acquisition value $31,988
Mileage 128,790

1989 Chevrolet 4×4 Suburban (tan)
Property No. 261114 - Serial No. 1GNGV26K2KF176088
Acquisition value $15,766
Mileage 160,915

Leica S8APO Microscope
Serial No. B1407890

Acquisition value $6014 (2016)

2016 Honda BF-225 Outboard Motor
Serial No. BAGJ-1800419
Acquisition value $14,860 (2016)
For 2004 Wooldridge boat

Halltech Backpack Electrofisher
Serial No. B433MK5
Acquisition value $7,694 (2016)

Leica M165 C Stereomicroscope System
Serial No. 5766180
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 replaced 2016
Property No. Electrofisher Combo 4005309
Acquisition value $50,871 (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 $42,846 (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 (2009)
Upgrade new model (2017) $49,984

Electrofisher SRI Backpack Combo

Serial No. BC-170057
Acquisition value $7,468 (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

2017 Ford F150 Super (blue)
Serial No. 1FTFX1EF0HKD34442
Acquisition Value $26,826
Mileage 226

2014 Dodge Ram 2500 (white)
Property No. 135050
Serial No. 3C6TR5DT0EG281683
Acquisition Value $29,197
Mileage 35,852

2008 Ford Escape Hybrid 4WD (grey)
Property No. 132775
Serial No. 1FMCU59H78KA13346
Acquisition Value $26,554 (2007)
Mileage 42,069

2005 GMC Sierra 2500 crew cab truck (green)
Property No. 132353
Serial No. 1GTHK23G65F944780
Acquisition Value $24,463 (2005)
Mileage 147,514

2001 GMC 1/2 ton 4×4 extended cab truck (green)
Property No. 132228
Serial No. 2GTEK19T911227311
Acquisition Value $15,255 (2005)
Mileage 188,703

Smith-Root Backpack Electrofisher
Serial No. F01157
Acquisition value $8,269 (2016)

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 $36,081 (2011)

BRP Evinrude 200 hp (for 1996 Wooldridge boat)
Serial No. 05257091
Acquisition value $10,444 (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 (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 (2)
Property No. 132057
Serial No. 11826A
Acquisition value $7,950 (2004)
Property No. 132058
Serial No. 11827A
Acquisition value $7,950 (2004)