# Montana Cooperative Fishery Research Unit

## 2024 Briefing Booklet

## Coordinating Committee Meeting
## 18 April 2024, Missoula, Montana

MONTANA FISH, WILDLIFE & PARKS

MONTANA STATE UNIVERSITY
Mountains & Minds

USGS
science for a changing world

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. 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**
Kevin Whalen, Western 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**
Alison Harmon
Vice President of Research and
Economic Development
MSU – P.O. Box 172460
Bozeman, MT 59717-2460

**U.S. Fish and Wildlife Service**
Matt Hogan, 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
Emily Almberg
Jessy Coltrane
Nicholas DeCesare
Mike Duncan
Justin Gude
Chris Hammond
Heather Harris
Ryan Kovach
Brad Liermann
Jason Mullen
Scott Opitz
Kelly Proffitt

David Schmetterling
Zack Shattuck
Kristina Smucker
Ron Spoon

Montana State University, Department of Ecology
Lindsey Albertson
Aidan Beers
Diane Debinski, Head
John Draper
Robert Garrott
Andrea Litt
Blake Lowrey
Jay Rotella

Montana State University, Department of Civil Engineering
Kathryn Plymesser

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

Montana State University, Department of Animal and Range
Jared Beaver
Lance McNew
Brent Roeder
Smith Wells

Montana State University, Department of Microbiology & Cell Biology
Zoe Pratt
Frank Stewart

USGS Northern Rocky Mountain Science Center
Claudia Regan, Director

U.S. Fish and Wildlife Service, Bozeman Fish Technology Center
Kevin Kappenman
Jeff Powell
Wendy Sealey
Molly Webb

Bureau of Land Management
Mike Borgreen

Jackson Hole One Fly Foundation

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

U.S. Forest Service
- Susan Adams

MPG Ranch
- Beau Larkin

NorthWestern Energy
- Grant Grisak

Real Jardin Botanico CSIC Madrid
- Laura Martin-Torrijos
- Javier Dieguez Uribeondo

Rocky Mountain Cooperative Ecosystem Studies Unit
- Lisa Gerloff

Wyoming Game and Fish Department
- Joe Deromedi
- Paul Gerrity

## 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

| | | |
|---|---|---|
| Kyle Butler | M.S. | advised by Kathryn Plymesser |
| Nolan Helmstetter | Ph.D. | advised by Andrea Litt |
| Jacob Melhuish | M.S. | advised by Andrea Litt |
| Elisabeth Krieger | M.S. | advised by Jay Rotella |
| Stacy Schmidt | M.S. | advised by Lindsey Albertson |
| Aubrey Sullivan | M.S. | advised by Lance McNew |

## Graduate Students Receiving Degrees: none

## Research Technicians

| | | |
|---|---|---|
| Katelyn Allen | Jodee Clark | Hilary Treanor |
| Brandon Bergum | Kelson Hickman | Tristan Whiting |
| Grant Christian | Blakely Thomas | |

## 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 2024
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 needed 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 2023 | | 18,373.32 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 14,389.49 | |
| Supplies | 0 | |
| Communications | 11.00 | |
| Travel | 394.67 | |
| Rent | 0 | |
| Tuition | 988.95 | |
| IDCs @ 17.5% | 2,589.21 | |
| Total Spent | | 18,373.32 |
| Balance | | 0 |
| Waived IDCs | | 4,340.63 |

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 internal funding

---

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.

## 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.

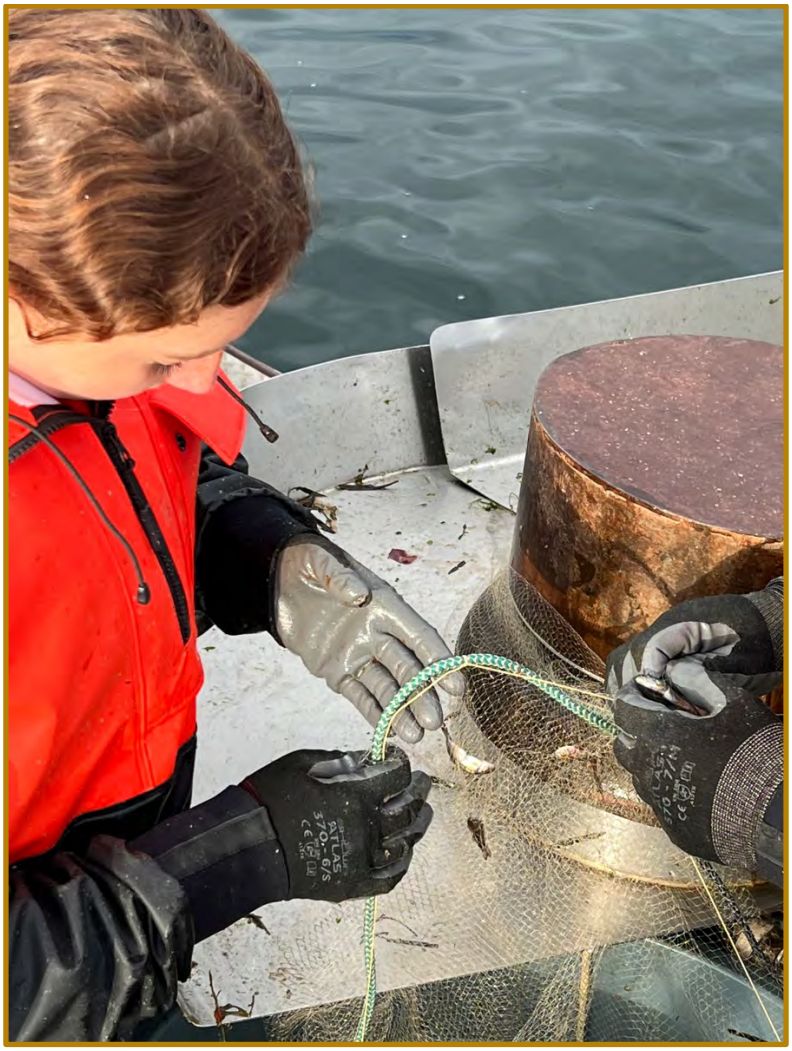
**Funding**
National Park Service
MSU index 4W8429

**Duration**
August 2020 – December 2024
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 2023 | | 33,267.25 |
| Additional Funding --2023 | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 23,772.03 | |
| Contracted Services | 0 | |
| Supplies | 289.97 | |
| Communications | 581.32 | |
| Travel | 61.25 | |
| Rent | 0 | |
| Repairs and Maintenance | 0 | |
| Tuition | 2,235.61 | |
| IDCs @ 17.5% | 4,323.36 | |
| Total Spent | | 31,263.54 |
| Balance | | 2,003.71 |
| Waived IDCs | | 7,408.55 |



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

**Investigator**
Christopher Guy
Assistant Unit Leader

**Collaborator**
Todd Koel
Yellowstone National Park

**Graduate Student**
Michelle Briggs, Ph.D.

**Duration**
June 2021 – December 2024
Continuing

**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 NPS | | $ 143,144.74 |
| Beginning Balance – January 2023 | | 123,114.73 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 34,122.20 | |
| Contracted Services | 632.73 | |
| Supplies | 4,549.02 | |
| Communications | 186.78 | |
| Travel | 6,551.11 | |
| Rent | 2,800.00 | |
| Tuition | 2,133.53 | |
| IDCs @ 17.5% | 8,267.34 | |
| Total Spent | | 59,242.71 |
| Balance | | 63,872.02 |
| Waived IDCs | | 14,018.23 |

| | | |
|---|---|---|
| Total Project Cost JHOF | | $ 26,076.00 |
| Beginning Balance – January 2023 | | 15,716.00 |
| Expenditures – January 2023 - December 2023 | | |
| Contracted Services | 0 | |
| Supplies | 4,451.34 | |
| Communications | 767.84 | |
| Total Spent | | 5,219.18 |
| Balance | | 10,496.82 |
| Waived IDCs | | 2,348.64 |

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
Continuing

---

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 – January 2023 | | 120,898.89 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 29,315.64 | |
| Supplies | 10,880.71 | |
| Communications | 406.80 | |
| Travel | 2,021.99 | |
| Rent | 0 | |
| Tuition | 2,083.53 | |
| IDCs @ 17.5% | 7,459.27 | |
| Total Spent | | 52,167.94 |
| Balance | | 68,730.95 |
| Waived IDCs | | 12,294.89 |

## 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 2024
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 estimated in Torrey Creek, Torrey Lake, Ring Lake, and Trail Lake in the autumn of 2021. Brown Trout were marked with individually numbered FD-94 Floy 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 2023 | | 55,291.26 |
| Additional Funding -- 2023 | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 27,294.75 | |
| Contracted Services | 0 | |
| Supplies | 2,025.91 | |
| Communications | 0 | |
| Travel | 2,285.45 | |
| Rent | 0 | |
| Repair & Maintenance | 0 | |
| Tuition | 4,259.71 | |
| IDCs @ 20% | 7,173.20 | |
| Total Spent | | 43,039.02 |
| Balance | | 12,252.24 |
| Waived IDCs | | 8,966.46 |

## 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 2024
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 – January 2023 | | 19,115.71 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 17,733.57 | |
| Contracted Services | 0 | |
| Supplies | 0 | |
| Communications | 0 | |
| Travel | 227.85 | |
| Rent | 0 | |
| Repair & Maintenance | 0 | |
| Tuition | 0 | |
| Total Spent | | 17,961.42 |
| Balance | | 1,154.29 |
| Waived IDCs | | 8,082.64 |

## 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
Continuing

**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, natural resource agencies need to 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, 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 abundance, 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 | | $ 125.219.00 |
| Beginning Balance – January 2023 | | 9,706.72 |
| Additional Funding -- 2023 | | 105,219.00 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 5,945.31 | |
| Contracted Services | 0 | |
| Supplies | 851.24 | |
| Communications | 0 | |
| Travel | 1,566.29 | |
| Rent | 0 | |
| Repair & Maintenance | 0 | |
| Tuition | 3,596.74 | |
| Total Spent | | 11,959.58 |
| Balance | | 102,966.14 |
| Waived IDCs | | 5,381.82 |

| | | |
|---|---|---|
| Total Project Cost 433295 | | $ 22,810.00 |
| Beginning Balance – January 2023 | | 16,838.97 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 12,569.75 | |
| Contracted Services | 0 | |
| Supplies | 94.76 | |
| Communications | 0 | |
| Travel | 80.00 | |
| Rent | 0 | |
| Tuition | 197.50 | |
| IDCs @ 6% | 764.61 | |
| Total Spent | | 13,706.59 |
| Balance | | 3,132.35 |
| Waived IDCs | | 0 |

# 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 2023 | | 80,449.36 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 32,886.11 | |
| Contracted Services | 981.34 | |
| Supplies | 1,185.79 | |
| Communications | 0 | |
| Travel | 1,025.73 | |
| Rent | 0 | |
| Repair & Maintenance | 0 | |
| Tuition | 3,804.29 | |
| Total Spent | | 38,883.26 |
| Balance | | 40,566.10 |
| Waived IDCs | | 17,497.47 |

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

## Feeding ecology and trophic level habits of juvenile Pallid Sturgeon in the Missouri River, above Fort Peck Reservoir

**Investigator**
Christopher Guy
Assistant Unit Leader

**Graduate Student**
Victoria Ogolin, M.S.

**Duration**
January 2023 – December 2025
New

**Collaborators**
Molly Webb, US Fish Wildlife Service
Zack Shattuck, Luke Holmquist
Montana Fish, Wildlife and Parks

**Funding**
US Fish and Wildlife Service
MSU index 4WA124
Montana Fish, Wildlife and Parks
MSU index 4WA686

---

Growth of hatchery-reared Pallid Sturgeon *(Scaphirhynchus albus*) in the Missouri River above Fort Peck Reservoir is highly variable, which can influence age and size at sexual maturity; therefore, understanding the mechanism for the variation in growth is warranted. This research will focus on differences in diet as the mechanism for variation in growth. Pallid Sturgeon will be sampled for stable isotopes and gut contents throughout the Missouri River from the confluence of the Marias River to the transition zone with Fort Peck Reservoir using a systematic sampling design. Stable isotope analyses (i.e., $\delta^{13}C$ and $\delta^{15}N$) and gut-content analyses will be used to describe trophic position and diet data (long term and short term). These data will be analyzed by year class, size, and river location to build an ontogenetic-spatiotemporal model of how Pallid Sturgeon use food resources throughout the upper Missouri River. The results from this study will explicitly address these questions: 1) are slow growing Pallid Sturgeon within a year class primarily feeding on macroinvertebrates, and 2) are fast growing Pallid Sturgeon within a year class primarily feeding on fish? The need for this information is timely given the continued questions surrounding variation in growth and carrying capacity of hatchery-reared Pallid Sturgeon in the Missouri River.

| | | |
|---|---|---|
| Total Project Cost 4WA124 | | $ 90,075.00 |
| Beginning Balance – January 2023 | | 90,075.00 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 43,989.88 | |
| Contracted Services | 335.47 | |
| Supplies | 12,388.79 | |
| Communications | 828.30 | |
| Travel | 6,566.27 | |
| Rent | 6,900.00 | |
| Maintenance | 1,621.78 | |
| Tuition | 5,154.17 | |
| IDCs @ 17.5% | 12,290.34 | |
| Total Spent | | 90,075.00 |
| Balance | | 0 |
| Waived IDCs | | 21,390.79 |

| | | |
|---|---|---|
| Total Project Cost 4WA686 | | $ 71,903.00 |
| Beginning Balance – January 2024 | | 71,903.00 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 0 | |
| Contracted Services | 0 | |
| Supplies | 0 | |
| Communications | 0 | |
| Travel | 0 | |
| Rent | 0 | |
| Maintenance | 0 | |
| Tuition | 0 | |
| IDCs @ 17.5% | 0 | |
| Total Spent | | 0 |
| Balance | | 71,903.00 |
| Waived IDCs | | 0 |

# 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

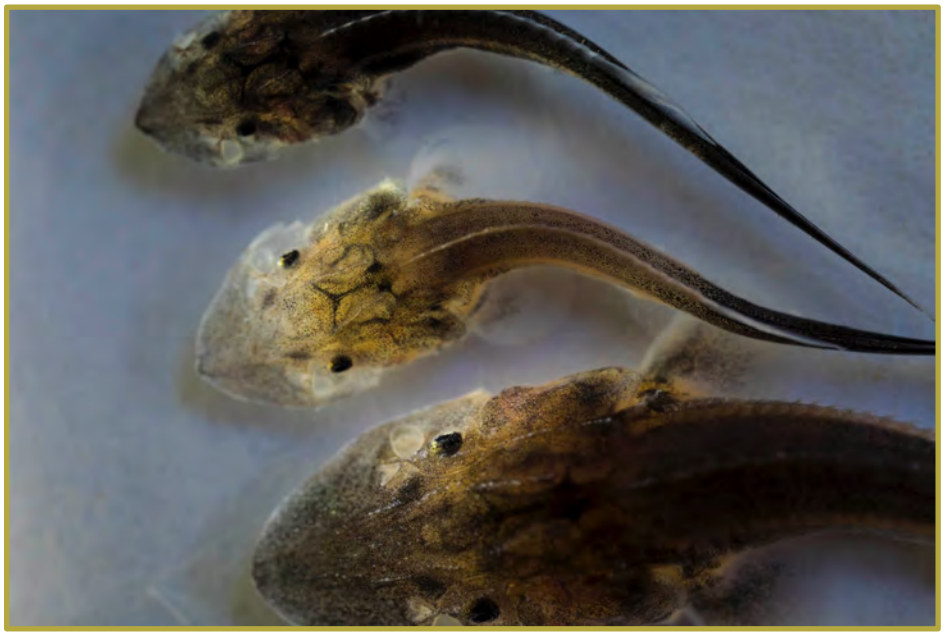
**Funding**
USGS RWO 77 SSP
MSU index 4W7764

**Duration**
April 2019 – December 2023
Completed

---

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 | | 181,915.00 |
| Beginning Balance – January 2023 | | 14,749.96 |
| Additional Funding -- 2023 | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 12,996.75 | |
| Contracted Services | 0 | |
| Supplies | 175.35 | |
| Travel | 0 | |
| IDCs @ 15% | 1,928.56 | |
| Total Spent | | 14,749.96 |
| Balance | | 0 |
| Waived IDCs | | 4,424.99 |



# Effects of handling on injury and secondary infection in Rainbow Trout

**Investigators**
Christopher Guy
Assistant Unit Leader
Al Zale, Unit Leader
Molly Webb
U.S. Fish and Wildlife Service

**Research Associate**
Hilary Treanor

**Collaborator**
David Schmetterling
Montana Fish, Wildlife and Parks

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA657

**Duration**
October 2023 – December 2024
New

---

Trout numbers have declined in southwestern Montana over the last five to ten years. Biologists and anglers have observed a specific pattern of injury to Brown Trout *Salmo trutta* and, to a lesser extent, Rainbow Trout *Oncorhynchus mykiss* with secondary *Saprolegnia* fungal infections. The specific cause(s) of the injury pattern is currently unknown, but could be related to low flow, high water temperature, handling, or disease. These injuries are typically observed from early summer through autumn. The number of fish observed with *Saprolegnia* infection has been so concerning that Montana Fish, Wildlife & Parks created a webform for the public to report sick or dead fish (https://fwp.mt.gov/sickfish). Therefore, determining the mechanism for the observed sick fish in the wild is warranted. Gloves and sunscreen can result in injuries similar to what has been observed on fish from rivers in southwest Montana. Repeated catch and release handling may remove enough protective mucus to result in the pattern of injury and *Saprolegnia* infection that has been observed by Montana Fish, Wildlife & Parks and anglers. We sought to recreate the observed pattern of injury and *Saprolegnia* infection in the wild by testing the effects of glove type and sunscreen. We think this will be an informative first step in trying to determine the cause of sick fish in southwest Montana rivers. Rainbow Trout were randomly allocated to experimental tanks and experimental tanks were randomly assigned to one of the following treatments: cotton gloves, nitrile gloves, bare hands with sunscreen, bare hands without sunscreen, and control with two replicate tanks per treatment. Designated handlers applied treatments to each fish in each tank. Fish were then monitored daily for injury, illness, and mortality. Two additional handling events occurred before the trial was ended after 60 days. We

observed scale injury and *Saprolegnia* infection; however, the frequencies of both were low. Future work will build on data collected in 2023 to better capture the environmental factors contributing to the observed pattern injury and *Saprolegnia* infection in southwestern Montana.

| | | |
|---|---|---|
| Total Project Cost | | $ 19,483.00 |
| Beginning Balance – October 2023 | | 19,483.00 |
| Expenditures – October 2023 - December 2023 | | |
| Salaries and Benefits | 1,172.01 | |
| Contracted Services | 0 | |
| Supplies | 0 | |
| Communications | 0 | |
| Travel | 0 | |
| Rent | 0 | |
| Repair & Maintenance | 0 | |
| Tuition | 0 | |
| Total Spent | | 1,172.01 |
| Balance | | 18,310.99 |
| Waived IDCs | | 527.41 |

## Delineating and mapping ungulate seasonal ranges and movement corridors in Montana

**Investigators**
Jay Rotella, Robert Garrott
MSU Department of Ecology

**Collaborator**
Kelly Proffitt
Montana Fish, Wildlife and Parks

**Research Associate**
Aidan Beers, MSU
Blake Lowrey, MSU

**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

---

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 in recognition of the need to protect and conserve big-game winter range and migration corridors to sustain robust ungulate herds across Montana. 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% 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%). 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 2023 | | 15,873.46 |
| Expenditures – January 2023 - April 2023 | | |
| Salaries and Benefits | 13,803.05 | |
| Contracted Services | 0 | |
| Travel | 0 | |
| IDCs @ 15% | 2,070.41 | |
| Total Spent | | 15,873.46 |
| Balance | | 0 |
| Waived IDCs | | 4,140.92 |

| | | |
|---|---|---|
| Total Project Cost 4W9879 | | $ 97,158.90 |
| Beginning Balance – January 2023 | | 71,287.34 |
| Additional Funding -- 2023 | | 25,908.90 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 60,594.31 | |
| Supplies | 0 | |
| Travel | 0 | |
| Total Spent | | 60,594.31 |
| Balance | | 36,601.93 |
| Waived IDCs | | 27,267.44 |

## Elk habitat management in Montana

**Investigators**
Jay Rotella
MSU Department of Ecology

**Collaborator**
Kelly Proffitt
Montana Fish, Wildlife and Parks

**Graduate Student**
Elisabeth Krieger, M.S.

**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 initiated analyses evaluating landscape factors associated with problematic elk distributions for 1 year before leaving the project for a new position. A new postdoc (Kaitlin Macdonald) will join the project in summer of 2024

and complete the analyses. Masters student Elizabeth Krieger is analyzing elk habitat selection during the rifle season.

| | | |
|---|---|---|
| Total Project Cost | | $ 692,260.00 |
| Beginning Balance – January 2023 | | 155,381.67 |
| Additional Funding 2023 | | 168,760.00 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 71,321.35 | |
| Contracted Services | 39,867.87 | |
| Supplies | 0 | |
| Travel | 66.24 | |
| Tuition | 2,006.07 | |
| Total Spent | | 113,261.53 |
| Balance | | 210,880.14 |
| Waived IDCs | | 50,967.69 |

## Pallid Sturgeon population and survival estimation

**Investigator**
Jay Rotella
MSU Department of Ecology

**Collaborator**
Zach Shattuck
Montana Fish, Wildlife and Parks

**Duration**
February 2023 – June 2025
New

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA233

---

This project will update population and survival estimates of wild and hatchery-reared Pallid Sturgeon, *Scaphirhynchus albus,* in Recovery Priority Management Areas (RPMAs) 1, 2, and 3 of the Missouri River. The estimates are intended to provide useful guidance in adaptive conservation for the Upper Basin Pallid Sturgeon Workgroup (Workgroup) using data collected through the end of the year 2023. The Pallid Sturgeon is listed as endangered under the Endangered Species Act. One component of the recovery plan is the artificial propagation and release of Pallid Sturgeon. Each year, up to several thousand juvenile Pallid Sturgeon are propagated in captivity and released throughout the Upper Basin according to a range-wide stocking and augmentation plan. The recently updated Strategy for Pallid Sturgeon Recovery in the Upper Basin (Upper Basin Pallid Sturgeon Recovery Workgroup 2013) notes the importance of survival estimates for different life stages as a key monitoring component. The Upper Basin Pallid Sturgeon Workgroup will designate a biologist who will assemble and share updated encounter histories for all Pallid Sturgeon that have been released and recaptured through 2023. This project will use mark-recapture modeling to analyze the updated encounter histories. Results of analyses will be used to update recapture and stocking information through 2023 for fish released as yearlings. It will incorporate data corrections from earlier years into existing models of survival for hatchery-reared Pallid Sturgeon in the Upper Basin. The objectives are as follows.

1. Update estimates of survival rates for hatchery-reared Pallid Sturgeon in Upper Basin RPMAs 1, 2, and 3 using an updated data set.
2. Incorporate tag loss into survival estimates.
3. Use tag-loss adjusted survival estimates and information on the number of fish released in each release cohort to estimate the number of surviving individuals by age class and RPMA.

| | | |
|---|---|---|
| Total Project Cost | | $ 36,811.75 |
| Beginning Balance – January 2023 | | 36,811.75 |
| Additional Funding 2023 | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 0 | |
| Contracted Services | 0 | |
| Supplies | 0 | |
| Travel | 0 | |
| Tuition | 0 | |
| Total Spent | | 0 |
| Balance | | 36,811.75 |
| Waived IDCs | | 0 |

Ryan Hagerty/USFWS, Public Domain

# Evaluation of Motus technology for monitoring space use of ground-dwelling birds

**Investigators**
Lance McNew
MSU Department of Animal & Range Sciences

**Collaborators**
Kristina Smucker, Chris Hammond
Montana Fish, Wildlife and Parks
Beau Larkin, MPG Ranch

**Graduate Student**
Aubrey Sullivan, M.S.

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA300

**Duration**
April 2023 – December 2025
New

---

The Motus Wildlife Tracking System is a collaborative research network that uses automated radio telemetry arrays to record transmitter detections remotely and distribute the data to researchers through the Motus database system. Whereas Motus technologies have successfully been used to track the phenology and large-scale habitat use of migrating birds, they have not yet been assessed for use in evaluating fine-scale space use, particularly of ground-dwelling birds. We estimated the accuracy, precision, and effective detection distances of Motus transmitters relative to standard VHF transmitters using handheld radio telemetry technology. We fit a preliminary set of generalized linear (GLM) models to 180 successful triangulations. The most supported models of triangulation precision included an interaction between technology type and observer distance; estimated location precision was greater for the Motus compatible technology at short distances, but VHF technology was more precise at farther observer distances (> 600 m). Relative humidity explained some of the variation in precision measurements; an increase in relative humidity negatively affects triangulation precision. The most supported model of triangulation accuracy suggests that the Motus technology is more accurate than VHF technology across all observed distances. However, the maximum

observable distance of VHF transmitters was nearly twice that of the Motus compatible transmitters. During April and May 2023 we captured 144 sharp-tailed grouse (75 females, 69 males) at leks in east-central Montana, fitted them with GPS PTT, traditional necklace-style VHF transmitters, or Motus transmitters, and translocated them to the Blackfoot and Bitterroot Valleys. We fitted 24 female and 30 male sharp-tailed grouse with Motus transmitters and deployed them on the Motus Network, allowing them to be automatically detected by Motus towers located within the restoration areas. All 54 sharp-tailed grouse fitted with Motus transmitters and released in our study areas were detected by the array of Motus automated towers. The number of detections per individual ranged from 60 to 4,517,274 detections (median = 11,310 detections) per individual over the course of 2 to 118 days. We are exploring the capabilities of Motus towers to estimate accurate locations and home-range sizes of sharp-tailed grouse in western Montana. Our results have important implications for monitoring of ground-dwelling birds, including the space use and habitat selection of reintroduced sharp-tailed grouse in western Montana.

| | | |
|---|---|---|
| Total Project Cost | | $ 151,068.00 |
| Beginning Balance – April 2023 | | 151,068.00 |
| Additional Funding 2023 | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 31,951.46 | |
| Contracted Services | 0 | |
| Supplies | 7,390.25 | |
| Communications | 167.27 | |
| Travel | 14,208.13 | |
| Repair Maintenance | 474.78 | |
| Total Spent | | 54,191.89 |
| Balance | | 98,876.11 |
| Waived IDCs | | 24,386.35 |

## Roost characteristics of *Myotis lucifugus* and *Myotis septentrionalis*

**Investigators**
Andrea Litt
MSU Department of Ecology

**Graduate Student**
Jacob Melhuish, M.S.

**Duration**
June 2023 – August 2024
New

**Collaborators**
Mike Borgreen, BLM
Heather Harris, Montana Fish, Wildlife and Parks

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA394

---

The northern long-eared myotis (*Myotis septentrionalis*, northern myotis) is a highly social species of bat that exhibits two distinct life stages each year: hibernation in the winter, and dispersal and reproduction from spring to autumn. This species also has suffered extensive population declines (>95%) as a result of white nose syndrome, which led to the species being listed as endangered under the Endangered Species Act in March 2023. Despite suffering these massive losses, the known range of this species was expanded into Montana in 2016, representing a new western frontier for northern myotis in the United States. We have been working to characterize habitat of northern myotis during the summer in the Fort Peck area of northeastern Montana. To do this, we attached VHF radio transmitters to 36 northern myotis from May-August 2022 and 2023. We tracked these 36 bats to 76 individual day roosts—locations in trees where they spend time during the day. We used a paired use-availability design, meaning that for each roost found, we also collected the same data for at least one paired random roost, representing what is available on the landscape. We focused on two levels–the roost itself and the surrounding habitat patch, to determine if northern myotis were preferentially selecting for specific characteristics of the trees or patches. Based on these data, we aim to answer several key questions: How do northern myotis roost trees differ from other trees available on the landscape? How do these characteristics differ based on the sex and reproductive status of bats? And how does

density of available roost trees in an area influence selection? We are currently analyzing data and synthesizing results, yet our data already have been used to inform continuing monitoring efforts of northern myotis in Montana and will be part of an updated key of *Myotis* species in the western United States. In addition, our findings will inform habitat management and conservation for northern myotis in Montana and across the western extent of the distribution this species.

| | | |
|---|---|---|
| Total Project Cost | | $ 30,368.00 |
| Beginning Balance – June 2023 | | 30,368.00 |
| Additional Funding 2023 | | 0 |
| Expenditures – June 2023 - December 2023 | | |
| Salaries and Benefits | 11,266.80 | |
| Contracted Services | 0 | |
| Supplies | 393.58 | |
| Communications | 0 | |
| Travel | 1,534.73 | |
| Tuition | 0 | |
| Total Spent | | 13,195.11 |
| Balance | | 17,172.89 |
| Waived IDCs | | 5,937.80 |

# Marten monitoring in Montana

**Investigators**
Andrea Litt
MSU Department of Ecology

**Graduate Student**
Nolan Helmstetter, M.S.

**Duration**
July 2023 – May 2028
New

**Collaborators**
Jessy Coltrane, Nicholas DeCesare, Montana Fish, Wildlife and Parks

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA471

---

Marten (*Martes* spp.) are a charismatic forest carnivore and an important furbearer species in Montana. Implementing an effective marten monitoring protocol is necessary for maintaining sustainable harvest and quantifying marten habitat relationships. Additionally, marten have recently been divided into two species (American marten *Martes americana* and Pacific marten *M. caurina*); both species occur in Montana and hybridize where sympatric. Little is known about the extent of hybridization in Montana (e.g., the extent of backcrossing and the breadth of hybrid zones) and whether habitat relationships differ between the species. We will develop a simulation-based power analysis using data on harvest and occurrence of marten that will guide extensive occupancy surveys for these species throughout Montana. These surveys will, in turn, help quantify how habitat features, marten harvest, and forest disturbance (e.g., fire) influence marten occupancy and assist in developing an effective monitoring protocol for future use. We also are working closely with trappers throughout the state to collect high quality DNA samples and identify the current distributions of both marten species and putative hybrids. This highly collaborative project will help guide the future management of marten as a furbearer species and representative of Montana's wild places.

| | | |
|---|---|---|
| Total Project Cost | | $ 612,419.00 |
| Beginning Balance – July 2023 | | 612,419.00 |
| Additional Funding 2023 | | 0 |
| Expenditures – July 2023 - December 2023 | | |
| Salaries and Benefits | 2,648.97 | |
| Contracted Services | 0 | |
| Supplies | 1,746.73 | |
| Communications | 0 | |
| Travel | 134.00 | |
| Tuition | 3,019.51 | |
| Total Spent | | 7,549.21 |
| Balance | | 604,869.79 |
| Waived IDCs | | 3,397.15 |

## Wild-domestic sheep comingling study

**Investigators**
Jared Beaver, Brent Roeder
MSU Department of Animal and Range Sciences

**Graduate Student**
To be decided

**Duration**
July 2023 – May 2028
New

**Collaborator**
Emily Almberg
Montana Fish, Wildlife and Parks

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA426

**Research Associate**
Smith Wells, MSU

---

Changes in wildlife populations, human development, land conversion, wildlife restoration efforts, and domestic animal operations have brought wildlife and domestic animals into more frequent contact, increasing the risk of disease transmission. The primary pathogen causing pneumonia in Caprinae species, *Mycoplasma ovipneumoniae* (*M. ovi*), can lead to significant die-offs and depressed lamb recruitment in wild sheep herds and can be transmitted among domestic sheep, domestic goats, wild sheep, and mountain goats. Mitigating the risk of disease spillover at the domestic-wild interface is a complex endeavor involving multiple stakeholders with different needs and interests, which necessitate co-produced problem solving and shared solutions. We will use GPS locations of wild sheep, domestic sheep, livestock guardian dogs, animal husbandry information, and field observations to identify individual, herd/band-level, and environmental factors that influence the probability of wild and domestic sheep contact among eight wild sheep herds across southwest and central Montana. We will use these findings to develop and implement tools that maintain effective separation in areas of high contact risk. The products of this study, including proposed management tools and updates to wild sheep habitat models to incorporate ecological risk factors for contact, will be presented to and vetted by producers, woolgrowers, sportspeople, and wildlife managers in a collaborative approach.

| | | |
|---|---|---|
| Total Project Cost | | $ 2,399,208.00 |
| Beginning Balance – July 2023 | | 2,388,208.00 |
| Expenditures – July 2023 - December 2023 | | |
| Salaries and Benefits | 25,984.53 | |
| Contracted Services | 46.75 | |
| Supplies | 626,950.13 | |
| Communications | 0 | |
| Travel | 643.48 | |
| Repair Maintenance | 0 | |
| Tuition | 0 | |
| Total Spent | | 653,624.89 |
| Balance | | 1,745,583.11 |
| Waived IDCs | | 294,131.20 |

## Status and effects of crayfish plague in Montana

**Investigator**
Lindsey Albertson
MSU Department of Ecology

**Graduate Student**
Stacy Schmidt, M.S.

**Duration**
August 2023 – May 2026
New

**Collaborators**
David Schmetterling, MT FWP
Chris Guy, MTCFRU
Susan Adams, U.S. Forest Service
Oxford, Mississippi
Laura Martin-Torrijos, Javier Diéguez Uribeondo, Real Jardín Botánico CSIC, Madrid, Spain

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA494

---

Crayfishes are important for ecological, recreational, and economic reasons. They play critical roles in freshwater ecosystems, occupying multiple trophic positions and serving as prey to over 300 species, including many birds and economically important sport fishes. Moreover, recreational crayfishing has increased in popularity, driven, in part, by social media. The crayfish plague pathogen, caused by the oomycete, *Aphanomyces astaci*, is endemic to North American crayfish and widespread in many genera in the US, but is generally assumed to not cause disease in its native range. Conversely, where introduced, it has caused one of the most severe global wildlife pandemics. The pathogen has decimated native crayfish species in Europe and Asia and threatens other freshwater crayfishes worldwide. Although North American crayfish are chronic carriers of the plague, they typically do not show clinical signs of disease or exhibit unusual behaviors when infected. However, in 2021, during the first statewide crayfish survey in Montana, crayfish (primarily virile crayfish *Faxonius virilis*) were discovered exhibiting unusual lesions caused by crayfish plague in some sites in western Montana. We are investigating the prevalence of this disease in Montana. Specifically, we are identifying the locations within Montana where crayfish exhibit clinical signs. We are also studying how the plague affects growth while investigating the best means to determine growth, population abundance, and survival of crayfish using mark-recapture methods.

| | | |
|---|---|---|
| Total Project Cost | | $ 52,019.14 |
| Beginning Balance – August 2023 | | 52,019.14 |
| Expenditures – August 2023 - December 2023 | | |
| Salaries and Benefits | 10,167.39 | |
| Contracted Services | 0 | |
| Supplies | 0 | |
| Communications | 0 | |
| Travel | 0 | |
| Repair Maintenance | 0 | |
| Tuition | 2,164.92 | |
| Total Spent | | 12,332.31 |
| Balance | | 39,686.83 |
| Waived IDCs | | 5,549.54 |

# FishXing fish swimming capabilities database upgrades

**Investigator**
Katey Plymesser, MSU Civil Engineering

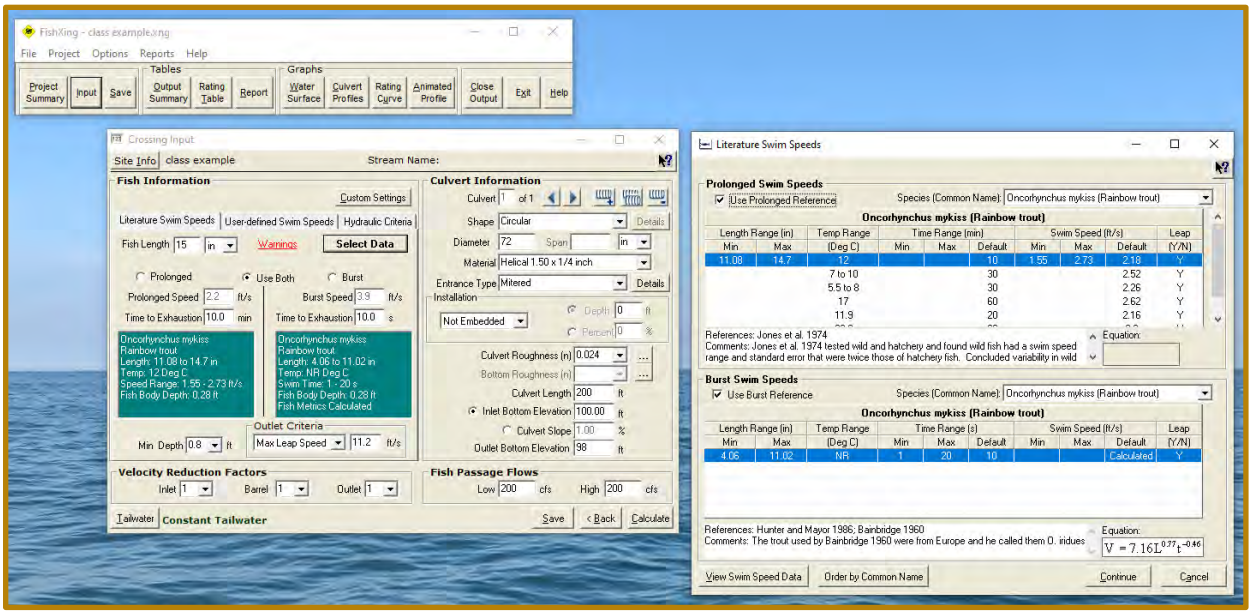
**Collaborator**
Alexander Zale
Unit Leader

**Graduate Student**
Kyle Butler, M.S.

**Funding**
USDA Forest Service
MSU index 4WA625

**Duration**
October 2023 – August 2028
New

---




This project aims to update the FishXing software, the foremost tool for analyzing fish passage through road stream crossings. Despite its comprehensive nature, the software was last updated in 2007, which has left gaps in fish species coverage and outdated swimming capability predictions. This agreement aims to incorporate the latest research findings on fish swimming abilities into the software, thereby enhancing its accuracy and relevance. The cooperation outlined in this agreement between the software developers and researchers signifies a collaborative effort to address these gaps and maintain the status of FishXing as a crucial resource for conservation and infrastructure planning.

| | | |
|---|---|---|
| Total Project Cost | | $ 66,000.00 |
| Beginning Balance – October 2023 | | 66,000.00 |
| Expenditures – October 2023 - December 2023 | | |
| Salaries and Benefits | 1,177.31 | |
| Supplies | 0 | |
| Travel | 0 | |
| Tuition | 0 | |
| IDCs @ 17.5% | 206.02 | |
| Total Spent | | 1,383.33 |
| Balance | | 52,166.67 |
| Waived IDCs | | 323.76 |

## Assessing the microbial community structure toward the health of freshwater fishes in Montana

**Investigator**
Zoe Pratt
MSU Microbiology & Cell Biology

**Collaborator**
Frank Stewart
MSU Microbiology & Cell Biology

**Duration**
October 2023 – July 2024
New

**Funding**
Montana Fish, Wildlife and Parks
MSU index 4WA656

---

We use molecular and bioinformatic analyses to study microbe-microbe, microbe-host, and microbe-environment associations in fishes of Montana. Collaboration with Montana Fish, Wildlife and Parks enables access to key fish species across Montana and allows us to identify baseline microbial species across the state and fish species, putting us in the ideal position to identify and characterize disease events that are bacterial or fungal related. Samples (swabs of fish surfaces) were collected by MT FWP during the summer of 2023. Current lab work is characterizing the genetic diversity of microbiomes from these environments to create baselines for future assessments, comparative data for regional and biogeographic studies, and to uncover novel biodiversity. At the time of this report, DNA had been extracted from all 2023 samples, and amplification of the 16S rRNA and 18S rRNA genes was underway. These samples will be sent for high-throughput sequencing. After the sequence data are available, we will identify and assess the taxonomic composition and potential physiological properties of multi-species microbiomes, and correlate these with fish health. These bioinformatic analyses will also leverage existing published freshwater fish microbiome data (from cultured and uncultured representatives) as a guide for testing hypotheses within these microbial communities. The results will include new interpretations of important microbial interactions and baseline datasets that can be used to characterize these environments in advance of anthropogenic or environmental change. These results will help guide policy and management decisions and advance basic knowledge on the role of microorganisms in shaping the health of freshwater environments.

| | | |
|---|---|---|
| Total Project Cost | | $ 25,879.00 |
| Beginning Balance – October 2023 | | 25,879.00 |
| Expenditures – October 2023 - December 2023 | | |
| Salaries and Benefits | 214.99 | |
| Contracted Services | 0 | |
| Supplies | 367.08 | |
| Communications | 0 | |
| Travel | 0 | |
| Tuition | 0 | |
| Total Spent | | 582.07 |
| Balance | | 25,296.93 |
| Waived IDCs | | 261.94 |

## 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 2023 | | $ 5,414.15 |
| Additional Funding -- 2023 | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| 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 | | 5,414.15 |

## 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 2023 | | $ 2,426.92 |
| Additional Funding – | | 0 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 0 | |
| Contracted Services | 0 | |
| Supplies | 7.93 | |
| Communications | 0 | |
| Travel | 0 | |
| Rent | 0 | |
| Education Costs | 991.21 | |
| Tuition | 0 | |
| Administrative Fee @ 6% | 59.96 | |
| Total Spent | | 1,059.10 |
| Balance | | 1,367.82 |

## MTCFRU Gift Account

**Investigators**
Alexander Zale
Unit Leader

**Funding**
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 2023 | | 12.16 |
| Additional Funding – 2023 | | 0 |
| STIP Interest 2023 | | .65 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 0 | |
| Supplies | 0 | |
| Travel | 0 | |
| Repairs and Maintenance | 0 | |
| Tuition | 0 | |
| Total Spent | | 0 |
| Balance | | 12.81 |

## 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 2023 | | $ 84,627.67 |
| Expenditures – January 2023 - December 2023 | | |
| Repairs and Maintenance | 3,917.69 | |
| Fuel | 4,794.74 | |
| Lewis Lab Remodel | 18,250.00 | |
| Administrative Assessment Fee @ 6% | 522.72 | |
| Total Spent | | 27,485.15 |
| Total Revenue Reimbursed | | 16,043.42 |
| Balance | | 73,185.94 |

## 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 2023 | | 30,948.20 |
| Expenditures – January 2023 - December 2023 | | |
| Repairs and Maintenance | 2,445.22 | |
| Fuel and Supplies | 1,409.29 | |
| New trailer | 8,300.00 | |
| Administrative Assessment Fee @ 6% | 729.27 | |
| Total Spent | | 12,883.78 |
| Total Revenue Reimbursed | | 8,586.00 |
| Balance | | 26,650.42 |

## 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 2023 | | $12,778.29 |
| Expenditures – January 2023 - December 2023 | | |
| Maintenance | 0 | |
| Contracted Services | 540.00 | |
| Supplies | 476.22 | |
| Communications | 943.25 | |
| CCM | 0 | |
| Rent (storage unit) | 15,200.00 | |
| Parking expense | 2,580.00 | |
| Administrative Assessment Fee @ 6% | 1,188.25 | |
| Total Spent | | 20,927.72 |
| Total Revenue from VPR | | 15,000.00 |
| Balance | | 6,850.57 |

## Monetary Equivalence for MSU Services and Facilities
## January 2023 - December 2023
## based on total expenditures of $1,419,402

| | |
|---|---|
| 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 ($1,419,402) | 11,355.22 |
| Utilities - General @ 12% of total expenditures ($1,419,402) | 170,328.24 |
| Unit Operations Account | 15,000.00 |
| Waived IDCs | 535,036.24 |
| Total | 827,427.46 |

## 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 2023 | | $ 19,374.37 |
| Additional Funding – 2023 | | 40,000.00 |
| Expenditures – January 2023 - December 2023 | | |
| Salaries and Benefits | 15,161.12 | |
| Contracted Services | 687.33 | |
| Supplies | 4,106.43 | |
| Communications | 16.00 | |
| Travel | 3,448.57 | |
| Rent | 0 | |
| Repairs and Maintenance | 4,140.73 | |
| Tuition | 2,121.04 | |
| Equipment | 0 | |
| Total Spent | | 29,681.22 |
| Total Returned MT FWP | | 0 |
| Balance | | 29,693.15 |

## Federal Budget January 2023 - December 2023

| | |
|---|---|
| Salaries and Benefits | $ 466,856.00 |
| New truck: Nissan Titan | 47,000.00 |
| Total | $ 513,856.00 |

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

**USGS**

2024 Nissan Titan, ½ ton, crew cab (white)
Property No. 435336 – Serial No.  1N6AA1EC1RN-108246
Acquisition value $47,062
Mileage 357

2019 Dodge Ram ¾ ton, 4x4 crew cab (dk green/black)
Property No. 434650 – Serial No. 3C6UR5CJ1KG676584
Acquisition value $30,559
Mileage 11,042

2016 Chevrolet Silverado 2500, 4x4 crew cab (white)
Property No. 434174 – Serial No.1GC1KUE80GF252052
Acquisition value $35,644
Mileage 23,168

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

2002 Chevrolet 4×4 Suburban (white)
Property No. 261052 - Serial No. 3GNGK26U52G249012
Acquisition value $31,988
Mileage 149,559

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. 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 15,906

2014 Dodge Ram 2500 (white)
Property No. 135050
Serial No. 3C6TR5DT0EG281683
Acquisition Value $29,197
Mileage 64,781

2008 Ford Escape Hybrid 4WD (grey)
Property No. 132775
Serial No. 1FMCU59H78KA13346
Acquisition Value $26,554 (2007)
Mileage 48,148

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)