Montana Cooperative Fishery Research Unit

2023 Briefing Booklet

Coordinating Committee Meeting
19 April 2023, Helena, Montana

MONTANA FISH, WILDLIFE & PARKS

MONTANA STATE UNIVERSITY
Mountains & Minds

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U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

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.

Personnel and Cooperators

Coordinating Committee Members

U.S. Geological Survey
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Matt Hogan, Regional Director
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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
Mike Duncan
Justin Gude
Ryan Kovach
Brad Liermann
Jason Mullen
Scott Opitz
Kelly Proffitt
Mike Ruggles
David Schmetterling
Ron Spoon

Montana Natural Resource Damage Program, Montana Department of Justice
Douglas Martin

Alicia Stickney

Montana State University, Department of Ecology
Lindsey Albertson
Aidan Beers
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John Draper
Robert Garrott
Blake Lowrey
Jay Rotella
Christine Verhille

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

Montana State University, College of Letters and Science
Yves Idzerda, Dean

USGS Northern Rocky Mountain Science Center
Claudia Regan, Director

U.S. Fish and Wildlife Service
Kevin Kappenman
Jeff Powell
Wendy Sealey
Molly Webb

Jackson Hole One Fly Foundation

Montana Biological Survey
David Stagliano

U.S. National Park Service
Patricia Bigelow
Brian Ertel
Todd Koel

Nebraska Game and Parks Commission
Kirk Steffensen

NorthWestern Energy
Grant Grisak

Rocky Mountain Cooperative Ecosystem Studies Unit
Lisa Gerloff

University of Montana – Western
Michelle Anderson

Missouri State University
Chris Barnhart

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

Graduate Students Advised by Unit Faculty

Michelle Briggs	Ph.D.
Robert Eckelbecker	Ph.D.
Kaitlyn Furey	M.S.
Drew MacDonald	M.S.
Victoria Ogolin	M.S
Coltan Pipinich	M.S.
Hannah Stapleton	M.S.
Cody Vender	M.S.
Keith Wellstone	M.S.

Graduate Students Advised by Cooperating Faculty

Cole Buller	M.S.	advised by Kathryn Plymesser
Nicole Daigle	Ph.D.	advised by Christine Verhille
Elisabeth Krieger	M.S.	advised by Jay Rotella

Graduate Students Receiving Degrees

Ian Anderson graduated with a M.S. in Fish and Wildlife Management and is working for the Washington Department of Fish and Wildlife as a Fish Biologist.

Colter Brown graduated with a M.S. in Fish and Wildlife Management and is working for the Wyoming Game and Fish Department as an Aquatic Habitat Project Biologist.

Kristen Cook graduated with a M.S. in Fish and Wildlife Management and is working for Montana Fish, Wildlife and Parks as the Native Species Coordinator for Western Montana.

Hayley Glassic graduated with a Ph.D. in Fish and Wildlife Biology and is working for the U.S. Geological Survey as a Fish Biologist.

Research Technicians

Katelyn Allen	Addison Dove	Ben Moulton
Hannah Brzezinski	Morgan Krell	Ciera Pitts
Jodee Clark	Valerie Kuppek	Hilary Treanor

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

Investigator

Alexander Zale
Unit Leader

Graduate Students

Ian Anderson, M.S.
Haley Tupen, M.S.
Andrew Johnson, M.S.

Duration

September 2018 – March 2022
Completed

Collaborators

Mike Ruggles, Montana Fish, Wildlife and Parks
Kathryn Plymesser, Matt Blank, Joel Cahoon, MSU College of Engineering
Alicia Stickney, Douglas Martin, Montana NRDP, DOJ

Funding

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

We evaluated passage of a diverse fish assemblage through the nature-like fishway built around Huntley Diversion Dam, the uppermost of six low-head diversion dams on the Yellowstone River in Montana. Although nature-like fishways purportedly facilitate the passage of many species, relatively few have been evaluated, particularly on large rivers with unregulated discharge regimes. We examined seasonal and diel use of the Huntley fishway, quantified efficiencies and temporal metrics, and determined which factors influenced attraction and passage. We implanted > 3,500 fish of 14 species with passive integrated transponder tags, released most fish 250 m downstream of the fishway, and used stationary antennas to monitor movements of fish through the fishway in 2019 and 2020. Seasonal use of the fishway was generally associated with

pre-spawning movements and occurred from April to August annually, and diel use reflected the known biology of each species. Attraction efficiencies were apparently low (usually < 50%), probably because of low motivation or the inability of fish to locate the entrance. Suckers released on opposite riverbanks downstream of the fishway were similarly successful at locating the entrance. Entrance efficiencies were usually > 90%. Both transit and passage efficiencies were usually > 60%, but fewer individuals (particularly among certain species) successfully passed than were able to transit to near the fishway exit. High river discharges were associated with decreased passage success and increased exit delays, probably because of problematic hydraulic conditions near the exit. Conditions throughout the rest of the fishway were appropriate, as most fish transited to near the exit in < 1 h regardless of discharge. Fourteen species passed upstream, demonstrating the functionality of nature-like fishways on large, unregulated rivers. However, the placement of such fishways must be thoughtfully considered to ensure that they remain effective over a wide range of environmental conditions.

Total Project Cost		$ 157,429.00
Beginning Balance – January 2022		0
Expenditures – January 2022 - December 2022		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repair & Maintenance	0	
Tuition	0	
Total Spent		0
Balance		0
Waived IDCs		0

Reproductive biology and phenology of Western Pearlshell mussels in Montana

Investigator
Alexander Zale
Unit Leader

Graduate Student
Kristen Cook, M.S.

Duration
May 2019 – May 2022
Completed

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

Funding
MT FWP State Wildlife Grants Program
U.S. Fish and Wildlife Service
SITKA Ecosystems
MSU index 4W8517

The Western Pearlshell mussel is the only native freshwater mussel inhabiting trout streams of western Montana; it has been designated a state Species of Concern because of declines in abundance and distribution. Conservation of Western Pearlshells in Montana will require fundamental information on their reproduction and life-history traits that is currently lacking. We therefore estimated the age and length at sexual maturity and incidence of hermaphroditism in mussels using histology. We determined the timing of reproductive events (spawning, brooding, embryogenesis, larval release, and larval infestation of hosts) and their relationship to temperature by collecting gonadal and marsupial biopsies to identify gamete presence and embryo developmental stages, visually identifying brooding mussels, and examining captured fish for the presence of mussel larvae. We identified the hosts of Western Pearlshells in nature by quantifying the probability of infestation and infestation intensities among salmonid species. Mussels reached sexual maturity at an estimated 34 mm in length and 11.5 years of age. Of 31 mature mussels examined histologically, all but one were gonadal hermaphrodites. The reproductive phenology of Montana Western Pearlshells differed among populations and years. Mussel populations brooded for about 24 to 39 days in May and June. Embryogenesis was synchronous among individuals in all populations except one and was about two to three weeks in duration. The larval infestation period

generally occurred in June and July and was 47 to 71 days in duration. Some larvae grew > 400% in length before leaving the host. Gonadal recrudescence was rapid whereby mussels possessed mature or nearly mature gametes by early autumn. Both photoperiod and temperature appear to influence the timing of reproductive events. Native Westslope Cutthroat Trout and nonnative Brook Trout were the most susceptible fish species to infestation of Western Pearlshell larvae. Nonnative Brown Trout were moderately susceptible to infestation in the Flint-Rock watershed. Nonnative Rainbow Trout and native Mountain Whitefish were least likely to be infested with mussel larvae. Our findings will inform future conservation and propagation efforts of Western Pearlshells in Montana.

Total Project Cost, SITKA		$ 2,100.00
Beginning Balance – January 2022		0
Expenditures – January 2022 - December 2022		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Rent	0	
Repair & Maintenance	0	
Tuition	0	
Total Spent		0
Balance		0
Waived IDCs		0

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.
Cole Buller, M.S.

Collaborator

Alexander Zale
Unit Leader

Funding

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

Duration

September 2019 – August 2022
Completed

The Arctic Grayling (*Thymallus arcticus*) is a species of special concern in Montana. It inhabits several drainages and lakes in southwest Montana, including the Big Hole River and Centennial Valley. These populations are the only remaining native Arctic 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 river systems in southwest Montana. They are essential for providing water for agriculture but can be barriers to grayling and other fish. For over two decades, Montana Fish, Wildlife and Parks, the Montana Department of Natural Resources and Conservation, the Natural Resources Conservation Service, the United States Fish and Wildlife Service, local ranchers, and others have worked to balance agricultural needs 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. Standard Denils 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 make more water available for irrigation, but such blockages impede fish movements. We developed and tested smaller 0.6-scale Denils that would require 20% less water at the Bozeman Fish Technology Center in its outdoor flume. Age-1 Arctic Grayling were tested in eight unique headwater and tailwater combinations replicated three times to understand passage of the species through the smaller fishway. Fish movements and passage efficiencies were tracked using PIT tag telemetry. Grayling showed high passage percentages in all scenarios except those with the largest difference between headwater and tailwater depths (high headwater and low tailwater). Grayling preferred to pass the through the Denil at night. Twelve combinations of headwater and tailwater depths were replicated three times for a total of 36 trials with Westslope Cutthroat Trout. Passage efficiencies ranged from 0% to 100%. Highest passage efficiencies were observed when the headwater and tailwater depths were approximately equal. As the headwater depth increased relative to the tailwater depth, passage efficiency decreased. Scaled Denil fishways show promise for enhancing upstream mobility of Arctic Grayling and Westslope Cutthroat Trout in small, water-limited streams.

Total Project Cost		$ 99,955.00
Beginning Balance – January 2022		4,781.23
Expenditures – January 2022 - August 2022		
Salaries and Benefits	4,157.62	
Contracted Services	0	
Supplies	0	
Travel	0	
Tuition	0	
IDCs @ 15%	623.61	
Total Spent		4,781.23
Balance		0
Waived IDCs		1,247.29

Evaluation of the management actions taken in the Lamar River watershed

Investigator
Alexander Zale
Unit Leader

Collaborators
Todd Koel, Brian Ertel
Yellowstone National Park

Graduate Student
Keith Wellstone, M.S.

Funding
National Park Service, CESU
MSU index 4W8476
SITKA 4W9765

Duration
August 2020 – December 2023
Continuing

Hybridization between native Cutthroat Trout and introduced Rainbow Trout is pervasive throughout western North America. Cutthroat and Rainbow Trout are closely related and often exhibit geographic and temporal reproductive overlap, facilitating hybridization between the two taxa. This hybridization has resulted in the loss of locally adapted gene complexes and genetic diversity, reduced fitness, altered life-history expression and growth rates, and, in some cases, the genomic extinction of native Cutthroat Trout subspecies. The Yellowstone Cutthroat Trout, a subspecies of Cutthroat Trout native to the intermountain West, is threatened by climate change, habitat fragmentation and degradation, and invasive species introductions. The most recent range-wide assessment of this subspecies suggests it currently occupies 43% of its native range, with only 23% of its native range occupied by non-hybridized populations. The Lamar River watershed in Yellowstone National Park is a large, fluvially connected river system that was once considered a stronghold for native, genetically unaltered Yellowstone Cutthroat Trout. Despite the federally protected status of aquatic habitats in this watershed, Yellowstone Cutthroat Trout populations are threatened by predation and displacement by hybridization with nonnative Rainbow Trout. In the early 1900s, the National Park Service intentionally stocked Rainbow Trout in the Lamar River watershed to diversify sportfishing opportunities. Though these stocking efforts ceased nearly a century ago, legacy populations still exist in waters where these fish were introduced, and they continue to invade, hybridizing with native Yellowstone Cutthroat Trout. Hybrids are now abundant in the lower Lamar River watershed, and, because of the fluvial connectivity of the system, appear to be invading the upper watershed. To mitigate the threat of hybridization in the Lamar River watershed, the National Park Service has acted to

remove Rainbow Trout and hybrids and block the upstream movement of these nonnative taxa into the upper watershed. Whereas the National Park Service is taking actions to remove Rainbow Trout and hybrids from the Lamar River watershed, a standardized monitoring protocol is desired to assess the response of fish populations to these management actions and to monitor existing populations of Yellowstone Cutthroat Trout. We are exploring the use of electrofishing, angling, and snorkeling to estimate the abundance and catch-per-unit-effort of each taxon in the lower Lamar River watershed and using simulations to evaluate tradeoffs in the cost, precision, and accuracy of each sampling method and estimator. This study will inform National Park Service long-term monitoring and management efforts for these taxa in the watershed.

Total Project Cost		$ 137,130.00
Beginning Balance – January 2022		69,231.37
Expenditures – January 2022 - December 2022		
Salaries and Benefits	33,260.38	
Supplies	187.01	
Communications	20.40	
Travel	3,077.87	
Rent	3,775.00	
Tuition	4,111.37	
IDCs @ 17.5%	6,426.02	
Total Spent		50,858.05
Balance		18,373.32
Waived IDCs		12,268.31

SITKA funded an additional $2,000 for supplies for this project.

An evaluation of the genetic structure and movement of Brown Trout in the upper Missouri River in relation to habitat fragmentation by Toston Dam

Investigator
Alexander Zale
Unit Leader

Graduate Student
Coltan Pipinich, M.S.

Duration
August 2021 – August 2024
Continuing

Collaborators
Ron Spoon, Mike Duncan, Ryan Kovach, Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks

Brown Trout play an important role in the sport fisheries of southwest Montana. As a top game species, preservation of abundant Brown Trout populations is a high priority for fishery managers. A declining population of Brown Trout in the Upper Missouri River has prompted an evaluation of habitat fragmentation effects on this important sport fish. Biologists have been concerned with the decline in abundance of Brown Trout in this reach of the Upper Missouri River since the early 1990s. Toston Dam bisects a 69-km reach of the Upper Missouri River between its headwaters and Canyon Ferry Reservoir. This concrete gravity overflow dam allows for no upstream fish passage and minimal downstream passage. Whereas the dam plays a vital role in halting upstream expansion of non-native species, Brown Trout may be vulnerable to the resulting habitat fragmentation. Altered mainstem river habitat makes access to the associated tributaries important, and Sixteenmile Creek (upstream of Toston Dam) is thought to be a historically important recruitment source for Brown Trout in the river. We are determining the effects of habitat fragmentation on the genetic structure and movement of Brown Trout within this reach to develop management practices to improve the fishery. Genetic variation and natal origins are being defined by characterizing the genetic structure of the population in conjunction with otolith microchemistry analysis. Movements of individual fish are tracked using radio telemetry. This research will lead to improved understanding of the effects of fragmentation by Toston Dam on this Brown Trout

population and identify actions that can be taken to improve local connectivity and management of this species.

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 – December 2022
Completed

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

The collapse of native Yellowstone Cutthroat Trout in Yellowstone Lake was caused by predation by invasive Lake Trout. As an ecosystem with a low-diversity fish assemblage and several long-term data sets, Yellowstone Lake provided a unique opportunity to evaluate the influence of an invasive salmonid population undergoing suppression beyond only predator-prey dynamics. Diet data for Yellowstone Cutthroat Trout and Lake Trout were evaluated at varying densities to determine the effects of density on diet composition and diet plasticity. During the Lake Trout high-density state, Lake Trout consumed fewer native Cutthroat Trout and switched to amphipods, which were also consumed by Cutthroat Trout, resulting in high diet overlap between the species. As suppression reduced invasive Lake Trout densities, Lake Trout returned to consuming Cutthroat Trout and diet overlap was released. A shift in Lake Trout $\delta^{13}C$ signatures from the high-density state to the moderate-density state also corroborated higher consumption of Cutthroat Trout and invasive Lake Trout diet plasticity. Beyond predator-prey dynamics of Lake Trout and Cutthroat Trout, the invasion of Lake Trout caused ≥ 25% change in energy flux of all organisms in Yellowstone Lake except for copepods. Food-web functional state did not change among food webs, but percentage of functional state contributing to total flux did vary. Herbivory was the dominant food-web functional state for all years, with the greatest percentage of flux from herbivory in 2011. In addition, by using a whole-ecosystem model that accounted for whirling disease and historical (natural) lake-level variation, we showed that suppression of the

Lake Trout population is necessary for Cutthroat Trout recovery, but the amount of suppression effort needed for Cutthroat Trout to reach recovery benchmarks is linked to severity of climate change. Additionally, if climate change increases the frequency and severity of reduced lake levels in the future, Cutthroat Trout recovery benchmarks may need to be adapted. With this research, we demonstrate how the feedbacks among predator-prey dynamics, disease, and climate change can complicate the suppression of invasive species and the conservation of invaded ecosystems and must be considered for establishing realistic conservation benchmarks.

Total Project Cost: 4W6204		$ 183,300.00
Beginning Balance – January 2022		0
Expenditures – January 2022 - August 2022		
Salaries and Benefits	0	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	0	
Tuition	0	
IDCs @ 17.5%	0	
Total Spent		0
Balance		0
Waived IDCs		0

Total Project Cost: 4W7971		$ 154,974.00
Beginning Balance – January 2022		83,677.52
Expenditures – January 2022 - December 2022		
Salaries and Benefits	39,720.81	
Supplies	23,196.45	
Contracted Services	1,616.48	
Communications	1,100.92	
Travel	1,400.15	
Tuition	4,679.98	
IDCs @ 15%	11,962.73	
Total Spent		83,677.52
Balance		0
Waived IDCs		21,514.44

Density and distribution of juvenile Lake Trout in Yellowstone Lake

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Graduate Student
Drew MacDonald, M.S.

Funding
National Park Service
MSU index 4W8429

Duration
August 2020 – December 2023
Continuing

Invasive Lake Trout in Yellowstone Lake, Yellowstone National Park, Wyoming, are causing the decline of Yellowstone Cutthroat Trout and inducing a trophic cascade. Invasive species are commonly managed by means of chemical, mechanical, or biological control. In Yellowstone Lake, the main method for Lake Trout control is gillnetting. Recently, embryo suppression techniques have been evaluated using carcass material and carcass analog pellets. Both methods have caused near 100% embryo mortality in experiments conducted at Lake Trout spawning sites. Embryo suppression sites are currently prioritized by Lake Trout catch from gill nets and concurrent telemetry on Yellowstone Lake. Identification and prioritization of spawning sites are crucial to the success of embryo suppression efforts. Benthic trawls are used in the Laurentian Great Lakes to locate Lake Trout spawning sites and to target juvenile Lake Trout to measure density, locate successful spawning sites, and assess body condition. Benthic trawling has not been conducted in Yellowstone Lake and would add to our understanding of Lake Trout early life history. In addition to trawling, small-mesh gill nets will be used to provide additional data on the spatial distribution of juvenile Lake Trout in Yellowstone Lake. Our study will evaluate the distribution, density, hatch date, growth, and diet of juvenile Lake Trout (< age 2). The data from this study will be used to prioritize suppression efforts within Yellowstone Lake.

Total Project Cost		$ 137,130.00
Beginning Balance – January 2022		80,851.57
Additional Funding --2022		0
Expenditures – January 2022 - December 2022		
Salaries and Benefits	31,714.78	
Contracted Services	117.00	
Supplies	679.76	
Communications	405.00	
Travel	3,331.79	
Rent	750.00	
Repairs and Maintenance	0	
Tuition	4,111.37	
IDCs @ 17.5%	6,474.62	
Total Spent		47,584.32
Balance		33,267.25
Waived IDCs		11,305.17

Investigating the status of Yellowstone Cutthroat Trout in Yellowstone Lake to improve management and update recovery benchmarks

Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Michelle Briggs, Ph.D.

Duration
June 2021 – December 2024
Continuing

Collaborator
Todd Koel
Yellowstone National Park

Funding
National Park Service
MSU index 4W9143, 4W9664
Jackson Hole One Fly 4W9993
SITKA 4W9763

Yellowstone Cutthroat Trout in Yellowstone Lake occupy protected habitat and represent the largest remaining genetically unaltered population of Yellowstone Cutthroat Trout, making this population of highest conservation importance. However, the population of Yellowstone Cutthroat Trout in Yellowstone Lake is threatened by the presence of invasive Lake Trout, increasing drought conditions, and whirling disease, caused by the parasite *Myxobolus cerebralis*. Yellowstone Cutthroat Trout are an important prey item for numerous terrestrial and avian predators, and reductions in the Yellowstone Cutthroat Trout population due to these threats have had far-reaching consequences throughout the Yellowstone Lake ecosystem. The Yellowstone Cutthroat Trout population is recovering due to intensive efforts by the National Park Service to suppress invasive Lake Trout by gillnetting. Despite extensive efforts to conserve Yellowstone Cutthroat Trout in Yellowstone Lake, the current status of the population and its recovery progress remains understudied. Recovery benchmarks for the Yellowstone Lake population of Yellowstone Cutthroat Trout are based on population metrics from the 1980s, before Lake Trout invasion, and may be unrealistic given the persistence of Lake Trout in the system. Additional research is required to update recovery benchmarks and guide the conservation and management of Yellowstone Cutthroat Trout in Yellowstone Lake.

We will use an integrated population model (IPM) to investigate how invasive Lake Trout, bycatch, and climate change influence the population dynamics of Yellowstone Cutthroat Trout in Yellowstone Lake. Our model will be made up of a mark-recapture study to estimate abundance and survival, a study on reproductive ecology to estimate fecundity and maturity, long-term monitoring data, and long-term bycatch data from Lake Trout suppression netting. We will also assess the genetic and life-history diversity of the population, which can be important indicators of resilience and will inform future conservation. We will estimate the spatial distribution and temporal variation of spawning runs in Yellowstone Lake, determine if the population exhibits genetic structure, and determine if spawning runs are genetically distinct. If spawning populations are genetically distinct, we will estimate the relative contribution of each spawning run to the population of Yellowstone Cutthroat Trout in Yellowstone Lake. Finally, we will use our population model to assess how future management scenarios will contribute to the persistence and resilience of the population over time. We will use the results of our research to identify comprehensive metrics that can be used as conservation benchmarks for Yellowstone Cutthroat Trout in Yellowstone Lake.

Total Project Cost		$ 143,144.74
Beginning Balance – January 2022		25,095.96
Additional Funding --2022		105,051.96
Expenditures – January 2022 - December 2022		
Salaries and Benefits	1,666.37	
Supplies	851.41	
Communications	60.76	
Travel	1,511.66	
Rent	450.00	
Tuition	1,993.68	
IDCs @ 17.5%	499.31	
Total Spent		7,033.19
Balance		123,114.73
Waived IDCs		1,796.82

Total Project Cost JHOF		$ 26,076.00
Beginning Balance – January 2022		26,076.00
Expenditures – January 2022 - December 2022		
Contracted Services	10,360.00	
Supplies	0	
Communications	0	
Travel	0	
Total Spent		10,360.00
Balance		15,716.00
Waived IDCs		4,662.00

SITKA funded an additional $2,000 for supplies for this project.

Cutthroat Trout individual growth pre- and post- Lake Trout invasion

Investigator
Christopher Guy
Assistant Unit Leader

Collaborator
Todd Koel
Yellowstone National Park

Graduate Student
Cody Vender, M.S.

Funding
National Park Service
MSU index 4W9806

Duration
August 2022 – December 2025
New

Yellowstone Lake has been the site of intensive efforts to conserve native Yellowstone Cutthroat Trout and restore natural ecological function since invasive Lake Trout were first discovered in 1994. Gillnetting was implemented in 1995 to suppress the Lake Trout population, but despite annual increases in gillnetting effort, the population expanded throughout Yellowstone Lake. Yellowstone Cutthroat Trout abundance declined precipitously in Yellowstone Lake until Lake Trout suppression efforts reached sufficient levels to reduce Lake Trout abundances in 2012. The number of Yellowstone Cutthroat Trout caught during annual long-term gillnetting assessments varied subsequently, with mean catch-per-unit-effort (CPUE) varying from 12.5 per 100-m net night in 2011 to 27.3 in 2014. Lake Trout predation has been associated with a long-term shift in Yellowstone Cutthroat Trout lengths from small (100–280 mm) and midsized (290–390 mm) individuals to large individuals (> 400 mm) in annual gillnetting assessments. The decrease in Yellowstone Cutthroat Trout abundance also resulted in an increase in individual weights and condition, with a large (> 400 mm) fish in 2020 weighing twice what they did prior to the Lake Trout invasion. Currently, the

benchmarks for Yellowstone Cutthroat Trout recovery described in the 2010 conservation plan are all based on abundance, and include gill net CPUE, angler catch per hour, and spawner counts in streams. Annual growth of Yellowstone Cutthroat Trout individuals greatly increased following the Lake Trout-driven decline in the Yellowstone Cutthroat Trout population. Existing recovery benchmarks do not account for shifts in individual growth. Patterns in Yellowstone Cutthroat Trout growth need to be examined relative to periods of Lake Trout invasion over the past four decades on Yellowstone Lake. Our results will be used to refine Yellowstone Cutthroat Trout recovery benchmarks to account for shifts in growth, greater individual weights, and overall population biomass.

Total Project Cost		$ 136,275.00
Beginning Balance – August 2022		136,275.00
Expenditures – August 2022 - December 2022		
Salaries and Benefits	6,889.32	
Supplies	4,093.53	
Communications	0	
Travel	287.51	
Rent	0	
Tuition	2,133.53	
IDCs @ 17.5%	1,972.22	
Total Spent		15,376.11
Balance		120,898.89
Waived IDCs		3,686.07

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
Completed

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 salmonid native to the northern Rocky Mountains that has experienced declines in population abundance in rivers throughout Idaho, Colorado, Wyoming, and Montana. Problems with recruitment are suspected, but often the specific mechanisms causing population declines are unknown. Our approach to better understand the mechanisms that influence Mountain Whitefish population dynamics was to compare population characteristics between the Green River, Wyoming, and the Madison River, Montana, populations. Jan Boyer conducted an extensive study of the movement and reproductive ecology of Mountain Whitefish in the Madison River, and we used her study as a template to make direct comparisons between the populations. Our primary research questions were 1) what is the age and length at first maturity, spawning periodicity, fecundity, and age structure of Mountain Whitefish, 2) what is the spatial and temporal distribution of Mountain Whitefish through their spawning period, and what influence do abiotic factors have on spawning and movement, and 3) what is the spatial distribution and habitat use of age-0 Mountain Whitefish? We collected otoliths and gonad samples from 127 Mountain Whitefish in the Green River, implanted 100 fish with radio transmitters and tracked them from

September 1 to early November in 2019 and 2020, determined spawning period and locations using egg mats, kick netting, and angling, and sampled age-0 Mountain Whitefish using a beach seine in slow-water habitats. The geographic separation and difference in hydrogeomorphic conditions between the systems allowed us to form generalizations about Mountain Whitefish in the Intermountain West. We found Mountain Whitefish in both systems mature between ages 2 and 4, primarily spawn annually, and have a similar relative fecundity. Spawning movements varied between sexes in both system, with males moving before females; age-0 fish drifted downstream from spawning locations and used slow-water silt-laden habitats after hatching. The main disparities between systems were that in the Green River water temperature was more suitable for embryo development, and age structure was more uniform and older. This research enhanced our understanding of Mountain Whitefish reproductive and juvenile ecology and provided evidence for factors that may influence recruitment of Mountain Whitefish.

Total Project Cost		$ 227,809.00
Beginning Balance – January 2022		66,559.24
Expenditures – January 2022 - December 2022		
Salaries and Benefits	19,712.38	
Contracted Services	2,183.93	
Supplies	0	
Communications	16.10	
Travel	49.21	
Tuition	1,292.48	
IDCs @ 20%	4,650.80	
Total Spent		27,904.90
Balance returned to sponsor		38,654.34
Waived IDCs		5,813.53

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

Collaborators
Paul Gerrity, Joe Deromedi,
Game and Fish Department

Graduate Student
Robert Eckelbecker, Ph.D.

Funding
Wyoming Game and Fish
MSU index 4W7910

Duration
July 2019 – June 2023
Continuing

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 are estimating 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 are being collected in the spring, summer, and autumn 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.

The bioenergetics model requires input parameters of water temperature and diet proportion. In spring of 2020, water temperature loggers were placed in Torrey, Ring, and Trail lakes, and in Torrey Creek and continued to collect water temperature data until October 2022. To obtain diet proportion, Brown Trout, Lake Trout, and Burbot were sampling during spring, summer, and autumn of 2020-2022. Diets were collected from 603 Brown Trout, 61 Lake Trout, and 76 Burbot. To date, Burbot have been identified in the diets of three Brown Trout.

Frequency of occurrence, mean proportion by weight, and Schoener's index of dietary overlap were used to describe diet composition. Lake Trout and Burbot were

piscivorous with fish occurring in 82% and 48% of diets representing 0.82 and 0.36 mean proportion by weight, respectively. Brown Trout displayed a more generalist feeding pattern with Trichoptera in 65% of diets representing 0.52 mean proportion by weight. Diet overlap was high between Brown Trout and Burbot (0.66). Conversely, diet overlap between Lake Trout and Burbot (0.50) and Brown Trout and Lake Trout (0.34) was low. Tissue samples have been collected from 601 individual fish to compare short term dietary contents to stable isotope ratios found within muscle tissue. Using 40% Bayesian ellipses of stable isotope signatures, isotopic niche overlap was determined among Brown Trout, Lake Trout, and Burbot. Brown Trout and Burbot had the highest isotopic overlap (39%) compared to Brown Trout and Lake Trout (13%) and Lake Trout and Burbot (1%). Brown Trout abundances were estimate in Torrey Creek, Torrey Lake, Ring Lake, and Trail Lake ion the autumn of 2021. Brown Trout were marked with individually numbered FD-94 Fly T-bar anchor tags. Estimated abundance of Brown Trout was highest in Ring Lake (337; 172-719 95% CI) compared to Torrey Lake (330; 220 – 515 95% CI) and Trail Lake (226; 143-418 95% CI). After the final recapture event, 154 Brown Trout otoliths were collected to develop an age distribution and growth model. This study will provide information regarding the interactions among Burbot, Brown Trout, and Lake Trout and insight if persistence of Burbot is possible with intraguild predation and changing environmental conditions.

Total Project Cost		$ 188,459.00
Beginning Balance – January 2022		88,798.01
Additional Funding -- 2022		0
Expenditures – January 2022 - December 2022		
Salaries and Benefits	21,944.62	
Contracted Services	78.19	
Supplies	961.09	
Communications	0	
Travel	2,374.08	
Rent	200.00	
Repair & Maintenance	0	
Tuition	2,364.29	
IDCs @ 20%	5,584.48	
Total Spent		33,506.75
Balance		55,291.26
Waived IDCs		6,980.57

Adaptive monitoring for salmonids given changing abiotic conditions of the Yellowstone River

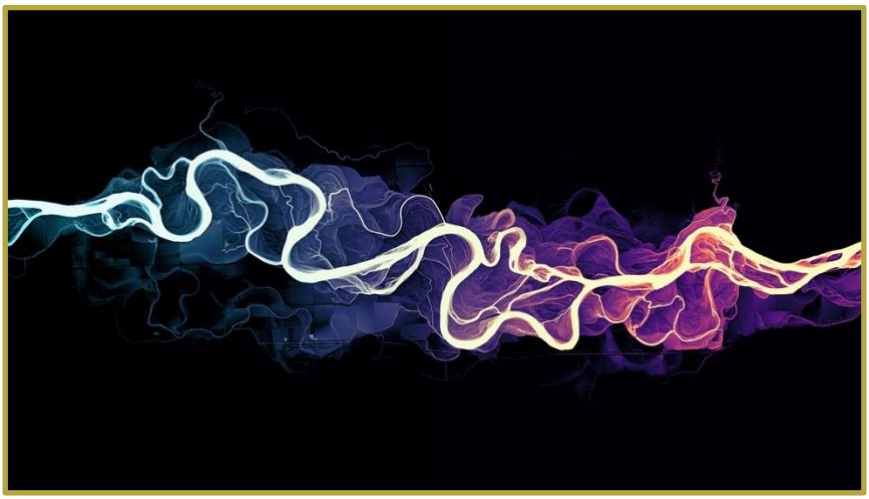
Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Michelle Briggs, Ph.D.

Duration
August 2021 – June 2023
Continuing

Collaborators
David Schmetterling, Scott Opitz, Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W9217



The upper Yellowstone River supports valuable recreational fisheries for Yellowstone Cutthroat Trout, Rainbow Trout, and Brown Trout. Although the Yellowstone River trout fishery is predominantly catch-and-release, fish populations are still susceptible to stressors including increases in angling pressure, increased susceptibility to disease due to elevated water temperatures, and changes in the seasonal hydrograph pattern due to a changing climate. Maintaining a monitoring program for trout populations in the Yellowstone River provides important information to natural resource agencies regarding population structure, vital rates, abundance, and distribution in response to environmental stressors. Additionally, identifying and understanding trends in the fishery can provide natural resource agencies with information necessary to adapt management strategies to mitigate for stressors and ensure the trout fisheries in the Yellowstone River are available for future generations to enjoy. Monitoring is of particular importance for the native Yellowstone Cutthroat Trout, a species of Special Concern in Montana. Montana Fish, Wildlife & Parks has used a standardized monitoring program to evaluate the abundance of trout in the upper Yellowstone River using mark-recapture techniques since the late 1970s. However, the standardized sampling events are becoming less effective or cannot be completed due to changing snowmelt patterns, resulting in an altered hydrograph and turbidity regime. We are investigating the feasibility of using novel analytical methods and additional sampling methodologies that could account for the logistical challenges and continue to provide time-series abundance data. Our objectives are to (1) use the existing long-term dataset to determine if N-mixture models and mean catchability analysis are effective

methods for estimating abundance of trout in the upper Yellowstone River and (2) to determine if individually marked trout can be used to develop an updated mark-recapture framework to estimate abundance and survival of trout over time. Our results indicate that neither N-mixture models nor mean catchability analysis provided unbiased estimates of trout abundance when compared to traditional mark-recapture methods. Given the changing abiotic conditions, novel analytical methods and improved sampling strategies will be vital to future monitoring and management of these valuable trout fisheries.

Total Project Cost		$ 44,660.00
Beginning Balance – August 2022		44,660.00
Expenditures – August 2022 - December 2022		
Salaries and Benefits	25,429.89	
Contracted Services	0	
Supplies	0	
Communications	0	
Travel	114.40	
Rent	0	
Repair & Maintenance	0	
Tuition	0	
Total Spent		25,544.29
Balance		19,115.71
Waived IDCs		11,494.93

Age-structured model of the Missouri River trout fishery

Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Hannah Stapleton, M.S.

Duration
April 2022 – July 2024
New

Collaborators
Jason Mullen, David Schmetterling
Montana Fish, Wildlife and Parks
Grant Grisak, NorthWestern Energy

Funding
Montana Fish, Wildlife and Parks
MSU index 4W9654
NorthWestern Energy MSU index 433295

Visitation in Montana increased 40% over the last decade, and anglers spent $919.3 million in 2017. Most of the spending was on Montana's coldwater trout fisheries. Given the economic importance of Montana's fishery resources and the projected increase in use of those fisheries, it is imperative that natural resource agencies understand the influence of increased use on fish populations. Of particular concern are climate resilient waters that are predicted to experience heightened fishing pressure as coldwater trout habitats diminish. The Missouri River Holter Dam tailwater fishery is a prime example; cool water released from Holter Reservoir can buffer against the effects of climate change during warm low-flow months. However, the amount of delayed mortality from catch-and-release angling may not be trivial given high levels of fishing pressure on this trout fishery. To better understand the environmental and anthropogenic mechanisms that influence the Missouri River fishery, we will develop age-structured population models for Rainbow Trout and Brown Trout. Age-structured population models can be used to forecast population structure related to changes in natural mortality, fishing mortality, and recruitment dynamics. The population model will be developed using long-term abundance data collected by Montana Fish, Wildlife & Parks coupled with detailed age-structure data (from otoliths), natural mortality estimates, and fishing mortality estimates. The models will be used to investigate population-level effects of angling pressure on the trout populations through simulation and will allow for the testing of hypotheses related to management actions. The specific research methods and objectives are to 1) collect and age otoliths from Rainbow Trout and Brown Trout; 2) estimate historic age-structured abundances of Rainbow Trout and Brown Trout to investigate trends in population size, mortality, and age structure; and 3) use an age-structured population model to simulate Rainbow Trout and Brown Trout population response to angling mortality.

Total Project Cost 4W9654		$ 20,000.00
Beginning Balance – April 2022		20,000.00
Expenditures – April 2022 - December 2022		
Salaries and Benefits	6,570.76	
Contracted Services	0	
Supplies	676.23	
Communications	0	
Travel	0	
Rent	0	
Repair & Maintenance	0	
Tuition	3,046.29	
Total Spent		10,293.28
Balance		9,706.72
Waived IDCs		4,631.98

Total Project Cost 433295		$ 22,810.00
Beginning Balance – April 2022		22,810.00
Expenditures – April 2022 - December 2022		
Salaries and Benefits	1,877.36	
Contracted Services	0	
Supplies	3,349.62	
Communications	0	
Travel	341.60	
Rent	0	
Tuition	0	
Overhead 6%	402.45	
Total Spent		5,971.03
Balance		16,838.97
Waived IDCs		2,328.71

Feeding ecology and trophic structure of salmonids in Georgetown Lake

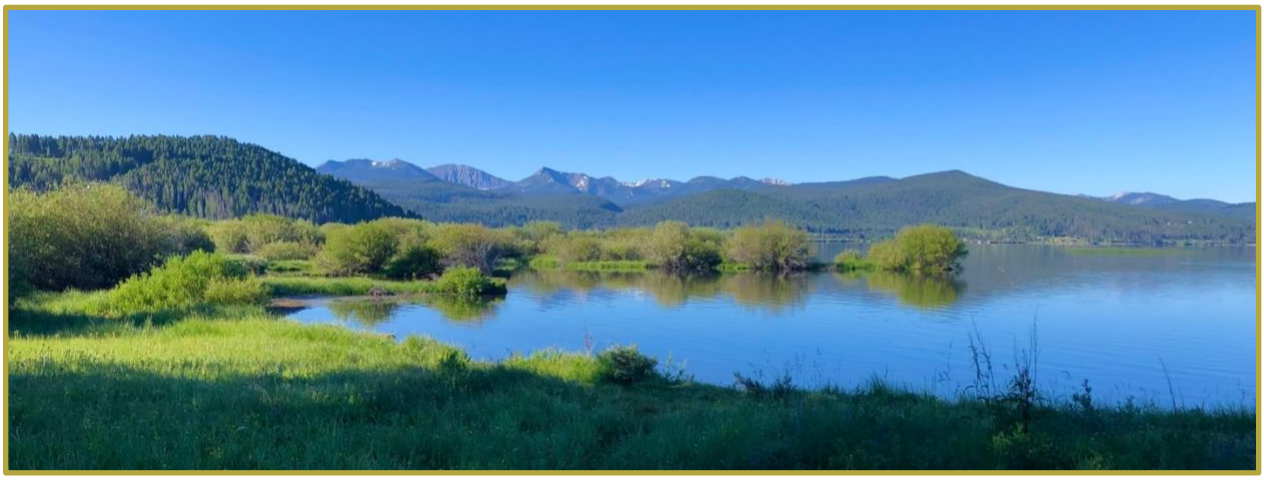
Investigator
Christopher Guy
Assistant Unit Leader

Graduate Student
Kaitlyn Furey, M.S.

Duration
January 2022 – December 2024
Continuing

Collaborators
David Schmetterling, Brad Liermann, Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W9576, 4W9579
SITKA 4W9766



Georgetown Lake is a highly productive reservoir known for producing large numbers of quality-sized Rainbow Trout and abundant kokanee and is a premier location for catching trophy Brook Trout. Georgetown Lake attracts more angling pressure per hectare than any other reservoir in Montana. The Rainbow Trout fishery is sustained by annual stocking by Montana Fish, Wildlife & Parks. Three Rainbow Trout strains occupy Georgetown Lake: Gerrard, Eagle Lake, and Arlee. Although many anglers enjoy targeting kokanee in Georgetown Lake for the quantities they can catch, the length of kokanee has typically been considered unsatisfactory by managers and many anglers. In 2015, Montana, Fish, Wildlife & Parks began stocking piscivorous Gerrard-strain Rainbow Trout to increase predation on kokanee, reduce their density, and improve the average size of kokanee. In the past five years, average sizes of Rainbow Trout and kokanee have increased. However, high variation in catch per unit effort (CPUE) makes among-year comparisons problematic. If Gerrard-strain predation alone explains the increase in kokanee size, the abundance of kokanee would probably need to decrease to induce density-dependent growth effects. However, because CPUE data may not be sensitive enough to detect a change in the abundance of kokanee, a food-web approach has been selected to better understand the dynamics among species. Results

from this research will allow Montana Fish, Wildlife & Parks to refine their management strategies in Georgetown Lake to continue providing a premier fishery.

Total Project Cost		$ 116,339.00
Beginning Balance – January 2022		116,339.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	23,027.97	
Contracted Services	378.14	
Supplies	4,430.67	
Communications	43.43	
Travel	2,295.30	
Rent	0	
Repair & Maintenance	0	
Tuition	5,714.13	
Total Spent		35,889.64
Balance		80,449.36
Waived IDCs		16,150.34

SITKA funded an additional $2,000 for supplies for this project.

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

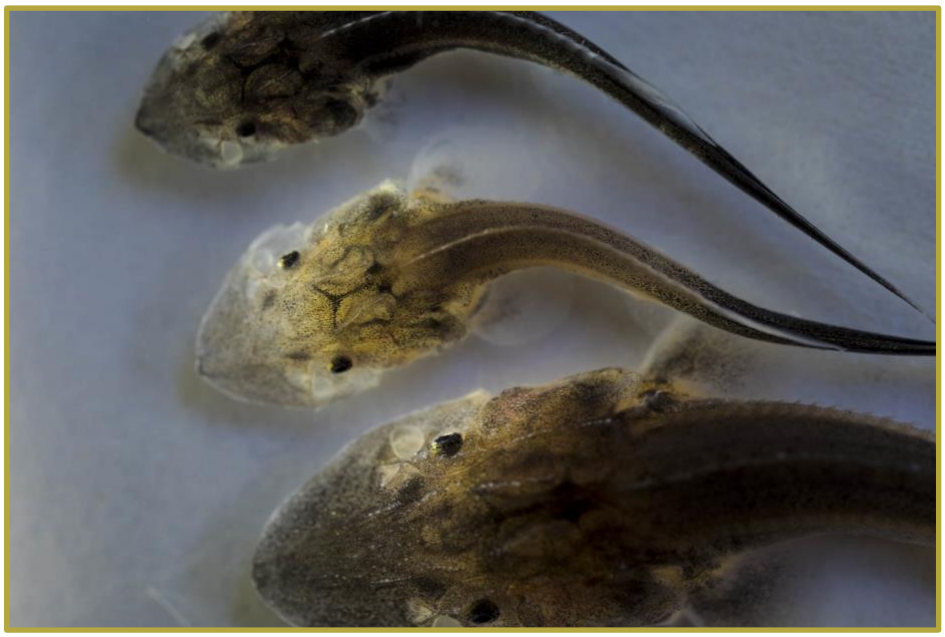
Collaborator
Wendy Sealey
U.S. Fish and Wildlife Service

Funding
USGS RWO 77 SSP
MSU index 4W7764

Duration
April 2019 – December 2023
Continuing

Conservation propagation facilities are currently experiencing variable survival of first feeding larval Pallid Sturgeon. Hatchery-induced "selection" can ultimately have unintended, negative consequences on genetic representation of Pallid Sturgeon returned to the Missouri and Yellowstone rivers. The observed variability in larval survival at conservation propagation hatcheries may be a result of poor response to feed offered to larvae. 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 to 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 the 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 2021, we completed trials with two genetically distinct families. We determined that the live diet (*Artemia*) improved survival and condition within each genetic lot in comparison to the commercial diet (Otohime). Survival in both families was higher for individuals fed *Artemia* – either exclusively or in combination with Otohime – than for those fed solely Otohime, suggesting that *Artemia* confers a survival benefit to first feeding larval Pallid Sturgeon. Our individual weight data demonstrated that *Artemia* produced heavier fish, and individuals fed solely *Artemia* were heavier than those fed solely Otohime. Data collected in 2022 essentially supported data collected in previous years.

Total Project Cost		142,033.00
Beginning Balance – January 2022		20,755.07
Additional Funding -- 2022		39,882.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	35,586.39	
Contracted Services	0	
Supplies	4,315.51	
Travel	0	
IDCs @ 15%	5,985.21	
Total Spent		45,887.11
Balance		14,749.96
Waived IDCs		11,970.57



Mechanisms underlying emaciation in adult Pallid Sturgeon evaluation

Investigator
Christine Verhille
MSU Department of Ecology

Graduate Students
Sierra Quinn, M.S.
Nicole Daigle, Ph.D.

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

Duration
February 2019 – September 2022
Completed

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

"Skinny" reproductive-age Pallid Sturgeon have been captured with 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. Our research addressed these problems through two objectives. The first objective was to develop evidence-based criteria for assessing the health and reproductive status of adult Pallid Sturgeon. These criteria 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 was 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 was completed in March 2020. A suite of physiological measurements was performed on fish at the end of this study to develop criteria for non-lethally assessing health status of adult Pallid Sturgeon and to test and calibrate a non-invasive microwave energy meter for determinations of whole-body energy concentration. We found the microwave energy meter to be effective at estimating whole-body energy concentration of adult pallid sturgeon and a manuscript is currently in review with the journal Conservation Physiology. Four field seasons of monitoring non-lethal physiological measurements on wild-captured adult Pallid Sturgeon within the Central Lowlands Management Unit were completed. After comparing these data with data from the hatchery study, we identified blood biochemistry biomarkers of tissue damage, nutritional deprivation, and stress. Plans to investigate environmental contaminants as a mechanism underlying emaciated adult Pallid Sturgeon were pivoted to a study evaluating the effects of tissue biopsy collection on hatchery reared adult Pallid Sturgeon (an essential step to secure permits from the U.S. Fish and Wildlife Service for future biopsy collections). We found negligible short-term effects of biopsy collection on hatchery adult Pallid Sturgeon. This project also takes advantage of the underused National Pallid Sturgeon Database to investigate whether characteristics predicting later emaciation could be identified. We have concluded that relative condition at capture is a weak but significant predictor of apparent future survival.

Total Project Cost		$ 127,540.56
Beginning Balance – January 2022		25,292.43
Expenditures – January 2022 - September 2022		
Salaries and Benefits	19,666.36	
Contracted Services	0	
Supplies	2,324.81	
Communications	0	
Travel	0	
Awards	0	
IDCs @ 15%	3,301.26	
Total Spent		25,282.43
Balance		0
Waived IDCs		6,594.36

Delineating and mapping ungulate seasonal ranges and movement corridors in Montana

Investigators
Jay Rotella, Robert Garrott
MSU Department of Ecology

Research Associate
Aidan Beers, MSU
Blake Lowrey, MSU

Collaborator
Kelly Proffitt
Montana Fish, Wildlife and Parks

Duration
May 2019 – June 2024
Continuing

Funding
Montana Fish, Wildlife and Parks
MSU index 4W8069, 4W9879
U.S. Geological Survey RWO 80
MSU index 4W8304

Recognizing the need to protect and conserve big-game winter range and migration corridors to sustain robust ungulate herds across Montana, Montana Fish, Wildlife and Parks 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 was bolstered by Secretarial 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 mapping effort and associated research will help fulfill local information needs as well as contribute to regional coordinated mapping efforts across the western U.S. We used existing GPS data from elk and mule deer herds across Montana to develop methods for delineating seasonal ranges and migration corridors. The elk populations were predominantly located in southwest and western Montana with a few populations in the northwest and eastern parts of the state. The mule deer populations were distributed across the state. We estimated 50, 95, and 99 percent home range contours for winter, summer, and annual periods for each individual year, which were then averaged to create population-level ranges. The contours represented the smallest areas where the probability of relocating an individual from the herd is equal to the given percentage (i.e., 50, 95, and 99 percent). Mule deer and elk mapping efforts were completed, and the focus of this work is shifting to 1) delineating pronghorn seasonal ranges and migration corridors and 2) using existing deer and elk telemetry data to generate statewide predictive maps of

winter range habitat suitability. We are currently working with postdoctoral researcher Aidan Beers, who is leading these analyses. We are also continuing to work with Montana Fish, Wildlife and Parks to provide the required data layers to populate a web page that will serve as an internal resource where Montana Fish, Wildlife and Parks staff can download herd-specific maps as well as an online tool for the general public to learn about Montana Fish, Wildlife and Parks research projects.

Total Project Cost 4W8069		$ 136,000.00
Beginning Balance – January 2022		26,644.29
Expenditures – January 2022 - December 2022		
Salaries and Benefits	25,501.48	
Contracted Services	61.50	
Supplies	1,081.31	
Travel	0	
Total Spent		26,644.29
Balance		0
Waived IDCs		11,989.93

Total Project Cost 4W8304		$ 56,848.00
Beginning Balance – January 2022		56,848.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	34,129.63	
Contracted Services	225.50	
Travel	1,274.96	
IDCs @ 15%	5,344.45	
Total Spent		40,974.54
Balance		15,873.46
Waived IDCs		10,689.03

Total Project Cost 4W9879		$ 71,250.00
Beginning Balance – January 2022		71,250.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	0	
Supplies	-37.34	
Travel	0	
Total Spent		-37.34
Balance		71,287.34
Waived IDCs		0

Elk habitat management in Montana

Investigators
Jay Rotella
MSU Department of Ecology

Graduate Student
Elisabeth Krieger, M.S.

Collaborator
Kelly Proffitt
Montana Fish, Wildlife and Parks

Funding
Montana Fish, Wildlife and Parks
MSU index 4W8829

Duration
November 2020 – June 2025
Continuing

Research Associate
John Draper, MSU

A recent focus in the western United States has been to identify and conserve big game migration corridors and winter ranges as highlighted in 2018 Secretarial Order 3362. Seasonal range and movement information is lacking for many elk populations in Montana, particularly in the central and eastern portions of the state. The project is building on results from previous security-habitat studies in Montana and provides information and recommendations on population and habitat management strategies for elk in central Montana and the prairie environments of eastern Montana by collecting, analyzing, and interpreting elk movement data in the Devil's Kitchen, Custer Forest, and Missouri Breaks areas. The specific objectives of this project are to (1) collect elk movement data and delineate seasonal range and migration corridors of three elk populations, (2) evaluate landscape factors associated with problematic elk distributions and provide information regarding elk habitat selection to enhance management strategies aimed at achieving more desirable distributions and harvest management objectives, and (3) evaluate elk habitat selection and the effects of hunter access management and provide information to enhance elk management. We are actively collecting location data from collared elk in these three study areas and will continue data collection throughout the next 2 years. A postdoc (John Draper) joined the project in March 2022 and has been conducting analyses evaluating landscape factors associated with problematic elk distributions.

Total Project Cost		$ 385,955.00
Beginning Balance – January 2022		152,629.99
Additional Funding 2022		137,545.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	81,490.60	
Contracted Services	47,824.78	
Supplies	1,080.93	
Travel	389.06	
Tuition	4,007.95	
Total Spent		134,793.32
Balance		155,381.67
Waived IDCs		60,657.00

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 2022		$ 5,414.15
Additional Funding		22,810.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	1,877.36	
Contracted Services	0	
Supplies	3,349.62	
Communications	0	
Travel	341.60	
Rent	0	
Repairs and Maintenance	0	
Tuition	0	
Administrative Fee @ 6%	402.45	
Total Spent		5,971.03
Balance		22,253.12

MTCFRU service project account

Investigators
Alexander Zale
Unit Leader

Funding
MT Fish, Wildlife and Parks
MSU Index 433309

Duration
Continuing

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 2022		$ 2,426.92
Additional Funding –		0
Expenditures – January 2022 - December 2022		
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


Adrian Sanchez-Gonzalez

MTCFRU Gift Account

Investigators
Alexander Zale
Unit Leader

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 2022		12.16
Additional Funding – 2022		0
STIP Interest 2022		0
Expenditures – January 2022 - December 2022		
Salaries and Benefits	0	
Supplies	0	
Travel	0	
Repairs and Maintenance	0	
Tuition	0	
Total Spent		0
Balance		12.16

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 Unit vehicle account covers all expenses related to Unit vehicles including replacement, repairs, maintenance, insurance, and fuel.

Beginning Balance – January 2022		$ 76,643.74
Expenditures – January 2022 - December 2022		
Repairs and Maintenance	1,702.45	
Fuel	6,730.25	
New	0	
Administrative Assessment Fee @ 6%	505.98	
Total Spent		8,938.68
Total Revenue Reimbursed		16,922.61
Balance		84,627.67

Adrian Sanchez-Gonzalez

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

Beginning Balance – January 2022		29,810.73
Expenditures – January 2022 - December 2022		
Repairs and Maintenance	128.55	
Fuel and Supplies	1,270.06	
New	0	
Administrative Assessment Fee @ 6%	83.92	
Total Spent		1,482.53
Total Revenue Reimbursed		2,620.00
Balance		30,948.20

Montana Cooperative Fishery Research Unit Operations Account

Administrator

Alexander Zale
Unit Leader

Funding

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

Beginning Balance – January 2022		$2,182.76
Expenditures – January 2022 - December 2022		
Maintenance	0	
Contracted Services	0	
Supplies	278.23	
Communications	657.25	
CCM	0	
Rent (storage unit)	7,600.00	
Parking expense	2,695.00	
Administrative Assessment Fee @ 6%	673.99	
Total Spent		11,904.47
Total Revenue from VPR		22,500.00
Balance		12,778.29

Monetary Equivalence for MSU Services and Facilities
January 2022 - December 2022

Program Manager salary and benefits	$ 71,234.30
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 ($699,367)	5,594.94
Utilities - General @ 12% of total expenditures ($699,367)	83,924.04
Unit Operations Account	22,500.00
Waived IDCs	198,820.36
Total	**406,547.10**

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 4W8602

Beginning Balance – January 2022		$ 25,293.56
Additional Funding – 2022		40,000.00
Expenditures – January 2022 - December 2022		
Salaries and Benefits	13,281.05	
Contracted Services	1,825.33	
Supplies	20,158.33	
Communications	51.79	
Travel	9,504.39	
Rent	75.00	
Repairs and Maintenance	1,023.30	
Tuition	0	
Equipment	0	
Total Spent		45,919.19
Total Returned MT FWP		0
Balance		19,374.37

Federal Budget January 2022 - December 2022

Salaries and Benefits	$ 466,673.83
Supplies	3,974.05
Total	$ 470,647.88

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

USGS

2019 Dodge Ram ¾ Ton, 4x4 crew cab (dk green/black)
Property No. 434650 – Serial No. 3C6UR5CJ1KG676584
Acquisition value $30,559
Mileage 2377

2016 Chevrolet Silverado 2500, 4x4 crew cab (white)
Property No. 434174 – Serial No.1GC1KUE80GF252052
Acquisition value $35,644
Mileage 22,091

2011 Ford F250 4×4 crew cab (green)
Property No. 433429 – Serial No 1FT7W2BTOBEA70586
Acquisition value $31,697
Mileage 65,981

2005 Chevrolet Silverado 2500, 4×4 crew cab (green)
Property No. 430750 - Serial No. 1GCHK23G15F926039 (2005)
Acquisition value $22,948
Mileage 144,175

2002 Chevrolet 4×4 Suburban (white)
Property No. 261052 - Serial No. 3GNGK26U52G249012
Acquisition value $31,988
Mileage 148,871

Hewes Craft 270 Boat
Property No. 1387575 – Serial No. HEW96582J021
EZ Loader Trailer – Serial No. 1ZETARYZ7MA005548
Acquisition value $113,987 (2020)

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)

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

2020 Dodge Ram ½ Ton 4x4 Crew Cab (white)
Serial No. 1C6RR7ST2LS100291
Acquisition Value $28,078
Mileage 12,727

2017 Ford F150 Supercab (blue)
Serial No. 1FTFX1EF0HKD34442
Acquisition Value $26,826
Mileage 12,878

2014 Dodge Ram 2500 (white)
Property No. 135050
Serial No. 3C6TR5DT0EG281683
Acquisition Value $29,197
Mileage 62,264

2008 Ford Escape Hybrid 4WD (grey)
Property No. 132775
Serial No. 1FMCU59H78KA13346
Acquisition Value $26,554 (2007)
Mileage 46,733

2005 GMC Sierra 2500 crew cab truck (green)
Property No. 132353
Serial No. 1GTHK23G65F944780
Acquisition Value $24,463 (2005)
Mileage 177,490

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)