Montana Cooperative Fishery Research Unit

2020 Briefing Booklet

MONTANA COOPERATIVE
FISHERY RESEARCH UNIT

Coordinating Committee Meeting
3 June 2020

Personnel and Cooperators

Coordinating Committee Members

U.S. Geological Survey
Kevin Whalen, Supervisor
Cooperative Research Units
2327 University Way
Bozeman, MT 59717

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

Montana State University
Jason Carter
Vice President of Research, Economic Development, and Graduate Education
MSU – P.O. Box 172460
Bozeman, MT 59717-2460

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

Cooperative Unit Staff

Alexander Zale
Unit Leader and Professor
Christopher Guy
Assistant Unit Leader and Professor
Lynn DiGennaro
Program Manager, MSU Department of Ecology

Cooperators and Collaborators

Montana Fish, Wildlife and Parks
Lorelle Berkeley
Steve Dalbey
Justin Gude
Luke Holmquist
Matt Jaeger
Ladd Knotek
Cody Nagel
Scott Opitz
Kelly Proffitt
Jason Rhoten
Mike Ruggles
David Schmetterling

Montana State University, Department of Ecology
Diane Debinski

Jesse DeVoe
Bob Garrott
Andrea Litt
Blake Lowrey
Tom McMahon
Terrill Patterson
Jay Rotella
Christine Verhille

Montana State University, Department of Animal and Range
Lance McNew

Montana State University, Department of Civil Engineering
Matt Blank
Joel Cahoon
Kathryn Plymesser

Montana State University, Department of Microbiology and Immunology
Deborah Keil

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

USGS Northern Rocky Mountain Science Center
Robert Al-Chokhachy
Adam Sepulveda

U.S. Fish and Wildlife Service
George Jordan
Kevin Kappenman
Robert Muth
Wendy Sealey
Greg Watson
Molly Webb
Bill West

Avista Corporation
Eric Oldenburg

BC Hydro
James Crossman

Creston Fish and Wildlife Center
Carter Fredenberg

Kootenai Tribe of Idaho
Shawn Young

Montana Biological Survey
David Stagliano

U.S. National Park Service
Patricia Bigelow
Todd Koel

Nebraska Game and Parks Commission
Kirk Steffensen

NorthWestern Energy
Grant Grisak

Rocky Mountain Cooperative Ecosystem Studies Unit
Lisa Gerloff

B. B. Shepard and Associates
Brad Shepard

University of California, Davis
Andrea Schreier
Anne Todgham
Joel Van Eenennaam

University of Montana, Western
Michelle Anderson

U.S. Forest Service
Tom Black
Shane Hendrickson
Charles Luce
Mike Schwartz
Michael Young

Western Transportation Institute
Matt Blank

Wyoming Game and Fish Department
- Craig Armadio
- Joe Deromedi
- Paul Gerrity
- Darren Rhea
- Mark Smith

Graduate Students Advised by Unit Faculty

Ian Anderson	M.S.
Colter Brown	M.S.
Kristen Cook	M.S.
Tanner Cox	M.S.
Kyle Crapster	M.S.
Colleen Detjens	M.S.
Mike Duncan	Ph.D.
Robert Eckelbecker	Ph.D.
Hayley Glassic	Ph.D.
Michael Lance	M.S.
Madeline Lewis	M.S.
Jason Marsh	M.S.
Paige Maskill	M.S.
Andriana Puchany	M.S.
Michael Siemiantkowski	M.S.
Nicholas Voss	M.S.

Graduate Students Advised by Cooperating Faculty

Matea Djokic	M.S.
Michael Forzley	M.S.
Shannon Hilty	M.S.
Megan Milligan	Ph.D.
Benjamin Triano	M.S.
Skyler Vold	M.S.

Graduate Students Receiving Degrees

Michael Duncan graduated with a Ph.D. in Fish and Wildlife Biology and is working for Montana Fish, Wildlife and Parks as a Fisheries Biologist.

Michael Lance graduated with a M.S. in Fish and Wildlife Management and is working for the Oregon Department of Fish and Wildlife as a Research Fisheries Biologist.

Research Technicians

Connor Ballard
Stephanie Driscoll
Katie Furey
Jessa Houghton
Kristin Lantz
Evan Matos
Stephen Messier
Cora Steinbach
Levi Umland
Jacob Williams
Russell Wilson

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.

Collaborators
Jason Mullen, Montana Fish, Wildlife and Parks
Tom McMahon, MSU
Robert Al-Chokhachy, USGS
Grant Grisak, Northwestern Energy

Duration
January 2015 – December 2018
Completed

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5241

The life history patterns and vital rates of stream dwelling fish can differ across biological, spatial, and temporal scales. We determined the movement patterns and vital rates of three abundant salmonids—brown trout (*Salmo trutta*), mountain whitefish (*Prosopium williamsoni*), and rainbow trout (*Oncorhynchus mykiss*)—in the Smith River watershed of Montana, a system with three distinct geomorphic regions: the headwaters, semi-wilderness canyon, and prairie. We marked 7,172 fish with passive integrated transponder (PIT) tags, monitored their watershed-scale movements past 15 stationary PIT arrays over four years, and relocated fish between arrays by conducting mobile surveys along the Smith River and major tributaries. Fish movement patterns and survival probabilities varied seasonally, among species, and among locations within the watershed. Volume of movement and diversity of movers were both greatest in the canyon region and in lower portions of tributaries. Fish rarely left the canyon, but movement into the canyon from other regions was common among some groups of fish. Mountain whitefish were most likely to move and brown trout were least likely to move. The stream lengths traversed by fish followed a leptokurtic distribution with most fish travelling < 10 km and decreasing numbers of fish travelling farther. Distinct life history patterns were not evident as judged by the stream lengths traversed by tagged fish; rather, a continuous spectrum of distances traversed was apparent. Species-specific spawning periods were associated with increased frequency of movement by mountain whitefish and rainbow trout. Increases in the frequency of watershed-scale movements of all three species were associated with mean daily water temperatures of 11.7–15.3°C, compared to periods when water temperatures were cooler or warmer. Annual probabilities of survival were highest among mountain whitefish (0.38–0.54) and lower among brown trout (0.16–0.38) and rainbow trout (0.08–0.39). Survival of rainbow trout and mountain whitefish was highest in the canyon. Survival of mountain whitefish was also high in the headwaters but was lowest in the prairie. Movements of fish in the Smith River watershed were diverse, allowed movement among habitats with different probabilities of survival, and probably contributed to meta-population function, population resiliency, and species diversity.

Total Project Cost		$ 150,922.00
Beginning Balance – January 2019		5,132.85
Expenditures – January 2019 - May 2019		
Salaries and Benefits	4,209.99	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	922.86	
Total Spent		5,132.85
Balance		0
Waived IDCs		2,258.45

Fish assemblage response to habitat restoration in Elk Springs Creek, Montana: implications for Arctic Grayling (*Thymallus arcticus*) restoration

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
Continuing

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

Anthropogenic manipulations of lotic ecosystems can degrade and fragment stream habitats, which can isolate fish and prevent them from migrating between foraging and spawning habitats. I examined the effects of two habitat restoration projects on Arctic Grayling, White Suckers (*Catostomus commersonii*), and Brook Trout (*Salvelinus fontinalis)* in Elk Springs and Picnic creeks. Elk Springs Creek was rerouted into its historical stream channel and spawning habitats near the headwaters of Elk Springs Creek were restored in autumn of 2016. I evaluated (1) stream temperature, dissolved oxygen concentration, and physical habitat (2) the movements of each species, and (3) the abundance, biomass, and size structure of each species before (2016) and after (2017 and 2018) restoration.

Mean maximum daily stream temperatures decreased at both restored temperature monitoring stations, and the average range of daily stream temperatures decreased at one restored temperature monitoring station as a result of restoration. Additionally, mean minimum daily dissolved oxygen concentration increased substantially from 2.0 mg/L before restoration in 2016 to 7.1 mg/L after restoration in 2018, and the average range of daily dissolved oxygen concentration decreased during both post-restoration years compared to before restoration. Spawning habitat restoration greatly reduced stream widths, increased stream depths and the percentage of pools along each restored reach, reduced the proportion of fine sediments, and increased the proportion of gravel substrates. Interchange of Arctic Grayling, Brook Trout, and White Suckers among PIT-tag interrogation stations was greater after restoration than before restoration. Among-station movements of Arctic Grayling, Brook Trout, and White Suckers were limited to two stations before restoration. However, Arctic Grayling, Brook Trout, and White Suckers moved among all four PIT-tag interrogation stations after restoration. Arctic Grayling abundance and biomass did not change as a result of restoration. However, Brook Trout abundance and biomass increased substantially in

restored reaches after restoration relative to control reaches. Additionally, White Suckers inhabited previously unoccupied stream reaches after restoration. The size distributions of Arctic Grayling and Brook Trout broadened after restoration. However, the size distribution of White Suckers was similar before and after restoration. Low recapture rates of PIT-tagged fish and high percentages of unmarked fish indicated that immigration rates were high, which suggests that movement is an important mechanism causing the increase in fish abundances after restoration in Elk Springs Creek.

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.

Collaborators
Todd Koel
Yellowstone National Park
Andrea Litt
MSU Department of Ecology
Mike Schwartz
U.S. Forest Service

Duration
January 2016 – December 2020
Continuing

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. Samples were collected from six tributaries in 2016, five in 2017, and three in 2018 from April through October. Samples were collected at several locations in each tributary and analyzed using qPCR. Visual surveys of spawner abundances were conducted in conjunction with water sample collection. Data are currently being analyzed.

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.

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

Duration

April 2016 – December 2019
Continuing

Non-native smallmouth bass (*Micropterus dolomieu*) introductions have negatively affected salmonids and other resident fishes in streams and rivers across the West. In the Yellowstone River, non-native smallmouth bass have demonstrated considerable upstream range expansion from their initial stocking locations in the lower river (river km 293 – 474), and adults are now sympatric with wild and native trout near Livingston, Montana (river km 797), and potentially as far upstream as Emigrant, Montana (river km 849). Information about their current and potential future distribution, habitat associations, and ecological interactions is therefore needed to assess the threat that smallmouth bass pose to other fishes in the Yellowstone River.

We set trap nets in side channels to determine the upstream extent of age-0 smallmouth bass in 2016, 2017, and 2018, as the presence of this life stage is indicative of habitats that are suitable for establishment by the species. We documented age-0 smallmouth bass as far upstream as Big Timber (river km 732) in 2016 and Reed Point (river km 700) in 2017, 2018, and 2019, which indicates a discrepancy between the upstream extent of adult distribution and that of successful reproduction.

We hypothesized that increasingly cold upstream habitat was unsuitable for reproduction because low age-0 growth potential would lead to small body sizes, and consequently high size-selective overwinter mortality. We tested this hypothesis in 2018 and 2019 by determining age-0 size at the onset of winter, hatch date, growth rate, thermal experience, and diet across 200 river km of their upstream distribution. Surprisingly, median age-0 size at the onset of winter was not significantly different across our study area. Otolith-inferred hatch date estimates indicate that this was largely due to earlier and shorter spawning in upstream areas, in contrast with a later and more prolonged spawning season in the lower river. Preliminary winter starvation modeling suggests that age-0 overwinter mortality is occurring but is not currently preventing further upstream establishment in the Yellowstone River.

Next steps include using these results alongside temperature and diet data to inform a bioenergetics model that will estimate age-0 growth potential in upstream areas where the population has not yet established. This modeling framework will allow us to map the potential for further upstream establishment by non-native smallmouth bass under present and future climate conditions.

Total Project Cost		$ 74,258.00
Beginning Balance – January 2019		18,909.19
Additional Funding - 2019		10,580.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	20,291.88	
Contracted Services	0	
Supplies	120.21	
Communications	0	
Travel	1,575.20	
Rent	0	
Repairs and Maintenance	0	
Tuition	3,651.40	
IDCs @ 15%	3,850.50	
Total Spent		29,489.19
Balance		0
Waived IDCs		7,435.22

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
Completed

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
USGS RWO 73, MSU index 4W6610

Unpaved roads are pervasive across many public lands in the western United States. The implications of these roads to aquatic habitats can be substantial, often limiting instream processes and aquatic organisms (e.g., macroinvertebrates, fish). However, sediment contributions from roads varies considerably across landscapes and costs of restoring roads to limit sediment contributions can be costly—justifying the need to identify sediment inputs and implications and prioritize management actions. Here, we consider road-stream connection points identified as areas of relatively high sediment sources in western Montana to identify areas for restoration. We specifically used multiple approaches for monitoring instream sediment, including suspended sediment, surface sediment, and subsurface sediment methods, to evaluate the consistency of results. Our study included three watersheds in western Montana where road restoration has been prioritized by management agencies. We considered three road-stream connection points in each watershed and quantified sediment levels above and below each connection point at each site. Our results indicated three different patterns: 1) sites where all metrics suggest road-stream connections compromise instream habitat; 2) sites where inferences from suspended sediment methods contrast with those from streambed substrate monitoring; and 3) sites where no clear congruence of the effects of roads on instream habitat was apparent. Our results illustrate the challenges of linking instream sediment with roads and highlight the need for refining of methods and studies linking sediment production from roads to the quantity of sediment in aquatic ecosystems.

Total Project Cost 4W6280		$ 65,009.74
Beginning Balance – January 2019		3,573.76
Expenditures – January 2019 - December 2019		
Salaries and Benefits	1,653.01	
Contracted Services	0	
Supplies	0	
Rent	100.00	
Travel	183.86	
Tuition	1,031.90	
Repairs and Maintenance	72.73	
IDCs @ 17.5%	532.26	
Total Spent		3,573.76
Balance		0
Waived IDCs		806.00

Assess the recovery of Westslope Cutthroat Trout and Arctic Grayling in Yellowstone National Park restoration areas

Investigator
Alexander Zale
Unit Leader

Graduate Student
Andriana Puchany, M.S.

Collaborators
Todd Koel
Yellowstone National Park
Bradley Shepard
B. B. Shepard and Associates
Matthew Campbell
Idaho Fish and Game

Duration
August 2016 – September 2019
Continuing

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 fishery 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.

Yellowstone National Park fishery 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 Yellowstone National Park fishery managers with information needed to better manage these populations and to guide future restoration efforts elsewhere in the Park.

High Lake and Grayling Creek were both sampled in 2018 and 2019. East Fork Specimen Creek was sampled in only 2019 because fire activity prevent sampling in 2018. We captured 12 WCT in 2018 and 16 WCT in 2019 at High Lake sample sites. We captured 303 WCT in 2019 at East Fork Specimen Creek depletion sites. We captured 450 WCT and 22 Arctic Grayling in 2018 and 416 WCT and 7 Arctic Grayling in 2019 at Grayling Creek mark-recapture and depletion sites. Captured fish were measured, PIT-tagged, and had scales and a fin clip taken for aging and genetic analysis. Mark-recapture and depletion methods will be used to estimate population abundances. Field work is completed and final analyses are underway. WCT natural reproduction was documented in all study sites by the presence of age-1 size classes in 2019. An age-0 fish of undetermined species was captured in Grayling Creek in 2019. Examination of the specimen's morphological characteristics suggest it is an Arctic Grayling rather than a WCT; however, the specimen will be genetically tested for definitive species identification. Initial genetic analyses on High Lake and East Fork Specimen Creek fish suggest WCT-Yellowstone Cutthroat Trout-Rainbow Trout hybrids have breached the lowermost barrier on East Fork Specimen Creek. Knowledge gained from this research will help Yellowstone National Park fishery managers make future management decisions regarding these species.

Total Project Cost		$ 125,357.00
Beginning Balance – January 2019		75,702.86
Expenditures – January 2019 - December 2019		
Salaries and Benefits	29,275.85	
Contracted Services	219.12	
Supplies	877.21	
Communications	0	
Travel	3,226.59	
Rent	0	
Repairs and Maintenance	0	
Tuition	4,218.54	
IDCs @ 17.5%	5,879.76	
Total Spent		43,697.07
Balance		32,005.79
Waived IDCs		10,967.02

Efficacy of the nature-like fish bypass channel at Huntley Diversion Dam, Yellowstone River, Montana

Investigator
Alexander Zale
Unit Leader

Graduate Student
Ian Anderson, M.S.

Collaborators
Mike Ruggles, Montana Fish, Wildlife and Parks
Kathryn Plymesser, Matt Blank, Joel Cahoon, MSU College of Engineering

Duration
September 2018 – March 2022
Continuing

Funding
Montana Natural Resource Damage Program, MT DOJ
MSU index 4W7438

The Huntley Diversion Dam was constructed in 1934 at river km 566 on the Yellowstone River 15 km downstream of Billings, Montana. A nature-like fish bypass channel was constructed around the dam in the late 1990s to facilitate fish passage, and was reconfigured to a more appropriate design in 2015. Nature-like bypass channels are unique in that they purportedly allow the passage of a wide range of species due to their low gradients and reduced water velocities. However, site-specific evaluations of these structures must occur to determine their overall effectiveness and identify corrective measures. The nature-like bypass channel at Huntley Diversion Dam has not yet been evaluated. Therefore, our objectives are to 1) quantify attraction, entrance, and passage efficiencies (%) of fish species through the bypass, 2) examine temporal and diel patterns of bypass use, 3) examine the effects of fish length and environmental variables on passage, and 4) characterize and model water depths, velocities, and flow patterns in and adjacent to the bypass channel.

We implanted almost 1,800 fish representing 14 species with passive integrated transponder (PIT) tags in 2019, released them upstream or downstream of Huntley Diversion Dam, and then used stationary PIT antennas to monitor their movement. We detected about 270 fish in the bypass channel, with at least one individual of each species being detected. In 2020, we will tag and release another 2,200 fish and then analyze PIT-tag detection data to address objectives 1, 2, and 3. Civil engineers from Montana State University collected discharge and survey measurements in the bypass channel throughout 2019 and are now building hydraulic models to address objective 4. Hydraulic models will be coupled with observed fish passage data to locate passage bottlenecks and determine the overall effectiveness of the bypass channel.

Total Project Cost		$ 157,429.00
Beginning Balance – January 2019		144,731.97
Expenditures – January 2019 - December 2019		
Salaries and Benefits	37,357.30	
Contracted Services	1,092.94	
Supplies	17,765.14	
Communications	7.51	
Travel	8,437.21	
Rent	2,300.00	
Repair & Maintenance	30.35	
Tuition	2,065.60	
Total Spent		69,056.05
Balance		75,675.92
Waived IDCs		30,384.66

Reproductive and basic life-history traits of western pearlshell mussels in Montana

Investigator
Alexander Zale
Unit Leader

Graduate Student
Kristen Cook, M.S.

Duration
May 2019 – May 2021
Continuing

Collaborators
David Stagliano, Montana Biological Survey
Michelle Anderson, University of Montana – Western
Lindsey Albertson, Chris Guy, MSU
Chris Barnhart, Missouri State University

Funding
MT FWP State Wildlife Grants Program
U.S. Fish and Wildlife Service

The Western Pearlshell mussel is the only freshwater mussel inhabiting trout streams in western Montana and is a species of concern in the state. The decline of this species is particularly concerning considering the benefits that freshwater mussels provide to aquatic ecosystems. Conservation of Western Pearlshells in Montana will require fundamental information on their reproduction and life-history traits that is currently lacking. Our objectives are to (1) determine the timing and duration of reproductive events of Western Pearlshells in Montana, (2) determine if Western Pearlshell mussels in Montana are hermaphroditic, and (3) identify fish host species of Western Pearlshell populations in Montana. Reproductive events include gonadal development, fertilization, brooding of eggs or embryos, glochidial release (expulsion of larvae, called glochidia), and glochidial infestation of hosts.

We are investigating the life-history traits of Western Pearlshell reproductive events in the Big Hole and Rock Creek watersheds in western Montana in 2019 and 2020. We are extracting gonadal fluid and marsupial gill contents to identify gametes and embryo developmental stages, visually identifying brooding mussels, collecting stream drift to quantify glochidial presence, and electrofishing to determine the timing and duration of glochidial infestation. We are determining if Western Pearlshells are a hermaphroditic species by performing histology. Finally, we are identifying host species by capturing salmonids at mussel beds and examining their gills for glochidial infestation. Preliminary results indicate Montana Western Pearlshell populations reproduce in late-May and early-June, brood embryos for several weeks, and release glochidia mid to late June. We documented Westslope Cutthroat Trout, Brook Trout, and Rainbow Trout infested with Western Pearlshell glochidia in both watersheds in July. The timing of reproductive events in Montana Western Pearlshells differs from that of populations in coastal states. These findings will inform any future propagation efforts because propagation requires the collection of brooding mussels and suitable fish hosts at specific times.

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

Investigators

Thomas McMahon
MSU Department of Ecology
Kevin Kappenman
U.S. Fish and Wildlife Service

Graduate Student

Benjamin Triano, M.S.

Duration

August 2017 – March 2019
Completed

Collaborators

Matt Blank, Kathryn Plymesser, Joel Cahoon, Nolan Platt
MSU College of Engineering and Western Transportation Institute
Alexander Zale, Unit Leader
Al Parker, MSU Mathematical Sciences
Kurt Heim, Stony Brook University

Funding

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

The Big Hole River in southwest Montana supports the only indigenous, self-sustaining fluvial Arctic grayling population in the conterminous United States. Movement is integral to the life history of Big Hole grayling, but the basin is fragmented by low-head irrigation diversion dams that support agriculture. Denil fish ladders have been installed at 63 irrigation diversions throughout the basin to provide grayling with improved access to critical habitats; however, a comprehensive evaluation of these fishways is necessary to ensure proper function and inform adaptive management strategies to improve their efficiency. Our objectives were to (1) quantify fishway efficiency (attraction, entrance, and passage) of grayling and other species over a range of fishway slopes and hydraulic conditions and (2) evaluate the effects of slope and hydraulic conditions on each efficiency component. We quantified attraction, entrance, and passage efficiency at 6 Denil fishways on 14 occasions in 2018 over a range of conditions using Passive Integrated Transponder telemetry. Tagged hatchery-reared grayling and wild fish of several taxa were released downstream of diversions and their upstream progress was monitored for 72 hours. Of 1,115 fish that approached fishways, 730 were attracted, 499 entered, and 456 passed. Attraction (66.5 %) and entrance (68.0 %) limited overall efficiency, but passage efficiency was greater than 90.0 % across all taxa. Attraction of grayling was limited at low upstream depths (low fishway discharges) and low attraction flows, but trout were less sensitive to these effects. Entrance of grayling and trout was limited at high upstream depths and steep slopes, and both species were more likely to enter fishways at greater downstream depths. Passage was not affected by slope or hydraulic conditions. Denil fishways demonstrated great promise for improving habitat connectivity for grayling and other species in the Big Hole basin. However, future research and adaptive management focused on increasing attraction and entrance efficiency of upstream migrants will help improve overall fishway efficiency.

Total Project Cost		$ 97,650.00
Beginning Balance – January 2019		31,066.90
Expenditures – January 2019 - December 2019		
Salaries and Benefits	21,474.11	
Contracted Services	0	
Supplies	58.58	
Communications	0	
Travel	3,351.24	
Rent	0	
Repairs and Maintenance	0	
Tuition	2,130.70	
IDCs @ 15%	4,052.27	
Total Spent		31,066.90
Balance		0
Waived IDCs		7,834.24

Lake Trout suppression and the ecological consequences in Yellowstone Lake

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Graduate Student
Hayley Glassic, Ph.D.

Duration
September 2016 – August 2021
Continuing

Funding
National Park Service
MSU index 4W6204
USGS RWO 78
MSU index 4W7971

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. The National Park Service gillnets 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. We will determine if carcass material is changing the diets of fishes in Yellowstone Lake and the trophic structure of the food web using diet and stable isotope analysis. We collected diets from 1,025 fishes in Yellowstone Lake and tissue from 359 individual fish during the 2018 field season and 212 diets and tissue samples from fish during 2019 field season. As of March 2020, 429 diets have been analyzed from the 2018 field season samples and stable isotope analysis has been conducted on 143 tissue samples. Additional diet analyses and stable isotope analyses are being conducted during spring and summer 2020 to determine if carcass nutrients can be detected in the food web. This study will provide information that will allow for an understanding of the consequences associated with a novel-suppression action in Yellowstone Lake.

Total Project Cost: 4W6204		$ 183,300.00
Beginning Balance – January 2019		126,585.06
Expenditures – January 2019 - December 2019		
Salaries and Benefits	25,831.50	
Contracted Services	1,904.75	
Supplies	1,992.39	
Communications	49.40	
Travel	4,781.81	
Rent	7,950.00	
Repairs and Maintenance	1,579.58	
Tuition	7,297.51	
IDCs @ 17.5%	8,992.66	
Total Spent		60,379.60
Balance		66,205.46
Waived IDCs		13,617.54

Total Project Cost: 4W7971		$ 46,997.00
Beginning Balance – September 2019		46,997.00
Expenditures – September 2019 - December 2019		
Salaries and Benefits	1,486.76	
Supplies	57.18	
Travel	317.97	
Tuition	0	
IDCs @ 15%	279.29	
Total Spent		2,141.20
Balance		44,855.80
Waived IDCs		539.95

Lake trout telemetry, Swan Lake, Montana

Investigators
Christopher Guy
Assistant Unit Leader

Graduate Student
Mike Siemiantkowski, M.S.

Collaborators
Carter Fredenberg, USFWS
Creston Fish and Wildlife Center

Funding
US Fish Wildlife Service
CESU MSU index 4W7111

Duration
February 2018 – October 2022
Continuing

Expansion of the Lake Trout *Salvelinus namaycush* population in Swan Lake, Montana threatens one of the core area populations of Bull Trout *Salvelinus confluentus* in Montana. An experimental gillnetting program was conducted to suppress the Lake Trout population between 2009 and 2016. Unfortunately, the Lake Trout suppression program in Swan Lake ended because of monetary constraints and potential increases in Bull Trout bycatch. However, given the increased efficacy of embryo suppression methods, there is renewed interest in Lake Trout suppression in Swan Lake. The specific objectives of this study were to identify Lake Trout spawning sites and quantify the area of spawning sites. Acoustic tags were surgically implanted in 48 Lake Trout in 2018, with an additional 37 Lake Trout implanted in 2019. Nightly tracking efforts during the autumn of 2018 resulted in 759 individual locations for 29 Lake Trout and 991 for 40 in 2019. Kernel-density analysis was used to evaluate Lake Trout locations and 11 putative spawning locations were identified—corroborating previous studies. For example, spawning continues to occur along the Highway 83 roadcut on the east shore of Swan Lake. In 2019, side-scan imaging was used at the 11 putative spawning locations to describe the composition and total area of suitable spawning substrate. Divers verified substrate assignments from side-scan imaging at 8 of the 11 locations. Quantification of the total area of spawning substrate where concentrations of Lake Trout occurred during the spawning seasons in Swan Lake will inform managers of the feasibility of implementing embryo suppression as a complementary technique to traditional gillnetting in Swan Lake.

Total Project Cost		$ 136,590.00
Beginning Balance – January 2019		19,890.44
Additional Funding -- 2019		79,111.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	23,614.40	
Contracted Services	160.12	
Supplies	1,144.07	
Communications	0	
Travel	4,189.01	
Rent	5,281.50	
Repair and Maintenance	0	
Tuition	3,383.50	
IDCs @ 17.5%	5,373.75	
Total Spent		43,146.35
Balance		55,855.09
Waived IDCs		10,009.74

Bull trout emigration study

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Eric Oldenburg
Avista Corporation

Graduate Student
Madeline Lewis, M.S.

Funding
Avista Corporation
MSU index 4W7227

Duration
May 2018 – December 2021
Continuing

The Clark Fork River historically served as a migration corridor for adfluvial Bull Trout that used Montana tributaries for spawning and rearing, and Lake Pend Oreille for growth to maturity. Three main-stem dams fragment the Clark Fork River and isolate previously migratory Bull Trout populations. In 2000, Avista, owner and operator of the Noxon Rapids and Cabinet Gorge dams, implemented a manual transport program to restore and maintain connectivity for Bull Trout populations between the lower Clark Fork River and Lake Pend Oreille. To address passage issues regarding juvenile Bull Trout, Avista implemented the Tributary Trapping and Downstream Juvenile Bull Trout Transport Program. In this program, juvenile Bull Trout are trapped when out-migrating from their natal tributary and transported directly downstream to Lake Pend Oreille; eliminating any potential risk associated with passage through the reservoirs or physical downstream passage of the dams. Initially, management of the downstream program was generally based on trial and error, with the primary goal of maximizing the number of juvenile Bull Trout captured. More recently, efforts have been focused on using applied research to better inform decisions regarding program objectives. Graves Creek and East Fork Bull River are the focus of research efforts because they currently have the necessary infrastructure to allow for understanding Bull Trout outmigration dynamics. The objectives of this study are to estimate capture efficiency, abundance and age distribution of out-migrating juvenile Bull Trout, timing distribution of out-migration events, and biotic-abiotic factors that influence out-migration in Graves Creek and East Fork Bull River.

In the summer of 2019, 491 Bull Trout were captured and PIT-tagged in Graves Creek. Using the electrofishing data from the summer, the population of juvenile Bull Trout in Graves Creek was estimated to be 2082 (+/- 289). During the autumn trapping season in Graves Creek, 823 (+/- 29) Bull Trout were estimated to outmigrate, with 720 confirmed out-migrants that were trapped or detected out-migrating. The average trap efficiency for the permanent weir during the autumn trapping season was 86%, with efficiency varying with month of outmigration and age of outmigrants. In the East Fork Bull River, 77 juvenile Bull Trout were captured and PIT-tagged in the summer of 2019. A total of 27 juvenile Bull Trout were captured out-migrating from the East Fork Bull River in the autumn trapping season, however only a small proportion were previously

tagged, making estimates of trap efficiency and total number of outmigrants not possible because of low sample size. Continued use of these methods will provide insight into the interrelated factors that influence out-migration dynamics of juvenile Bull Trout and will be used to maximize the efficiency of the trap and transport program.

Total Project Cost		$ 68,202.00
Beginning Balance – January 2019		10,476.52
Additional Funding -- 2019		47,402.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	29,115.08	
Contracted Services	90.39	
Supplies	2,132.27	
Communications	0	
Travel	3,163.56	
Tuition	7,318.68	
IDCs @ 20%	8,364.02	
Total Spent		50,184.00
Balance		7,694.52
Waived IDCs		10,036.80

Spawning characteristics and juvenile sampling for mountain whitefish in the Green River, Wyoming

Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Colter Brown, M.S.

Duration
July 2018 – June 2022
Continuing

Collaborators
Darren Rhea, Mark Smith
Wyoming Game and Fish
Molly Webb, USFWS Bozeman
Fish Technology Center

Funding
Wyoming Game and Fish
MSU index 4W7263

Mountain Whitefish *Prosopium williamsoni* are a coldwater sportfish native to rivers and lakes throughout the western United States and Canada. In the last two decades, Mountain Whitefish population declines have been reported in many waterbodies in the southern part of the species range. Problems with recruitment are suspected, but little research has been done to describe the spawning characteristics and early-life history of Mountain Whitefish. The most thorough investigation of Mountain Whitefish movement and early-life history, in the southern portion of the species range, was conducted in the Madison River, Montana—a population that has experienced recruitment problems. Conversely, the Mountain Whitefish population in the upper Green River, Wyoming has consistent recruitment and a stable age structure. This study will occur in the Green River and will use identical methods to those in the Madison River study, which will allow for direct comparisons between populations. Comparing the movement and early-life history characteristics between populations will provide a better understanding of the factors that may be limiting recruitment and produce additional knowledge on this understudied species. The specific objectives of the study are: 1) identify large-scale movement patterns through the spawning period; 2) describe the age structure, age at maturity, fecundity, and spawning periodicity; 3) identify the drift distance of age-0 whitefish; 4) identify which river reaches in the upper Green River have high age-0 whitefish density; and 5) compare results between studies.

In the spring and summer of 2019, 38 sexually mature Mountain Whitefish were radio tagged. Mountain Whitefish were tracked from 1 September to 1 November in the Green River from Lower Green River Lake downstream to Swains Bridge (125 km). Spawning locations were identified and confirmed at several locations within the study reach. Preliminary analysis indicates that spawning occurs throughout the study reach and there is limited large-scale spawning migration, unlike what was observed in the Madison River, Montana.

Total Project Cost		$ 168,323.00
Beginning Balance – January 2019		112,854.00
Additional Funding -- 2019		55,469.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	23,438.22	
Contracted Services	646.51	
Supplies	16,307.78	
Communications	0	
Travel	9,698.07	
Rent	925.00	
Repair & Maintenance	16.60	
Tuition	3,111.85	
IDCs @ 20%	10,828.80	
Total Spent		64,972.83
Balance		103,350.17
Waived IDCs		12,994.57

Quantifying brown trout predation on burbot: are non-native predators contributing to the decline of native fish populations in Torrey Creek drainage?

Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Robert Eckelbecker, Ph.D.

Collaborators
Paul Gerrity, Joe Deromedi, Craig Armadio, Wyoming Game and Fish Department

Duration
July 2019 – June 2023
New, approved

Funding
Wyoming Game and Fish
MSU index 4W7910

Burbot are a native sportfish species in Wyoming and classified as a species of greatest conservation need. Biologists have become concerned with the decline in abundance of Burbot in the Torrey Creek drainage since the 1990s. A potential cause of the decline could be attributed to the introduction of Brown Trout, which probably entered the drainage in the early 1950s. Confirmation of Brown Trout predating on Burbot was observed in 2017 when Burbot occurred in 33% of Brown Trout diets. We will estimate the age distribution of Brown Trout in the Torrey Creek drainage; Trail Lake, Ring Lake, Torrey Lake, and Torrey Creek. In addition, diets of Brown Trout will be collected in the spring, summer, and fall and used in a bioenergetics model. The bioenergetics model coupled with the previous abundance estimates will be used to estimate the effects of Brown Trout predation on the Burbot population in the Torrey Creek drainage, which will inform management decisions regarding the effects of non-native predators on native species.

Total Project Cost		$ 58,004.00
Beginning Balance – July 2019		58,004.00
Expenditures – July 2019 - December 2019		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repair & Maintenance	0	
Tuition	0	
IDCs @ 20%	0	
Total Spent		0
Balance		58,004.00
Waived IDCs		0

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

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

Graduate Student
Tanner Cox, M.S.

Collaborator
Luke Holmquist
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6930

Duration
September 2017 – June 2020
Continuing

The Pallid Sturgeon population above Fort Peck Reservoir, Montana, has not produced a year class in 50 years. Recruitment failure is hypothesized to be a result of inadequate drift distance for embryo development. Additionally, a high incidence of follicular atresia has been observed in Pallid Sturgeon in the study area. Here, we used reproductive assessments of hatchery-origin Pallid Sturgeon to determine ovulatory outcome of reproductively active female Pallid Sturgeon. Additionally, we used radio-telemetry to describe movement and spawning locations of hatchery-origin Pallid Sturgeon in the Missouri and Marias rivers. Although three hatchery-origin female Pallid Sturgeon that were reproductively active during 2018 or 2019 underwent follicular atresia, five other Pallid Sturgeon successfully spawned in the Missouri River—this is the first record of hatchery-origin fish spawning in the Missouri River above Fort Peck Reservoir. Reproductively active female Pallid Sturgeon were detected 143 kilometers farther upstream, including detections of three individuals in the Marias River, during high-discharge events in 2018. Furthermore, female Pallid Sturgeon that spawned used locations farther upstream in the Missouri River during 2018 when discharge was higher. These results illustrate that Pallid Sturgeon will spawn in the Missouri River above Fort Peck Reservoir and that large-scale spawning locations may be related to discharge.

Total Project Cost		$ 150,075.00
Beginning Balance – January 2019		28,961.86
Additional Funding – 2019		62,390.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	26,264.65	
Contracted Services	16,847.40	
Supplies	2,097.25	
Communications	0	
Travel	5,878.84	
Rent	3,000.00	
Repair and Maintenance	159.73	
Tuition	3,261.50	
Total Spent		57,509.37
Balance		33,842.49
Waived IDCs		25,304.12

Enhancing survival and condition of first feeding larval pallid sturgeon through diet

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

Research Associate
Hilary Treanor

Collaborator
Wendy Sealey
U.S. Fish and Wildlife Service

Funding
USGS RWO 77 SSP
MSU index 4W7764

Duration
April 2019 – December 2022
New, approved

Conservation propagation facilities are currently experiencing variable survival of first feeding larval Pallid Sturgeon (PS). This type of hatchery-induced "selection" can ultimately have unintended, negative consequences on genetic representation of Pallid Sturgeon returned to the Missouri and Yellowstone Rivers. There is indication that the observed variability in larval survival at conservation propagation hatcheries is a result of poor response to feed offered to larvae. There is also evidence that first feeding larvae are unable to properly digest formulated diets because they lack the digestive enzymes necessary to process and assimilate a diet high in protein typical of commercial dry diets. The objectives of this study are as follows: 1) identify a diet that improves parity of survival and condition (i.e., weight) of first feeding larval Pallid Sturgeon, regardless of genetic lot; 2) determine length of time required to feed diet identified in Objective 1 that enhances survival, condition, and weaning success, regardless of genetic lot; 3) determine if diet and feeding duration identified in Objectives 1 and 2 can be applied successfully at Pallid Sturgeon propagation facilities; and 4) develop a feeding regimen for implementation at Upper Basin conservation propagation hatcheries. In 2019, we completed a trial with one genetic lot and identified a flaw with the experimental system that impacted our results. We believe that the filtration system meant to keep organic matter from being distributed to the tanks was not, in fact, preventing movement of organic material. Because of this, we could not be certain that larvae received only the diet to which they had been randomly assigned. This was made evident by the fact that a few larvae in the control (i.e., no food) tanks survived and attained a size similar to that achieved by larvae that received food. As a result, we did not continue the trials with the second PS family lot. Despite issues with food movement among tanks, preliminary results from the trial indicate the mortality was lower in PS larvae fed enriched *Artemia* than those fed the commercial Otohime diet. The design flaw has been resolved for 2020.

Beginning Balance – April 2019		52,513.00
Expenditures – April 2019 - December 2019		
Salaries and Benefits	25,015.41	
Contracted Services	3,783.75	
Supplies	8,261.54	
Travel	0	
IDCs @ 15%	5,559.08	
Total Spent		42,619.78
Balance		9,893.22
Waived IDCs		10,747.60

Survival and abundance of paddlefish in the Missouri River above Ft. Peck Reservoir

Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Hayley Glassic, Ph.D.

Collaborators
Steve Dalbey, Cody Nagel
David Schmetterling, Montana Fish, Wildlife and Parks
Jay Rotella, MSU Department of Ecology

Duration
June 2018 – June 2019
Completed

Funding
Montana Fish, Wildlife and Parks
MSU index 4W7278

Excessive fishing pressure can induce population declines or complete collapse of fisheries. Unless commercial and recreational fisheries for K-selected fishes, or those with slow growth and late maturation, are carefully managed, declines in abundance or fishery collapse is probable. Paddlefish *Polyodon spathula,* are a K-selected species that experienced historical declines in abundance as a result of habitat degradation and overfishing. Mark-recapture studies are well-suited for long-lived fishes by providing information on population density and vital rates. For sustainable commercial or recreational fisheries targeting species such as the paddlefish, managers require accurate estimates of population vital rates including survival, abundance, and exploitation. We used a Montana Fish, Wildlife & Parks (MFWP) mark-recapture dataset and modified Jolly-Seber (POPAN) models to estimate survival, recapture, probability of entry, and abundance of 8518 tagged paddlefish over a 25-year period. With many supporting estimates including stable survival, low exploitation rates, and stable abundance estimates, the Fort Peck paddlefish population appears to be stable and well-managed over the past 25 years. Presently, this is the only study focused on paddlefish in North America that has estimated survival and abundance for both male and female paddlefish using contemporary analyses. This research provided a unique opportunity to highlight that the effort exerted by management agencies to collect long-term field data is extremely useful to our understanding of fish populations and management.

Total Project Cost		$ 25,000.00
Beginning Balance – January 2019		16,726.90
Expenditures – January 2019 - June 2019		
Salaries and Benefits	15,290.37	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	1,436.53	
Total Spent		16,726.90
Balance		0
Waived IDCs		7,359.84

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
Continuing

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. The overall goal of this study was to determine if the hatchery-origin White Sturgeon in the LCR, Canada have reached puberty and to assess the size, growth, and relative condition factor of the population. To accomplish this goal, we described the reproductive structure of the population using numerous tools (ultrasound, endoscopy, plasma sex steroids, and gonadal biopsy) available to assign sex and stage of maturity. True sex was determined by histological analysis of gonadal tissue and was used to assess the accuracy of each tool in assigning sex and stage of maturity in hatchery-origin White Sturgeon as well as a small number of the existing wild White Sturgeon. The wild fish provided plasma sex steroid profiles from post-pubertal fish and enabled a comparison of accuracy in assigning sex and stage of maturity between pre-pubertal and post-pubertal animals. Information on size, growth, and relative condition factor were used to identify areas of the river where fish may reach puberty at an earlier time due to environmental factors. Sampling occurred during the spring and fall of 2017 and 2018. The hatchery-origin population has not yet reached puberty. The otoscope was the most accurate tool to assign sex and was 98% accurate in assigning sex in the hatchery-origin population and 100% accurate in assigning sex in the wild population. The results from this study will help to further develop a monitoring program, which can track changes in the reproductive structure of the hatchery-origin population over time as well as inform the number of fish to stock from the conservation aquaculture program.

Total Project Cost		$ 82,154.00
Beginning Balance – January 2019		22,729.68
Additional Funding – 2019		18,500.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	18,746.35	
Contracted Services	82.16	
Supplies	0	
Communications	0	
Travel	1,747.52	
Rent	0	
Tuition	6,008.52	
IDCs @ 17.5%	2,862.38	
Total Spent		29,446.93
Balance		11,782.75
Waived IDCs		7,044.91

Determining causes, costs, and benefits of triploidization to improve sturgeon caviar production

Investigators

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

Collaborators

Joel Van Eenennaam, Andrea Schreier, Anne Todgham, UC Davis
Shawn Young, Kootenai Tribe of Idaho

Research Associate

Hilary Treanor

Funding

University of California Davis
MSU index 4W7205, 4W7795

Duration

September 2017 – August 2020
Continuing

Few studies have examined the relative performance of triploid and diploid finfishes from the perspective of aquaculture production. Because all sturgeon are naturally polyploid (4N, 8N, 12N), they may be more tolerant of genome size manipulation than other fishes. Although the utility of triploidization has yet to be explored in the sturgeon industry, unintentional induction of genetic triploidy (diploid 2x = 8N to triploid 3x = 12N) has been discovered in two white sturgeon culture facilities. Our long-term objective is to evaluate the influence of spontaneous (unintentional) 12N sturgeon production on the caviar industry. We will determine whether 12N sturgeon represent a new avenue of improvement for sturgeon farming while simultaneously determining whether spontaneous triploid sturgeon negatively affect the industry. Specifically, the Bozeman Fish Technology Center will participate in evaluating non-reproductive females and their ploidy levels. To date, we have found that plasma T and E2 concentrations did not differ among ploidy levels in females. Plasma T concentrations were lower in females undergoing follicular atresia compared to females with ripe ovarian follicles (T: $p<0.001$, $F=27.624$, $df=1$). Plasma T and E2 concentrations did not differ between ploidy levels for immature females in Stage 1 and 2 (T: $p=0.063$, $F=3.56$, $df=1$; E2: $p=0.146$, $F=2.156$, $df=1$). The immature females (8N) that were vitellogenic (Stages 3 and 4) had low T and E2 concentrations compared to female white sturgeon with normal gonadal development and few adipocytes present in the gonadal tissue. One possible explanation for the low steroid concentrations in Stage 3 and 4 females may be that because steroids are produced by the developing ovarian follicles, females with few ovarian follicles and considerable adipocytes may have low circulating steroid concentrations compared to females with a many ovarian follicles and few adipocytes.

Total Project Cost		$ 22,960.00
Beginning Balance – January 2019		11,457.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	11,457.00	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Total Spent		11,457.00
Balance		0
Waived IDCs		5,041.08

Carnivore management and elk recruitment in western Montana

Investigators
Robert Garrott, Jay Rotella, MSU Department of Ecology
Terrill Paterson, Postdoctoral Research Associate

Graduate Student
Michael Forzley, M.S.

Collaborator
Kelly Proffitt
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5906

Duration
February 2016 – June 2020
Continuing

Montana Fish, Wildlife and Parks Region 2 in west-central Montana 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 elk abundance in some areas. To reduce predation on elk, wildlife managers have applied integrated carnivore-ungulate management strategies over the past 5 years. In particular, carnivore harvest quotas have been increased in an attempt to reduce wolf, black bear, and mountain lion populations. Our goals were threefold and designed to determine the efficacy of increasing the harvest quotas for large carnivores to increase elk recruitment and overall elk populations.

First, we assessed the effects of mountain lion harvest management on mountain lion population abundance by comparing their abundances in a study area located within a watershed managed for carnivore reductions (i.e., treatment area) to abundances in a study area located within a watershed that was managed for stable carnivore populations (i.e., control area) before and 4 years after increased harvest quotas in the treatment area. We used DNA-based spatially explicit capture-recapture models in conjunction with telemetry information from collared individuals to estimate mountain lion abundances. The increased mountain lion harvest quotas coincided with (1) slight increases in mountain lion abundance in the control area from 57 (90% CI = 37-85) to 72 (90% CI = 47-105) and (2) decreases in the treatment area from 161 (90% CI = 104-233) to 115 (90% CI = 69-173).

Second, we evaluated the effects of increased carnivore harvest quotas on elk calf survival in the East Fork and West Fork watersheds of the Bitterroot River. We used ear-tag radio transmitters to monitor the survival and mortality of elk calves for the first year of their life, over five years (2011-2014, 2016-2018). We radio-tagged 534 elk calves, and used time-to-event survival and mortality analyses to 1) estimate potential changes in elk calf survival and cause-specific mortality before, during, and after increased carnivore harvest quotas, and 2) understand the relative effects of spatiotemporal covariates and individual characteristics on elk calf survival in the area.

Average rates of survival of female elk calves were lowest before the carnivore harvest treatment (0.38, 95% CI = 0.00-0.54), highest during the carnivore harvest treatment (0.65, 95% CI = 0.47-0.83), and intermediate 4-5 years after the carnivore harvest treatment (0.46, 95% CI = 0.31-0.61). Increased rates of elk calf survival during the period of increased carnivore harvest quotas coincided with moderate evidence for decreased rates of mountain lion predation and no overall changes to the probabilities of black bear and wolf predation. Increasing the harvest of mountain lions may be effective in allowing for short-term increases in elk calf survival and may be an effective management tool to increase calf recruitment. However, because a number of calves in each treatment era died due to unknown causes, we cannot rule out the possibility that changes in predation by carnivores other than mountain lions caused the changes we observed across the 3 treatment eras.

Third, to understand sources of variation in elk calf recruitment at the regional scale, we developed a population model that incorporated survey data (including counts and age ratios) and harvest numbers. This model had significantly higher statistical power than a model based on age ratios alone and provided additional information regarding variation in key vital rates. Our results suggest that per capita recruitment rates were negatively associated with cold, wet springs and severe winters and were positively associated with summer precipitation. This approach based on a population model provided estimates of the region-wide mean per capita recruitment rate (mean = 0.25, 90% CI = 0.21-0.29), temporal variation in hunting-district-specific recruitment rates (minimum = 0.09, 90% CI = 0.07-0.11; maximum = 0.43, 90% CI = 0.38-0.48), and annual population growth rates (minimum = 0.83, 90% CI = 0.78-0.87; maximum = 1.20, 90% CI = 1.11-1.29). We recommend using count data and a population modeling approach rather than interpreting estimated age ratios as a substantial improvement in understanding population dynamics.

Total Project Cost		$ 909,000.00
Beginning Balance – January 2019		139,326.31
Additional Funding – 2019		62,000.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	87,306.06	
Contracted Services	4,652.41	
Supplies	3,185.91	
Communications	0	
Travel	3,191.38	
Rent	0	
Repairs and Maintenance	0	
Tuition	1,031.90	
Total Spent		99,367.66
Balance		101,958365
Waived IDCs		43,721.77

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

Investigator
Robert Garrott
MSU Department of Ecology

Collaborators
Kelly Proffitt
Montana Fish Wildlife and Parks

Research Associates
Jesse DeVoe, Blake Lowrey, MSU

Funding
Montana Fish, Wildlife and Parks
MSU index 4W6318

Duration
October 2016 – June 2019
Completed

We evaluated the impact of the MPB infestation on elk distributions, forage, and habitat security in the Elkhorn Mountains. The project was designed to provide managers with recommendations for managing elk populations and habitat in areas impacted by MPB infestations. Since 1997, MPB have affected an estimated 85,000 km^2 (> 21 million acres) of pine forests in the western United States and British Columbia resulting in widespread tree mortality and defoliation of tree canopy that have strongly influenced forest community composition and structure, timber production, fuels and wildfire characteristics, and wildlife habitat. About 1,655 km^2 (411,431 acres; 64%) of the study area was affected by the MPB infestation, with tree mortality approaching 90% over the affected area. The infection peaked in 2009 (Figure 1), meaning that this study took place over the period spanning 6-9 years following the peak of the outbreak in the Elkhorns. We sampled vegetation to learn more about elk forage abundance and quality in an area impacted by MPB. Overall, the most abundant and species-diverse herbaceous forage occurred in riparian areas followed by grasslands and shrublands. We found modest variation in forage metrics and overstory canopy cover between MPB infestation classes of lodgepole pine forest. Generally, levels of herbaceous forage abundance, cover, species richness, and quality increased and shrub forage abundance and forage species richness decreased from the unaffected to affected class.

During 1982-1992, MFWP conducted an elk telemetry study in the Elkhorn Mountains. We compared location data from the 1982-1992 study to location data collected during the current study and found a reduction in proportional use of areas affected by MPB between the pre- and post-MPB-infestation study periods), but the cause of this reduction in use was not clear. We evaluated elk selection for security areas during the fall archery and rifle hunting seasons based on GPS location data with a goal of providing recommendations for security standards for elk inhabiting forests impacted by MPB. Based on thresholds derived from our security model, we recommend that definitions of elk security in the Elkhorn Mountains include objectives of canopy cover values ≥ 23–60% and distance from motorized routes ≥ 1,846–3,679 m, which represent the thresholds for areas that contain 75% and 50% of the elk use on the landscape, respectively.

We observed an 8.5% reduction in canopy cover within MPB-infested lodgepole pine forests compared to levels prior to the MPB outbreak. Canopy cover in MPB-infested forests remained relatively high (mean = 69 ± 15% SD) and had higher canopy cover values than Douglas fir and ponderosa pine forests by 15% and 42%, respectively. Canopy cover was an important component in defining elk security. Given the relatively high degree of cover offered by lodgepole pine forests, the changes in cover associated with defoliation post-MPB-infestation were relatively minor and did not result in a meaningful reduction in canopy cover below the thresholds used to define security areas). Although elk may use MPB-affected areas less than prior to MPB infestation, these forests maintained a high degree of canopy cover relative to Douglas fir and ponderosa pine forests and probably provide valuable security during hunting seasons.

Within the Elkhorn Mountains, public lands are largely forested and contain the majority of the MPB-affected areas. Consequently, MPB infestation may encourage the redistribution of elk from public lands to adjacent private lands. Both changes in land use on private lands and MPB-infestation on public forested lands have the potential to result in decreased use of forested areas that are predominantly public. Strategies for manipulating distributions of elk on private lands might include working with private landowners to restrict elk access to high-value forage or increase hunter access on their properties to discourage elk from using these areas during the hunting seasons and other times of the year. These strategies combined with a continued focus on providing security habitat on public lands may provide a more holistic approach for encouraging elk to remain broadly distributed across public and private lands during the hunting seasons, ensuring hunter access to elk on public lands and minimizing property damage by elk on private lands.

Total Project Cost		$ 140,163.00
Beginning Balance – January 2019		73,819.63
Expenditures – January 2019 - December 2019		
Salaries and Benefits	73,508.52	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Tuition	0	
Repairs and Maintenance	0	
Total Spent		73,508.52
Balance		311.11
Waived IDCs		32,343.75

Delineating and mapping ungulate seasonal ranges and movement corridors in Montana

Investigator
Robert Garrott
MSU Department of Ecology

Collaborator
Kelly Proffitt
Montana Fish, Wildlife and Parks

Research Associate
Blake Lowrey, MSU

Funding
Montana Fish, Wildlife and Parks
MSU index 4W8069

Duration
May 2019 – June 2021
Continuing

Recognizing the need to protect and conserve big-game winter range, stopover, and migration corridors to sustain robust ungulate herds across Montana, Montana Fish, Wildlife and Parks (FWP) recently prioritized a broad effort to delineate migration routes and seasonal ranges of elk, mule deer, and pronghorn using rigorous methodologies that account for varied terrain, habitat, and big game migration behaviors across the state. This effort has been bolstered by Sectorial Order 3362, which mandated that Department of Interior bureaus work with state wildlife agencies to enhance and improve habitat quality of big game winter range and migration corridors. The broad mapping effort and associated new research will help fulfill local information needs as well as contribute towards regional coordinated mapping efforts across the western US. Spatial files and maps from the mapping effort will be made available to FWP staff and the public.

We began aggregating and analyzing existing elk, mule deer, and pronghorn telemetry data in October 2019. Elk have the most expansive existing GPS data set consisting of over 850 individuals sampled from 22 populations and an aggregate of nearly 10 million GPS locations. These data have been cleaned and formatted and are currently being used to assess various methods of delineating annual and seasonal ranges. In addition to the existing elk data, FWP has plans to capture an additional 50 adult female elk in Devils Kitchen in early 2020 and has plans for future captures in 5 additional areas identified as part of a long-term elk research initiative. The existing mule deer dataset consists of nearly 300 individuals sampled from 10 populations between 2004 and 2018. These data are currently being aggregated across the different study areas and will be available for inclusion in the seasonal range and corridor mapping in early 2020. Additionally, there are plans to deploy 40 GPS collars in Carbon County and 30 GPS collars in the Gardner Basin in February and March 2020. Future capture efforts will also be conducted in 4 areas identified as part of a long-term mule deer research initiative. Lastly, the pronghorn GPS data set consists of 60 individuals sampled in the Madison Valley in 2019 and 2020. In addition, captures are ongoing to deploy 60 collars in each of 7 additional study areas by March 2020. This will result in a total of nearly

500 GPS collars on pronghorn that will be included in the seasonal range and migration mapping efforts as these collars continue to collect spatial data over the next 3 years.

The first analysis goal is to explore different analytical methods for delineating annual and seasonal ranges of elk. This work is currently under way with final products expected in spring 2020. The second research goal is to delineate and define migration routes for the 3 species in the study areas across Montana. Additional elk, mule deer, and pronghorn data sets will be included as they are cleaned and aggregated. We will collaborate with FWP Geographic Data Services to develop a platform where GIS layers can be viewed and downloaded.

Total Project Cost		$ 136,000.00
Beginning Balance – May 2019		136,000.00
Expenditures – May 2019 - December 2019		
Salaries and Benefits	5,582.17	
Contracted Services	0	
Supplies	2,282.03	
Travel	0	
Total Spent		7,864.20
Balance		128,135.80
Waived IDCs		3,460.25

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

Investigator
Andrea Litt
MSU Department of Ecology

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
Continuing

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 roosting sites may be limiting, we aimed to quantify structural features of roosts in lodgepole pine-dominated forests during the summer and determine whether bats are selecting roosts with particular features disproportionately to what is available on the landscape.

To characterize roosting sites, we mist-netted for bats in forests dominated by lodgepole pine (*Pinus contorta*) that exhibited varying degrees of tree mortality due to MPB during the summers of 2017 and 2018 (total bats captured = 222). We captured these bats in two drainages within the Helena-Lewis and Clark National Forest of southwestern and central Montana: 1) Moose Creek in the Little Belt Mountains between June and August of 2017, and 2) Little Blackfoot River in the Boulder Mountains between June and August of 2017 and 2018. Two bat species made up the majority of captures: little brown myotis (*Myotis lucifugus*) and silver-haired bat (*Lasionycteris noctivagans*). We attached radio-transmitters to 41 male bats (35 little brown myotis, 4 long-legged myotis [*Myotis volans*], and 2 long-eared myotis [*Myotis evotis*]) and located at least 1 roost for 25 individuals (total roosts = 74). We focused subsequent analysis on roosting by male little brown myotis.

Although snags were available, most bats roosted in rock features (86% in rocks, 14% in snags); these rock roosts were mainly in crevices (85%) with vertical orientations instead of rock cavities (15%). Male bats were more likely to select roosts with less canopy cover that were closer to water. They also selected roosts in areas with more overall rock cover and wider entrances that provided access to a skyward-facing crevice. These results suggest that rock features may provide important summer habitat for male little brown myotis and that lodgepole pine in this landscape may not provide appropriate roosting features. Roost selection in these forests will help inform management decisions for conserving western bats. Future research should work towards identifying unknown hibernacula in the west and investigate whether rock

features in similar western landscapes provide appropriate characteristics for hibernating bats.

We also used acoustic detectors to characterize foraging by bats. We deployed 39 detectors in forest stands (16 in lodgepole pine, 12 in lodgepole pine and Douglas fir [*Pseudotsuga menziesii*] mixture, and 11 in ponderosa pine [*Pinus ponderosa*]) with varying degrees of MPB-caused tree mortality across the Helena Lewis and Clark National Forest between June and August 2017 and 2018. During summer 2017, these detectors recorded 902 GB of data resulting in 30,693 sound files, or bat passes. We are processing data from summer 2018. We will analyze data from both years to understand how bat foraging activity varies with MPB severity.

Total Project Cost		$ 74,100.00
Beginning Balance – January 2019		5,357.35
Additional Funding -- 2019		5,000.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	7,006.27	
Contracted Services	0	
Supplies	25.63	
Communications	0	
Travel	0	
Tuition	0	
Repairs and Maintenance	0	
Total Spent		7,031.90
Balance		3,325.45
Waived IDCs		3,094.04

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
MSU Department of Animal and Range Sciences

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

Collaborator
Lorelle Berkeley
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5907

Duration
February 2016 – June 2020
Continuing

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. Our results suggest that the various grazing systems were not important predictors of grouse nest site selection, nest survival, adult survival, or space use and that, overall, the rest-rotation grazing system did not contribute to vegetation heterogeneity at a spatial scale that is relevant to breeding grouse. Further, no noticeable benefit of rest-rotation grazing on the abundance or species diversity of grassland birds existed relative to season-long and summer rotation grazing systems. Species-specific responses to livestock grazing system occurred among three obligate grassland birds, but support for interactions between grazing system and local rangeland production potential limits the ability to recommend general livestock management practices for the benefit of grassland bird populations. Occupancy of mesocarnivores was highest in rest-rotation grazing systems, followed by season-long and summer rotation systems, respectively. Taken

together, our results suggest that the rest-rotation grazing system recommended by Montana FWP did not have the greatest benefit for either sharp-tailed grouse or grassland birds.

Total Project Cost		$ 533,975.00
Beginning Balance – January 2019		183,832.48
Additional Funding – 2019		27,925.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	36,431.54	
Contracted Services	1,927.85	
Supplies	5,048.37	
Communications	0	
Travel	5,100.38	
Rent	0	
Repairs and Maintenance	3,436.13	
Total Spent		51,944.27
Balance		159,813.21
Waived IDCs		22,855.48

Pallid Sturgeon condition evaluation

Investigator
Christine Verhille
MSU Department of Ecology

Collaborator
Kevin Kappenman
U.S. Fish and Wildlife Service

Graduate Student
Matea Djokic, M.S.

Funding
Montana Fish, Wildlife and Parks
MSU index 4W7302

Duration
July 2018 – June 2021
Continuing

Previous researchers have been successful in relating stream-side non-invasive physiological assessments of wild-captured salmonids to performance outcomes. However, assessments of wild pallid sturgeon populations are based on measurements of size and survival, which provide poor resolution and slow detection times of population health responses to fluctuations in habitat conditions. We proposed to develop a life-stage-specific pallid sturgeon field health assessment criterion through a hatchery experiment and streamside assessments of wild-captured juvenile pallid sturgeon performed in conjunction with existing monitoring efforts. Assessments will involve an extensive suite of health assessment variables for prediction of overall health of pallid sturgeon. Measurements making up the extensive suite of health assessment variables will include blood and tissue biochemistry (e.g., metabolic substrates and end products as well as stress and reproductive hormones), a visual fish health index, and non-invasive microwave and bioelectrical impedance determinations of whole-body energy concentration.

Lethal sampling was performed on juvenile hatchery pallid sturgeon for blood biochemistry measurements as well as for direct determination of whole-body energy concentration to confirm indirect, but non-invasive, microwave measurements of whole-body energy. Microwave measurements were determined to be moderately effective at estimating whole body energy of juvenile pallid sturgeon when combined with size and relative condition values. A set of blood biochemistry analytes and body composition variables that both co-vary and predict recent growth of juvenile hatchery pallid sturgeon were identified. This set of variables will make up the field health-assessment criterion, which will be applied to measurements on wild captured juvenile pallid sturgeon as the priority life stage identified by Upper Missouri River Basin biologists and managers to infer their body composition and recent growth.

Total Project Cost		$ 172,114.00
Beginning Balance – January 2019		69,745.58
Additional Funding – 2019		86,869.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	27,984.69	
Contracted Services	12,812.25	
Supplies	20,573.67	
Communications	57.66	
Travel	2,203.22	
Tuition	3,972.91	
Total Spent		67,604.40
Balance		89,010.18
Waived IDCs		29,745.94

Mechanisms underlying emaciation in adult pallid sturgeon evaluation

Investigator
Christine Verhille
MSU Department of Ecology

Graduate Student
Sierra Quinn, M.S.

Collaborators
Kevin Kappenman
U.S. Fish and Wildlife Service
Kirk Steffensen
Nebraska Game and Parks Commission

Duration
February 2019 – September 2021
Continuing

Funding
U.S. Army Corps of Engineers
USGS RWO 75, MSU index 4W7686

Skinny reproductive-age pallid sturgeon are being captured at increasing frequency between Gavins' Point Dam and the Kansas River (Central Lowlands Management Unit) since 2011. Managers have approached the 'skinny fish' phenomenon as a food limitation issue and directed efforts towards hatchery reconditioning programs aimed at fattening wild-captured reproductive age sturgeon for the next spawning year. However, the evidence in support of pallid sturgeon food limitations within the Central Lowlands Management Unit habitat and hatchery reconditioning practices is tenuous to non-existent. This research addresses these problems through two objectives. The first objective will be to develop evidence-based criteria for assessing the health and reproductive status of adult pallid sturgeon. These criteria will primarily involve blood and tissue biochemistry, energy reserves, and condition measurements that can be applied to monitor hatchery reconditioning progress and assess health of captured wild pallid sturgeon. The second objective is to test hypotheses explaining the biological mechanism within the Central Lowlands Management Unit habitat causing some adult pallid sturgeon to become excessively emaciated. Understanding the biological causes of emaciated Central Lowlands pallid sturgeon will guide managers to effectively allocate resources towards reconditioning or habitat restoration to address this issue that threatens jeopardy of this endangered species.

A hatchery study designed to create maximum variation within an experimental population of adult hatchery pallid sturgeon through feed ration manipulation will be completed in March 2020. At the end of this study, a suite of physiological measurements will be performed on fish to develop criteria for non-lethally assessing health status of adult pallid sturgeon. Sampling with this study will also be applied to test and calibrate a non-invasive microwave energy meter for determinations of whole-body energy concentration.

Two field seasons of monitoring non-lethal physiological measurements on wild-captured adult pallid sturgeon within the Central Lowlands Management Unit have been

completed and the final season is currently in progress. These data will be compared with data from the hatchery study to infer health status of wild-captured fish.

To investigate environmental contaminants as a mechanism underlying emaciated adult pallid sturgeon, we are working toward collecting tissue biopsies from wild-captured pallid sturgeon for quantification of known contaminants of concern. To secure permits from the U. S. Fish and Wildlife Service for these collections, a hatchery study testing for impacts of biopsy collection on hatchery adult pallid sturgeon will begin this spring.

This project also takes advantage of the underused National Pallid Sturgeon Database to investigate whether characteristics predicting later emaciation could be identified. Preliminary analysis suggests that relative condition at capture is a weak, but significant predictor of apparent future survival.

Total Project Cost		$ 127,540.56
Beginning Balance – February 2019		127,540.56
Expenditures – February 2019 - December 2019		
Salaries and Benefits	8,814.70	
Contracted Services	0	
Supplies	10,414.81	
Communications	187.74	
Travel	2,892.78	
IDCs @ 15%	3,252.01	
Total Spent		24,932.04
Balance		102,608.52
Waived IDCs		6,287.21

Developing small-scale Denil fishways for use in headwater streams

Investigators
Matt Blank, Joel Cahoon, Kathryn Plymesser, MSU College of Engineering
Kevin Kappenman
U.S. Fish and Wildlife Service

Graduate Student
Megan Conley, M.S.

Collaborator
Alexander Zale
Unit Leader

Funding
U.S. Geological Survey RWO 76
MSU index 4W7973

Duration
September 2019 – March 2021
Continuing

Arctic grayling (*Thymallus arcticus)* are a species of special concern in Montana. They are resident to several drainages and lakes in southwest Montana, including the Big Hole River and Centennial Valley. Montana's grayling represents the last stronghold of native grayling in the lower 48 states. Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi)* are also a species of special concern in Montana. They reside in streams west of the Continental Divide in Montana, as well as in the upper Missouri River drainage. Hydraulic structures such as irrigation diversions are common to the river systems in southwest Montana. They are essential for providing water diversion for agriculture but can be barriers to grayling and other fish. For over two decades, Montana Fish, Wildlife and Parks (MFWP), Montana Department of Natural Resources and Conservation (DNRC), Natural Resources Conservation Service (NRCS), the United States Fish and Wildlife Service (USFWS), local ranchers, and others have worked to balance water for ranching and farming with the conservation of native fish, rivers. and streams. This partnership is a model for how conservation and agriculture can be blended to maintain and ideally improve both.

Denil fishways have been installed in irrigation diversions throughout the Big Hole River watershed to provide fish passage, with more structures planned in this watershed and others. They are either included as part of the standard design and installation for new diversions or are installed as a retrofit to existing diversions. The Denils are in their configuration in terms of baffle size, shape, and spacing. They are made of steel, are 2 ft by 2 ft in cross section, and are either 6 ft or 12 ft in length. They are typically installed into the pin and plank portion of the diversion with a total vertical drop of 1 ft, regardless of length. When water is in high demand by agriculture during the summer months, these Denils can be partially or completely blocked to increase water available for irrigation, which can affect movements of Artic grayling and westslope cutthroat trout. This study was developed to test smaller Denils that would require less water for operation.

Total Project Cost		$ 99,955.00
Beginning Balance – September 2019		48,744.00
Expenditures – September 2019 - December 2019		
Salaries and Benefits	2,777.62	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
IDCs @ 15%	416.66	
Total Spent		3,194.28
Balance		45,549.72
Waived IDCs		805.51

Environmental Libby amphibole asbestos: potential risk of injury to U.S. Fish and Wildlife Service's trust resources and their habitat

Investigator
Deborah Keil
MSU Department of Microbiology and Immunology

Collaborator
David Rouse
U.S. Fish and Wildlife Service

Duration
September 2019 – May 2020
Continuing

Funding
U.S. Geological Survey RWO 79
MSU index 4W7970

A significant amount is known about the effects of asbestos on human health; however, there is little information compiled about the ecotoxicological effects of asbestos. A vermiculite mine in Libby, Montana, was in operation from the 1920s to 1990; throughout the duration of its operation, asbestos was released with the vermiculite mining. Libby became a Superfund site after the mine's shut down to facilitate removal of amphibole asbestos. As a result, 400 people have died and 2,000 more have health problems due to the vermiculite mine. Still, little is known about the effects on native animals and plants of the area. We sought to compile the current research results on the effects of asbestos on plants and animals to advocate for extended reconstruction of the ecosystem in Libby, Montana. This pre-assessment screen concludes that the original analysis was insufficient in the exploration of ecological effects of the vermiculite mine and that further exploration needs to be done in the Libby area.

Total Project Cost		$ 18,867.92
Beginning Balance – September 2019		18,867.92
Expenditures – September 2019 - December 2019		
Salaries and Benefits	1,583.54	
Travel	0	
IDCs @ 15%	237.53	
Total Spent		1,821.07
Balance		17,046.85
Waived IDCs		459.23

Taxonomic and ecological service project account

Investigator
Alexander Zale
Unit Leader

Funding
NorthWestern Energy
MSU Index 433295

Duration
Continuing

Unit personnel provide services and workshops periodically.

Beginning Balance – January 2019		$ 5,683.96
Additional Funding		550.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
Administrative Fee @ 6%	0	
Total Spent		0
Balance		6,233.96

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

Continuing

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 2019		$ 2,426.92
Additional Funding –		0
Expenditures – January 2019 - December 2019		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
Administrative Fee @ 6%	0	
Total Spent		0
Balance		2,426.92

MTCFRU Gift Account

Investigators

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

Funding

Eccles Foundation
MSU Index 423077

Duration

Continuing

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

Beginning Balance – January 2019		774.85
Additional Funding – 2019		0
STIP Interest 2019		12.71
Expenditures – January 2019 - December 2019		
Salaries and Benefits	0	
Supplies	0	
Travel	0	
Repairs and Maintenance	0	
Tuition	0	
Total Spent		0
Balance		787.56

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 2019		$ 70,300.60
Expenditures – January 2019 - December 2019		
Repairs and Maintenance	4,311.35	
Fuel	12,139.75	
Insurance	0	
Administrative Assessment Fee @ 6%	987.07	
Total Spent		17,438.17
Total Revenue Reimbursed		36,070.33
Balance		88,932.76

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 2019		13,695.38
Expenditures – January 2019 - December 2019		
Repairs and Maintenance	5,698.05	
Fuel	5,185.65	
New	0	
Administrative Assessment Fee @ 6%	653.04	
Total Spent		11,536.74
Total Revenue Reimbursed		28,970.00
Balance		31,128.64

Montana Cooperative Fishery Research Unit Operations Account

Administrator
Alexander Zale
Unit Leader

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

Beginning Balance – January 2019		$<2,706.20>
Expenditures – January 2019 - December 2019		
Maintenance	0	
Contracted Services	15.50	
Supplies	389.42	
Communications	776.75	
CCM	0	
Rent (storage unit)	8,233.04	
Parking expense	2,458.70	
Administrative Assessment Fee @ 6%	712.60	
Total Spent		12,586.01
Total Revenue from VPR		30,000.00
Balance		14,707.79

Monetary Equivalence for MSU Services and Facilities
January 2019 - December 2019

Program Manager salary and benefits	$ 60,431.00
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 ($1,011,662)	8,093.30
Utilities - General @ 12% of total expenditures ($1,011,662)	121,399.44
Unit Operations Account	30,000.00
Waived IDCs	291,538.38
Total	**535,935.58**

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

Administrator
Alexander Zale
Unit Leader

Funding
Montana Fish, Wildlife and Parks
MSU index 4W5335

Beginning Balance – January 2019		$ 58,676.22
Additional Funding – 2019		30,000.00
Expenditures – January 2019 - December 2019		
Salaries and Benefits	16,563.43	
Contracted Services	7,373.32	
Supplies	16,625.80	
Communications	738.24	
Travel	6,414.74	
Rent	2,730.00	
Repairs and Maintenance	20,731.57	
Tuition	1,006.17	
Equipment	0	
Total Spent		72,183.27
Balance		16,492.95

Federal Budget
January 2019 - December 2019

Salaries and Benefits	$ 401,919.12
Supplies	9,965.00
Total	$ 411,884.12

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 13,231

2011 Ford F250 4×4 crew cab (green)
Property No. 433429 – Serial No 1FT7W2BTOBEA70586
Acquisition value $31,697
Mileage 64,950

2005 Chevrolet Silverado 2500, 4×4 crew cab (green)
Property No. 430750 - Serial No. 1GCHK23G15F926039 (2005)
Acquisition value $22,948
Mileage 138,730

2002 Chevrolet 4×4 Suburban (white)
Property No. 261052 - Serial No. 3GNGK26U52G249012
Acquisition value $31,988
Mileage 138,888

1989 Chevrolet 4×4 Suburban (tan)
Property No. 261114 - Serial No. 1GNGV26K2KF176088
Acquisition value $15,766
Mileage 161,402

Smith-Root Electrofisher
Serial No. 302352
Acquisition value $9,965 (2020)

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 Supercab (blue)
Serial No. 1FTFX1EF0HKD34442
Acquisition Value $26,826
Mileage 5,105

2014 Dodge Ram 2500 (white)
Property No. 135050
Serial No. 3C6TR5DT0EG281683
Acquisition Value $29,197
Mileage 48,479

2008 Ford Escape Hybrid 4WD (grey)
Property No. 132775
Serial No. 1FMCU59H78KA13346
Acquisition Value $26,554 (2007)
Mileage 44,515

2005 GMC Sierra 2500 crew cab truck (green)
Property No. 132353
Serial No. 1GTHK23G65F944780
Acquisition Value $24,463 (2005)
Mileage 170,722

2001 GMC 1/2 ton 4×4 extended cab truck (green)
Property No. 132228
Serial No. 2GTEK19T911227311
Acquisition Value $15,255 (2005)
Mileage 199,914

2017 Hewes Craft with Yamaha 115 hp motor
VIN HEW80240K617

Yamaha Serial No. 6EKX-1047110
EZ Loader Trailer Serial No. 1ZEAAMPK1HA006148
Acquisition value $34,434 (2018)

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)