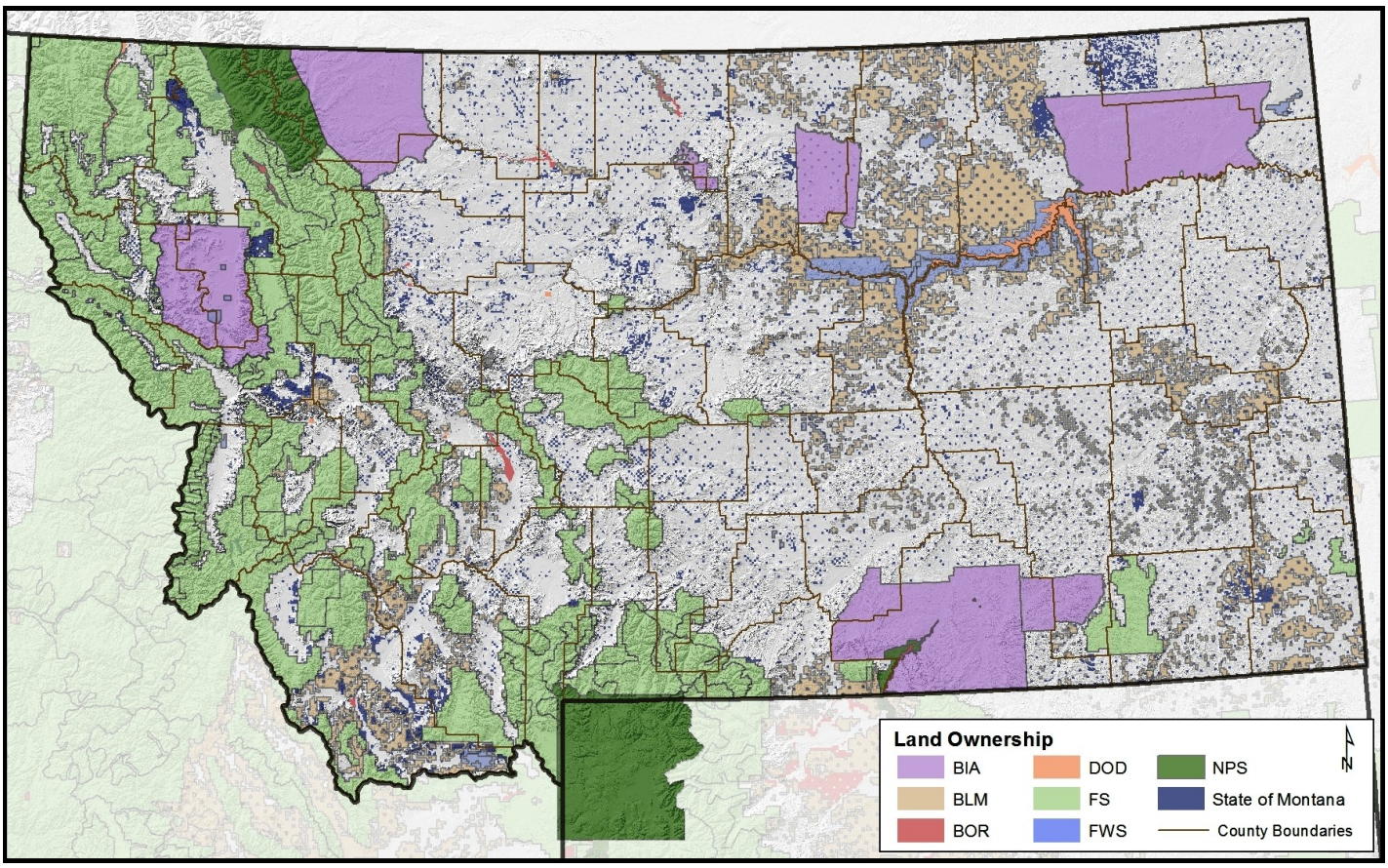
MONTANA CHAPTER

of the

AMERICAN FISHERIES SOCIETY

Management Across Jurisdictional Boundaries:

Working Together to Get the BIG and Small Jobs Done



About the American Fisheries Society and the Montana Chapter

The American Fisheries Society (AFS), founded in 1870, is the oldest and largest professional society representing fisheries scientists. Our mission is to improve the conservation and sustainability of fishery resources and aquatic ecosystems by advancing fisheries and aquatic science and promoting the development of fisheries professionals. AFS promotes scientific research and enlightened management of resources for optimum use and enjoyment by the public. We also encourage the comprehensive education for fisheries scientists and continuing on the job training. The AFS publishes some of the world's leading fisheries research journals and organizes scientific meetings where new results are reported and discussed. In addition to these primary functions, the Society has many other programs in areas such as professional certification, international affairs, public affairs, and public information.

The Montana Chapter of the AFS (MTAFS) was formed in 1967 and our membership is currently composed of approximately 250 fisheries professionals affiliated with state and federal agencies, universities, and private industry across the state. This is the major gathering of the year for fisheries professionals of all affiliations from across the state. It is a great opportunity to learn about what is happening in the management and conservation of fisheries resources in Montana and explore timely issues.

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Acknowledgements

There are so many individuals to thank for their time and effort in putting this meeting together. I cannot thank the current and past Executive Committee officers enough for taking the time to answer my endless stream of questions and for their unwavering encouragement and support. Amber, Leslie, and Marc, your hard work and dedication to the Chapter and this meeting are inspiring. Thank you to Scott Opitz, for sharing his wealth of knowledge on meeting planning, MTAFS operations, plenary session ideas, and always being there to bounce an idea off of. Many thanks to our plenary session speakers for taking the time in your busy schedules to discuss the increasingly important topic of working together. Special thanks to all of our speakers, moderators, sponsors, and vendors for your help in making this meeting a success. Thank you to our student sub-units for taking the time to put together the raffle, fish trivia, and volunteering. I would also like to thank our Committee Chairs for your continued dedication to protecting Montana's and our nations (remember we work across jurisdictional boundaries) aquatic resources. Finally, a special thank you to Mike Sanctuary and Ty Traxler of Confluence Consulting, Inc. for stepping up and saving our continuing education course.

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LOTEK WIRELESS FISH & WILDLIFE MONITORING

Welcome to the 51st annual meeting of the Montana Chapter of the American Fisheries Society. The annual meeting offers a fantastic time to network with individuals we rarely have the opportunity to interact with, meet with professionals working on similar research and projects, expand our professional circles, and hopefully come away with new knowledge and friends. Each year I am inspired by and in awe of the vast diversity of projects being conducted throughout our great state and the level of expertise located right at our doorstep. I think this meeting helps us open that door and reach out to help solve the many problems our aquatic resources face.

This years meeting theme, "Management across jurisdictional boundaries: Working together to get the big and small jobs done" was inspired by the many multi-jurisdictional projects I have been fortunate to be part of over the past several years. With each of these projects, without cooperation and coordination from all agencies and individuals involved, none would have been successful. As our country seems to be less willing to work together every day, I believe that our group is doing just the opposite. By working together, sharing knowledge, lending expertise, and having a willingness to check our egos at the door, we are showing what great successes can be achieved.

As we move forward, and the small, local projects become fewer and further between, our ability to work together will become increasingly important. I have no doubt of our ability to accomplish this and the American Fisheries Society is at the forefront of fostering the relationships to make it possible. We will continue to put the resource first and allow the science to guide us.

I consider myself lucky to be part of this profession and this organization. We are all especially fortunate to do what we do in the intermountain west. Montana's fisheries are recognized as some of the best world wide. You all are the reason for this. So, continue to work together, continue to put the resource first, and continue to do great things.

Sincerely,

Brian Ertel

Schedule at a Glance

Date/Time	Event	Location
Tuesday, January 30		
0730	Registration	Convention Area
0800	Continuing Education, Stream Restoration	
1000	**Break**	
1020	Continuing Education, Stream Restoration	
1200	Lunch (on your own)	
1300	Continuing Education, Drive to Mine	Main Lobby
1400	Continuing Education, Mine Tour	
1600	Continuing Education, Depart Mine for Copper King	
1800	Welcome Social with Drinks and Hors d'oeuvres	

Date/Time	Event	Location
Wednesday, January 31		
0730	Registration / Trade Show Ongoing	Convention Area
0800	Welcome and Announcements	
0810	Plenary Session	
0950	**Break**	
1005	Plenary Session	
1215	Lunch (Provided)	
1315	**AFS President-Elect Jesse Trushenski,**	
1335	Contributed Papers	
1515	**Break**	
1530	Contributed Papers	
1710	End Session	
1730	Committee Caucuses, Montana Association of Fish and Wildlife Biologists	
1830	Poster Session, Plenary Speaker Appreciation Social	

Date/Time	Event	Location
Thursday, February 1		
0730	Registration	
0800	Trade Show Ongoing	
0810	Contributed Papers	
0930	**Break**	
0945	Contributed Papers	
1130	Business Lunch	
1400	Contributed Papers	
1520	**Break**	
1535	Contributed Papers	
1700	End Session	
1730	Student Mentoring Session & Fish Trivia	
1800	Evening Social	
1900	Awards Banquet and Raffle	

Date/Time	Event	Location
Friday, February 2		

Happy Groundhog Day!!

0800	Contributed Papers	
0930	**Break**	
0950	Contributed Papers	
1130	Adjourn. Thank you for attending, travel safe.	

Continuing Education

Stream Restoration and Mine Tour

Presented by:

Mike Sanctuary

Over the past 14 years at Confluence, Mike has worked with State and Federal agencies, tribes, private landowners, non-profit organizations, and municipalities to plan and implement stream habitat and water quality improvement projects. Mike has a bachelor's degree in biology from the University of Colorado and a Master's degree in Environmental Studies from the University of Montana. He has rowed his raft down approximately 2,700 river miles in the western U.S. and is currently spending his weekends teaching his 3- and 5-year old daughters how to ski at Bridger Bowl.

Ty Traxler

Ty Traxler is Confluence's lead design engineer and has 11 years of experience in civil and water resources engineering. Ty specializes in stream channel, bank stabilization, and irrigation infrastructure design, hydraulic analysis using HEC-RAS 1d and 2d modeling programs, and construction management and oversight. He has a bachelor's degree in Mechanical Engineering from the University of Mississippi and chose to pursue an engineering career more closely related to his interest in fishing and floating western rivers. When not restoring fish habitat and crunching scour calculations, Ty can be found with a shotgun, bow, rifle, or flyrod in his hand. His second child is due in two weeks!

Tuesday, January 30, 2018

0800 Welcome and Introductions

0810 Stream Restoration Classroom Session

1000 Break

1020 Stream Restoration Classroom Session

1200 Lunch (on your own)

1300 Meet in Lobby and Load Bus

1330 Depart for Mine Tour

1400 Begin Mine Tour

1630 Return to Copper King

1700 Adjourn

CONFLUENCE

THE 51st ANNUAL MEETING OF THE MONTANA CHAPTER OF THE AMERICAN FISHERIES SOCIETY

Agenda

Wednesday, January 31, 2018
Plenary Session
Moderator: Wade Fredenberg

8:00	**Welcome &Introduction of Plenary Session:** Brian Ertel (National Park Service)
8:10	**Getting Things Done in the Bitterroot,** Michael Jakober (U.S. Forest Service)
8:45	**Fostering Public Resource Conservation on Private Lands: A 20-year Multi-jurisdictional Story,** Carter G. Kruse (Turner Enterprises, Inc.)
9:20	**Cactus and the Case for Open Toed Shoes,** Mark Reller (Bonneville Power Administration)
9:50	**Break**
10:05	**Approaches for Planning and Coordinating Multijurisdictional Fisheries Projects,** Clint Sestrich (U.S. Forest Service)
10:40	**Native Fish Conservation in Yellowstone National Park** Todd M. Koel (National Park Service)
11:15	**Bison Conservation Across Jurisdictional Boundaries: It is not too late to preserve a native species in Greater Yellowstone** Rick Wallen (National Park Service)
11:45	**Panel Discussion and Questions**
12:15	**Lunch (Provided)**

Contributed Papers — Co-Authors are listed in abstract section of the program
**** Indicates Student Paper**
Moderator: Patricia Bigelow

1:15	**Jesse Trushenski, National AFS President-Elect**
1:35	**Guides, Outfitters, and Biologists: Working Together for the Resource,** Brant Oswald (Guides for Conservation)

1:55 **Advancing Engagement with Contemporary Anglers: Crowd-sourcing Creel Data,** Adam Strainer (Montana Fish, Wildlife & Parks)

2:15 **Paddlefish Life History: Advances and Applications in Design of Harvest Management Regulations,** Dennis Scarnecchia (University of Idaho)

2:35 **Evaluation of Portable, Field-based eDNA Approaches,** Adam Sepulveda (U.S. Geological Survey)

2:55 **Proliferative Kidney Disease in Montana,** Patrick Hutchins (U.S. Geological Survey)

3:15 **Break**

3:30 **Do Habitat Attributes Influence the Relationship Between Native Trout abundance and eDNA Concentrations in Northwest Montana?,** Kyle Crapster (Montana State University)

3:50 **Effects of Lodophor Use During Water-hardening and Chilling of Eggs During Incubation on Bone Deformity Rates Of Brook Trout *Salvelinus Fontinalis*,** Matthew Wipf (Grant Springs State Fish Hatchery)

4:10 ****The Assessment of Ultrasound and Plasma Sex Steroid Concentrations to Assign Sex and Stage of Maturity in Wild Burbot,** Lauren McGarvey (Montana State University)

4:30 ****Determining Sex and Stage of Maturity of Hatchery Origin White Sturgeon in the Lower Columbia River, Canada,** Paige Maskill (Montana State University)

4:50 **Investigations Into Water Quality Parameters Affecting Rotenone Toxicity to Fish,** Don Skaar (Montana Fish, Wildlife & Parks)

5:10 **Adjourn**

5:30 **Committee Caucuses and Montana Association of Fish and Wildlife Biologists**

6:30 **Poster Session and Plenary Speaker Social**

Thursday February 1, 2018

Contributed Papers: Bull Trout

Moderator: Leo Rosenthal

8:00 **Announcements**

8:10 **Brown Trout and the Conservation of Native Salmonids,** Robert Al-Chokhachy (U.S. Geological Survey)

8:30 **Non-native Species Management and Control (or other involving native trout issues and management),** W. Ladd Knotek (Montana Fish, Wildlife & Parks)

8:50 **Evaluation of Tradeoffs Among Bull Trout Life-history Traits,** Tracy Bowerman (Salish Kootenai College)

9:10 **Not All Streams are Created Equal: Towards an Understanding of Remnant Native Salmonid Assemblages in Neighboring Headwater Streams,** Jason Blakney (Montana Fish, Wildlife & Parks)

9:30 **Break**

Contributed Papers: Nonnative Species Management (Lakes and Reservoir)

Moderator: Lisa Eby

9:45 **Evaluation of Suppression Methods Targeting Nonnative Lake Trout Embryos in Yellowstone Lake,** Nathan A. Thomas (Montana State University)

10:05 ****Laboratory Evaluations of Lake Trout Embryo Suppression Methods for use in Yellowstone Lake,** Alex Poole (Montana State University)

10:25 ****Locating Lake Trout Aggregations in Yellowstone Lake to Improve Suppression Efficacy,** Jacob R. Williams (Montana State University)

10:45 **Preservation of Threatened Bull Trout in Glacier National Park,** Vin D'Angelo (U.S. Geological Survey)

11:05 ****Feasibility of Suppressing a Non-native Walleye Population in Buffalo Bill Reservoir, Wyoming,** Daniel Kaus (Montans State University)

11:30 **Business Lunch (Affiliate Membership Discussion)**

Contributed Papers: Nonnative Species Management

Moderator: Dan Mahony

2:00	****Patterns and Limits of Smallmouth Bass Distribution in the Upper Yellowstone River,** Nicholas Voss (Montana State University)
2:20	**Aquatic Invasive Species (AIS) Risk Management at a Local Level: The Whitefish AIS Management Program,** John Muhlfeld (River Design Group, Inc.)
2:40	**Evaluating Basin-scale Trout Recruitment in a Recovering River and Implications for Restoration,** Nathan Cook (Montana Fish, Wildlife & Parks)
3:00	**Where the Two Corners Meet,** David Schmetterling (Montana Fish, Wildlife & Parks)
3:20	**Break**

Contributed Papers

Moderator: Tom McMahon

3:35	**Spatio-temporal Dynamics of Introgressive Hybridization in River Systems,** Marty Kardos (University of Montana)
3:55	**The Continued Loss of Non-hybridized Westslope Cutthroat Trout: New Methods and Tools to Aid Conservation and Management,** Ryan Kovach (U.S. Geological Survey)
4:15	****Effects of Invasive Hybridization on Spawning Dynamics in Yellowstone Cutthroat Trout Across a Gradient of Environmental Conditions,** Kurt Heim (Montana State University)
4:35	**American White Pelican (*Pelecanus erythrorhynchos*) Predation of Upper Smith River Fisheries,** Katie Vivian (Montana Fish, Wildlife & Parks)
5:00	**End Session**
5:30	**Student Mentoring Session & Fish Trivia**
6:00	**Evening Social**
7:00	**Awards Banquet and Raffle**

Friday Feburary 2, 2018

Contributed Papers

Moderator: David Schmetterling

8:00	**Announcements,** Ertel
8:10	**Floodplain Connectivity Analysis: A Tool for Restoration,** Selita Ammondt (River Design Group, Inc.)
8:30	****Drought-Driven Changes in Migration Distance and Responses in Recruitment of the Bear Lake Strain of the Bonneville Cutthroat Trout,** Haley Glassic (Montana State University)
8:50	**Where the Two Corners Separate!,** Chris Clancy (Montana Fish, Wildlife & Parks)
9:10	**Cessation of Cattle Grazing Brings About Rapid Stream and Riparian Recovery in the Upper Jocko River Drainage,** Craig Barfoot (Confederated Salis and Kootenai Tribes)
9:30	**Break**

Contributed Papers

Moderator: Lauren McGarvey

9:45	**Fish Response to Contemporary Timber Harvest Practices in a Second-growth Forest,** Robert Gresswell (U.S. Geological Service, Northern Rocky Mountains Science Center)
10:05	**French Gulch & Moose Creek Restoration Case Study,** Matt Barnes
10:25	**Spring Creek Management and Restoration to Promote Climate and Drought Resiliency,** Jim Lovell (Confluence Consulting, Inc.)
10:45	**Big Spring Creek: From Meandering Stream to Ditch and Back Again,** Clint Smith (Montana Fish, Wildlife & Parks)
11:05	**Adjourn! Adios, Thank you for coming and safe travels.**

Plenary Speaker Abstract and Biographies

Getting Things Done in the Bitterroot

Mike Jakober, U.S. Forest Service, Bitterroot National Forest, MT, mjakober@fs.fed.us

The fisheries program on the Bitterroot National Forest has always been closely linked with Montana Fish, Wildlife, and Parks throughout my entire 23-year career on the Forest. I really don't know any other way to operate. We share common databases, survey sites, field collection methods, equipment, and technicians. This is largely due to the combined efforts of three persons (Chris Clancy, Rick Swanson, and Gary Decker) who built the aquatics program in the Bitterroot from the ground up in 1989-1990. The original focus of the program was to collect data in reference and managed streams that showed the relationship between different levels of forest management (i.e. roads and timber harvest) and fish populations and watershed health. Once that task was completed, we just continued to work together. Over time, we have become even more closely integrated as budgets and work forces have declined. For a small workforce like ours, integration is critical for maximizing our efficiency. It also makes our jobs more enjoyable.

About the speaker

My name is Michael Jakober, and I have been a fisheries biologist on the Bitterroot National Forest for the past 23 years. After graduating from high school in 1981, I spent the next nine years in the U.S. Air Force as a Chinese Mandarin linguist. I received a bachelor's degree in Wildlife Biology-Aquatics from the University of Montana in 1992, and a master's degree in Fish and Wildlife Management from Montana State University in 1995. On the Bitterroot, much of my career has been involved with fire and post-fire fishery response.

Fostering Public Resource Conservation on Private Lands: A 20-year Multi-jurisdictional Story

Carter G. Kruse (Turner Enterprises, Inc.), Bozeman, MT 59718, carter.kruse@retranches.com

Turner Enterprises, Inc. (TEI) is a land management and conservation organization with a mission to manage Turner lands in an economically sustainable and ecologically sensitive manner while promoting the conservation of native species and their habitats. Together with the Turner Endangered Species Fund, TEI has implemented successful efforts to restore and conserve species as diverse as Rocky Mountain gray wolves, cutthroat trout, prairie dogs and Chupadera spring snails, with an emphasis on private lands. We implement projects that are multidisciplinary, collaborative, and guided by the principles of conservation biology. Success requires working closely with state and federal agencies, universities, other conservation organizations, and zoological institutions. From our beginning we have believed that wrapping many minds around problems leads to durable solutions. Further, given the high profile and legal status of the imperiled species we target, working closely with state and federal agencies is not only good practice, but requisite. From receiving permits to technical advice and support, our relationships with government agencies have been supremely important. These relationships have been established and then successful with mutual interest, hard work, consistency, honesty, open communication, longevity, thick skin, and, of course, financial assistance. With examples from our Cutthroat Trout Initiative we discuss what has ultimately led to successful implementation of large scale, cross jurisdictional conservation projects on Turner Ranches and surrounding public lands.

About the speaker

Carter has been with the Turner organization since June of 2000. He currently serves as the Director of Conservation and Coordinator of the Turner Biodiversity Divisions for Turner Enterprises, Inc. He earned a B.Sc. in Wildlife and Fisheries Sciences from South Dakota State University in 1993, and M.Sc. and Ph.D. in Zoology from the University of Wyoming in 1995 and 1998, respectively. Prior to joining the Turner organization, Carter worked for the Federal Energy Regulatory Committee. As a Senior Scientist with the Turner organization, Carter coordinates science, research, and conservation planning activities on Turner Ranches. He oversees a diverse array of natural resource related projects ranging from native species conservation to habitat restoration to water rights and permitting. Current conservation efforts include work on Rio Grande and westslope cutthroat trout, Blandings turtle, prairie wetlands, desert bighorn sheep, arctic grayling, prairie birds, and riparian restoration. Carter has co-authored several book chapters and technical articles, and has served as affiliate faculty at Montana State University, Idaho State University, and New Mexico State University. Inspired by the natural wonders around us, Carter's professional motivation is quite simple – *"To keep every cog and wheel is the first precaution of intelligent tinkering"* (Aldo Leopold, A Sand County Almanac).

Cactus and the Case for Open Toed Shoes

Mark Reller, Bonneville Power Administration Helena, MT, mdreller@bpa.gov

Working across jurisdictional boundaries is the norm for the Bonneville Power Administration as it implements the Northwest Power Act's mitigation requirements along with the Reasonable & Prudent Alternatives required under the Endangered Species Act for listed and threatened species.

BPA owns and operates over 15,000 miles of high voltage transmission lines that span Montana, Oregon, Washington, Idaho, and parts of Nevada & Wyoming. As a Power Marketing Authority, it sells the electricity generated at the Federally owned dams on the Columbia and its tributaries, collectively known as the Federal Columbia River Power System (FCRPS). Decisions regarding such a far flung and complex system are routinely scrutinized by a diverse set of constituents.

This talk is intended to provide an overview and update of the of BPA's statutory mitigation obligations, a summary of the BPA's mitigation successes, a review of the status of the various hydropower operations for anadromous fish & resident fish, the Columbia River System Operation Environmental Impact Statement now underway, the Columbia River Treaty negotiations and a general overview of the changing utility world. The talk will also include how BPA sets rates for the power products it sells and how a part of the revenue generated is allocated to meet Fish & Wildlife obligations.

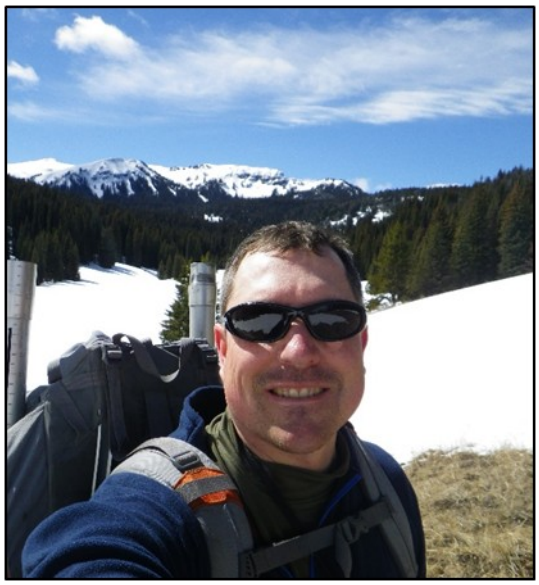
Approaches for Planning and Coordinating Multijurisdictional Fisheries Projects

Clint Sestrich, U.S. Forest Service, Gallatin Custer National Forest, Livingston, MT, csestrich@fs.fed.us

Fisheries projects spanning multiple jurisdictional boundaries are inherently more complex than those occurring on lands managed by a single entity. For example, project planners may have difficulty navigating the discrepancies in environmental compliance requirements and jurisdictional and management authorities among cooperating agencies. Moreover, with increasing complexity of implementing interagency projects, comes increased potential for logistical and operational challenges that may negatively affect project success. Here we present successes, challenges, and lessons learned from approaches used to facilitate coordination among multiple agencies in planning and implementing the Soda Butte Yellowstone Cutthroat Trout Restoration Project in southwest Montana. These approaches include: preparing a memorandum of agreement to document agency commitments, roles, and responsibilities; drafting a single environmental assessment that simultaneously satisfies compliance requirements of all participating agencies; and utilizing the incident command system to safely and efficiently coordinate interagency nonnative fish removal efforts.

About the speaker

Clint Sestrich was born in Anaconda, Montana, but after the shutdown of the Anaconda smelter in 1980 his family relocated to Chinook, Montana where he graduated high school. Clint received his B.S. degree from Montana State University in 1999 and returned there to receive his M.S. in Fish and Wildlife Management in 2005. His graduate thesis assessed changes in native and nonnative fish assemblages and habitat following the 2000 Bitterroot fires. Clint has worked as a fisheries biologist for the U.S. Forest Service for 14 years. Currently, he works for the Custer Gallatin National Forest in Livingston, Montana. His geographic area of responsibility spans much of the historic range of Yellowstone cutthroat trout in Montana including the Gallatin, Absaroka, Beartooth, Crazy, and Pryor mountain ranges. Clint finds reward in working with partners to achieve common goals, especially those focused on conserving and restoring native Yellowstone cutthroat trout populations. Time spent working seasonally for the Montana Department of Fish, Wildlife and Parks and the U.S. Fish and Wildlife Service has given him perspective that has helped build productive interagency partnerships. He sees education for all ages as a cornerstone of aquatic resource conservation and is actively engaged in a wide variety of aquatic education activities including youth fishing days. Clint most enjoys spending time in the outdoors with his wife and three kids.



Native Fish Conservation in Yellowstone National Park

Todd M. Koel, National Park Service, Yellowstone National Park, WY 82190, todd_koel@nps.gov

Actions to conserve native fish in Yellowstone National Park (YNP) are guided by a Native Fish Conservation Plan completed in 2010. This plan provides a park-wide, twenty-year vision for preservation and restoration activities. At the heart of the plan is an adaptive management strategy wherein desired conditions are specified for key native fish resources. On Yellowstone Lake, an aggressive gillnetting program is underway to suppress nonnative Lake Trout and recover the native Yellowstone Cutthroat Trout and the ecosystem they support. Nearly 400,000 lake trout were killed in 2017, with >1.8 million removed over the past six years. Partnership with Trout Unlimited, Greater Yellowstone Coalition, National Parks Foundation, the Yellowstone Forever Foundation and others has provided for substantial financial and logistical support of the program each year. The USGS, Montana State University and several other agency and university partners continue to support the suppression program via conducting critical research on lake trout movement patterns, locating spawning areas, developing new alternative methods to kill the lake trout embryos on the spawning sites, and assessing impacts of suppression methods on lake ecology. The program is guided by an annual scientific panel review of research, conservation actions, long term monitoring, and population modeling results. Cutthroat Trout are showing strong signs of recovery as a result. Outside of the Yellowstone Lake Ecosystem, YNP is taking actions to preserve the Yellowstone Cutthroat Trout of the Lamar and lower Yellowstone Rivers, and restore native Westslope Cutthroat Trout and fluvial Arctic Grayling to watersheds in the Gallatin and Madison river drainages. These conservation actions are strongly supported by state and federal agency and Turner Enterprises biologists who work hand-in-hand with YNP to complete large, logistically complex projects in remote locations. Reintroductions of native species are due to dedicated support by the Sun Ranch and Drake Associates; and the MTFWP Big Timber and Anaconda Hatcheries. These collaborative efforts to successfully recover native fish populations have resulted in positive stories and press that supports important fund-raising efforts for the YNP fish program overall, including the killing of lake trout in Yellowstone Lake.

About the speaker

For 17 years Todd Koel has led the Native Fish Conservation Program for Yellowstone National Park. Previously he was a fish component leader for the Long-Term Resource Monitoring Program of the Upper Mississippi River System and held positions with the Illinois Natural History Survey and the Minnesota DNR. Todd received his BS Biology from Minnesota State University-Moorhead in 1991; MS Zoology from North Dakota State University in 1993; and Ph.D Zoology from NDSU in 1997.

Bison Conservation Across Jurisdictional Boundaries: It is not too late to preserve a native species in Greater Yellowstone

Rick Wallen, Team Leader, Bison Ecology and Management Program, Yellowstone National Park, WY 82190, rick_wallen@nps.gov

Bison conservation has a long and storied history with constituents exhibiting a wide range of values for conservation. Values range from considering bison as competitors and nuisance species to revered native species and icon of prairie wildlife. The history of the great contraction and the fight to restore bison is long and controversial, from 30 million to 2 dozen and back from the brink of extinction. Now we have wild bison preserved in nature reserves across the continent and domestic bison raised for profit and zoological display. The conservation history began with collaboration and partnerships but if you read the newspapers today you often find conflict and litigation. The Yellowstone experience includes partnership with other state and federal agencies and more recently has included numerous tribal organizations. The conservation values are so diverse that all constituents who engage have difficulty finding common interests and often revert to winner take all perspectives. The issues facing managers today include abundance and distribution targets, jurisdiction, legal designations, hybrids, effective population size, restoration techniques, and range expansion. Will modern society find a place on our landscape for conservation of this native species? What sort of partnerships will it take to succeed?

About the speaker

Rick has been the leader of the bison ecology program since January 2002. After completing a graduate degree in Fish and Wildlife Management at Montana State University he worked seasonal jobs with Grand Teton National Park, Idaho Fish and Game and Wyoming Game and Fish. He has worked as a career staff biologist for the National Park Service since 1989 at Grand Teton National Park, Redwood National and State Parks and Yellowstone National Park.

Contributed Paper Abstracts (in order of presentation)

Guides, Outfitters, and Biologists: Working Together for the Resource

Brant Oswald, Guides for Conservation, Livingston, MT, brant@brantoswaldflyfishing.com
Sean Blaine, Guides for Conservation
Whitney Tilt, Guides for Conservation

In recent years, Montana's rivers and their aquatic resources have seen a growing number of challenges: earlier and lower streamflows, warm water temperatures, invasive species, demands from agricultural and municipal users, and increasing recreational traffic. Fishing guides and outfitters recognize that our livelihoods depend on the health of the public resource on which we operate, and the 2016 PKD outbreak and subsequent emergency closure on the Yellowstone was a wakeup call to the fishing industry that business as usual will not suffice.

Presently, there are minimal qualifications to become a professional fishing guide in Montana. Most guides receive minimal formal training and current guide schools cover only basic skills. The purpose of this presentation is to introduce a "Guides for Conservation" program to provide advanced education to fishing guides to increase practical skills and competence, ethical behavior, and in particular, science-based knowledge of fisheries, watershed health, and water-related community issues.

Potential positive outcomes include

•Demonstration of the commitment of guides, outfitters, and the fly fishing industry to the conservation of aquatic resources

•Better communication and reduced conflicts between the outfitting/guiding community and other stakeholder groups

•Development of a program to train guides in data collection protocols.

•Provide guides with current, accurate scientific information, so they can act as a conduit of that information to the public

The input of fisheries professionals—particularly on the content and structure of the curriculum—is critical to the success of the "Guides for Conservation" concept.

Advancing Engagement with Contemporary Anglers: Crowdsourcing Creel Data

Adam Strainer, Montana Fish, Wildlife & Parks, Helena, MT, astrainer@mt.gov
David Schmetterling, Montana Fish, Wildlife & Parks

Traditional creel surveys connect fisheries management strategies and angler success, but advancements in web-based or mobile application technology may allow for more angler participation. Montana Fish, Wildlife and Parks (FWP) began an angler driven creel program, the Fishing Log Program, in 1951 using crowdsourced angling data from across the state for both popular and lesser known waterbodies. Anglers requested a data log annually, recorded basic data about each outing (i.e. time fished, species caught, measurements, etc.), and submitted their log to FWP for analysis each year. Reports, based on program participant data, were generated yearly for program participants and data from the program was available for use by agency staff at their discretion. Despite a dedicated following by a relatively small group of anglers over the years, the program has been underutilized by anglers and agency staff alike. The program was suspended in late 2017 and is currently under consideration for an upgrade to meet the needs of today's anglers and fisheries managers. Considerations like web-based data applications, mobile applications, and social media are increasingly necessary and must be investigated to reinvigorate interest and secure a future for the program. This investigation asks the question: Is a contemporary angler crowdsourcing tool needed and what realistic, cost-effective options, separately or in combination, are available to meet angler and agency needs.

Paddlefish life history: advances and applications in design of harvest management regulations

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In the past decade, advances in our understanding of paddlefish life history have provided additional insight into what is needed for sustainable harvest management of this long-lived species. Recovery of known-age fish in some stocks has enabled stock assessment biologists and managers to not only validate ages of individual fish, but to begin to validate the entire life histories. A framework for potentially recruited paddlefish life history can be broken into five stages: Lifespans in more northern stocks tend to be 2-3 times longer than southern stocks. Natural mortality is also typically lower in northern stocks. These differences necessitate fundamentally different harvest management strategies among stocks. Consistent with recommendations for other long-lived freshwater and marine species, harvest management strategies should be planned to retain some prime spawning females in the population. In many localities, paddlefish management has been developed based on minimum size limits. This approach can provide some conservation benefits, but should optimally be pursued at levels adequate to retain larger, older fish (especially females) in the population. In addition to these biological considerations, the ecological consideration of sporadic or episodic recruitment in many stocks makes steady-state harvest models unrealistic, and necessitates harvest to be appropriately matched to recruitment rates, or events.

Evaluation of Portable, Field-based eDNA Approaches

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Environmental DNA (eDNA) has improved detection probabilities for rare and cryptic aquatic invaders but the lab-based methods for eDNA analyses slow opportunities for rapid response. Effective approaches that address this analytical bottleneck and improve capacity for rapid response are urgently needed. We tested the sensitivity of a portable, field-based eDNA approach relative to lab-based eDNA analyses for detecting invasive Northern pike (Esox lucius; pike) in eight lakes in Alaska's Kenai Peninsula. The portable, field-based approach takes ~ 1 hr from sample collection to final results and uses a field-based DNA extraction, a shelf-stable assay, and a portable real-time PCR thermocycler. The lab approach takes days to weeks for final results and uses a lab-based DNA extraction, a lab-bound assay, and a benchtop real-time thermocycler. We found that the portable, field-based approach was less sensitive than lab-based approaches and was more prone to inhibition, thus increasing the potential for false-negatives. Until sensitivity and inhibition issues can be resolved, this portable, field-based approach is best viewed as a complement to rather than a replacement of standard eDNA lab-based analyses.

Proliferative Kidney Disease in Montana

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An outbreak of proliferative kidney disease (PKD) in the Yellowstone River, Montana in 2016 resulted in a large kill of mountain whitefish (Prosopium williamsoni), a multi-week closure of 180 river miles to all recreation, and lost business revenue. While the causative agent of PKD – the myxozoan parasite Tetracapsuloides bryosalmonae – had been reported in remote areas of Montana previously, little is known about this parasite in the West. To improve knowledge about T. bryosalmonae distribution in wild fish and waters in Montana, we developed novel molecular detection assays to detect this parasite in fish tissue and in environmental water samples. We then used these assays to determine the presence and prevalence of T. bryosalmonae in wild fish sampled from rivers in central and western Montana in 2016 and 2017. We are currently taking a population genetics approach to determine if distinct genetic variants of T. bryosalmonae exist and, if so, examine the relationship of this genetic variation with biogeographical patterns, fish infections, and disease outbreaks.

Do habitat attributes influence the relationship between native trout abundance and eDNA concentrations in northwest Montana?

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Native trout populations are becoming increasingly vulnerable to interactions between large-scale natural and anthropogenic disturbances. Rapid and cost-effective tools that allow managers to monitor populations at corresponding scales are therefore needed. Whereas environmental DNA (eDNA) ostensibly could be used to assess population abundances, considerable variability exists in the relationship between eDNA concentration and fish abundance, limiting its use as a monitoring tool. We therefor investigated how habitat and environmental attributes influence this relationship between eDNA concentrations and fish abundances. We simultaneously quantified eDNA concentrations and abundances of westslope cutthroat (Onchorhynchus clarki lewisi) and bull trout (Salvelinus confluentis) in four tributaries to the Clearwater River. In addition, we concomitantly collected habitat and environmental attributes potentially influencing eDNA production, persistence, and transportation. Our results reinforce large variability was present among replicate eDNA samples and in their relationship with fish abundance. Furthermore, several habitat variables moderated the relationship between eDNA concentrations and relative abundance, but varied between species. Whereas eDNA is a powerful tool, its use to precisely estimate fish population abundances in lotic systems will require additional refinement.

Effect of Iodophor use during water-hardening and chilling of eggs during incubation on bone deformity rates of Brook Trout *Salvelinus fontinalis*

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Recent increases in bone deformity (Scoliosis, kyphosis, and lordosis) rates of juveniles from a feral brood stock of Brook trout Salvelinus fontinalis from Crystal Lake Fish Hatchery have been observed. This study was designed to evaluate if bone deformity rates in Brook trout progeny from Crystal Lakes were correlated to water-hardening eggs in 50ppm iodine, chilling eggs during incubation or both variables. Eggs that were water-hardened in iodine and eggs that were water-hardened in lake water were incubated in ambient hatchery water or chilled water at Giant Springs State Fish Hatchery, Great Falls, MT. Survival was calculated at eye-up and hatch with subsequent deformity analysis observed 5d post hatch. Eggs that were not water hardened in iodine and reared in both ambient and chilled water had a significantly ($P < .038$, $P < 0.05$ respectively) better survival rate to eye-up and hatch than those water-hardened in iodine. Inversely, those eggs water-hardened in iodine and chilled during incubation showed significantly ($P < 0.040$) less deformities than all other study groups. Bacterial loadings on eggs were not significant between or amongst groups. No correlation of bone deformities from water-hardening eggs in 50mg/L iodine or chilling eggs was found.

The Assessment of Ultrasound and Plasma Sex Steroid Concentrations to Assign Sex and Stage of Maturity in Wild Burbot

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Burbot (Lota lota) are a popular sport fish in many lakes and rivers across North America. Lake Roosevelt supports the only known native Burbot population with a stable population structure in Washington state. However, stock assessments including the reproductive structure of the population are limited. Burbot do not display sexual dimorphism and spawning periodicity is unknown in Lake Roosevelt. The objectives of this work are to describe gametogenesis and the plasma sex steroid profile in adult Lake Roosevelt Burbot, and assess non-invasive (ultrasound) and less-invasive (plasma sex steroids) tools to assign sex and stage of maturity. Paired blood, gonadal ultrasound images, and gonadal tissue were collected monthly from 12 fish (6 females and 6 males) for 12 months. Plasma sex steroids, testosterone and estradiol-17β, were measured by radioimmunoassay. Gonadal tissue was processed histologically. Gametogenesis and the plasma sex steroid profile were described over an entire reproductive cycle. Sex was identified with 95% accuracy with ultrasound based on gonadal morphology. The tools assessed in this study will be used to assign sex and stage of maturity of wild Burbot, which is essential to understanding population productivity and establishing appropriate harvest limits.

Determining Sex and Stage of Maturity of Hatchery Origin White Sturgeon in the Lower Columbia River, Canada

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Conservation aquaculture has been the main recovery measure since 2001 for endangered White Sturgeon (Acipenser transmontanus) in the lower Columbia River, Canada. Survival of hatchery origin fish has been high, with certain year classes estimated to be in higher abundance than the wild population. Furthermore, disproportionate survival among maternal family groups has led to lower than expected genetic diversity in the hatchery origin population. We assessed sex and stage of maturity of hatchery-origin fish to estimate the proportion of the hatchery population that are contributing to natural spawning. Fish from multiple age classes (age 10-15; n=100) were captured using setlines in 2016 and 2017. As sturgeon are not sexually dimorphic, sex and stage of maturity was estimated using both plasma sex steroids (testosterone and estradiol-17β) and gonadal histology. Histological analysis of gonadal tissue was used as a true measure of sex and stage of maturity allowing for the accuracy of steroids as a non-invasive tool to be determined. Preliminary results indicate that males (>9 years of age) are reaching sexual maturity and could be contributing to annual spawning events. Results from this study are important to evaluating the long-term genetic risks and recovery of the wild population.

Where the two corners meet

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Fisheries professionals across Montana are constantly collecting data. Previously, Fish, Wildlife & Parks data were relegated to regional file cabinets or local computer hard drives, which was unsafe, and limited our ability to share information with one another and with the public. Data we disseminated relied on summaries and, internally, a priori designations of their analyses. To modernize data storage, standardize data collection protocols and facilitate transparency and collaboration, we created a comprehensive statewide fisheries database, known as "Godzilla". Godzilla allows unprecedented access to, and safe storage of, Montana's fisheries information. It was designed to enable future analysis of existing data, because it includes important metadata and archives data in the closet form to how they were collected. We currently have over 70% of all our data in Godzilla, and this represents over 2,000 waters, 60,000 sampling events, 3 million fish records, 70,00 tagged fish, and 1500 redd surveys. Godzilla interfaces with a public facing web application, FishMT, which is our primary tool for communication. Together Godzilla and FishMT replaced existing, outdated systems, and improved how FWP delivers fisheries information to the public. This has been an ambitious project across the state to update obsolete technology, reduce the duplication of effort, and improve our ability to store, analyze and share information.

Brown trout and the conservation of native salmonids

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Non-native brown trout are considered one of the most valued sportfish in Montana. Although generally considered a species confined to lower-elevation, cool-water stream reaches, recent evidence indicates that brown trout distribution is expanding. With this changing distribution there remains growing concerns of the interactions with native bull trout and cutthroat trout. Here we used empirical field studies to investigate the competitive interactions between brown trout and bull trout and cutthroat trout. We combined these results with recent mark-recapture and trend data to consider the implications of further brown trout expansions. Our diet and stable isotope data indicate extensive overlap in forage patterns and trophic position with bull trout and brown trout; these patterns were consistent with data from cutthroat trout. The diet studies in combination with lower cutthroat trout growth rates and survival in the presence of brown trout highlight the potential risks to native salmonids in Montana. Given the socioeconomic importance of brown trout, our results question the need for potential management actions, what are the biggest data gaps to inform management, which actions would be most cost- and ecologically effective, and which ecosystems may be targeted to facilitate robust populations of native salmonids, while still maintaining healthy brown trout populations.

Trout Wars in Western Montana: Concurrent contraction of bull trout (Salvelinus confluentus) and accelerated expansion of brown trout (Salmo trutta) in the upper Clark Fork Basin

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The upper Clark Fork Basin supports numerous migratory bull trout populations, including Montana's strongest remaining fluvial stocks. Despite extensive restoration and protection efforts, these populations face increasing threats posed by changing stream environments and concurrent, accelerated expansion of nonnative trout. In this paper, we highlight the status of migratory bull trout in the Middle Clark Fork, Clearwater, and lower Blackfoot systems near Missoula. Intensive monitoring indicates that the most robust populations in these watersheds have been stable and, in some cases, increasing in abundance over recent decades. However, the overall distribution of bull trout is declining and many of the smaller spawning populations are no longer consistently detectable. Factors associated with these trends include regional changes in temperature and flow regimes, contraction of suitable spawning and rearing habitat, and consistent upstream expansion of brown trout in bull trout core areas. Effective measures to counteract these trends are limited, but possible management actions will be discussed.

Evaluation of Tradeoffs Among Bull Trout Life-history Traits

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Bull Trout exhibit considerable variation in life history traits, including whether individuals migrate or not, and age at migration and reproduction. In turn, these traits can influence demographic rates such as survival. We examined variations in growth and survival rates within and among two Bull Trout populations. Although individual growth rates showed considerable variability, subadult growth rates were generally higher for fish that migrated at a younger age, but survival was lower for these early outmigrants. Using an integral projection model, we used these observed demographic rates to estimate long-term population growth rates (lambda). Different combinations of demographic rates yielded a range of lambda estimates from steeply declining to rapidly increasing. Sensitivity analyses indicated that individual fish growth and early life survival had the greatest influence on lambda. Variations within and among Bull Trout populations likely help buffer populations against environmental stochasticity, but may not be sufficient to safeguard populations against the prolonged effects of habitat degradation and warming stream temperatures.

Not all streams are created equal: Towards an understanding of remnant native salmonid assemblages in neighboring headwater streams

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Prospect Creek is a tributary to the lower Clark Fork River and historical accounts noted it once held significant spawning runs of migratory Bull Trout. Today, resident Bull Trout remain in three headwater streams. Streams in the upper watershed are impaired by past and present anthropogenic stressors including power line corridors, gas pipeline, mining, riparian timber harvest, forest roads, and a forest highway. Given the impacts to the landscape and the sensitivity of native salmonid assemblages in small streams, a better understanding of factors that influence Bull Trout and Westslope Cutthroat Trout distribution and abundance was needed to focus future restoration and land management. In 2016 and 2017, we studied two adjacent streams with differing levels of Bull Trout abundance, Crow Creek and Cooper Gulch. Past redd counts and electrofishing surveys indicate that Bull Trout are relatively common in Cooper Gulch, while the species occurs at lower abundances in Crow Creek. The streams are similar in discharge, temperature, anthropogenic impacts, drainage area, and amount of occupied habitat. Electrofishing surveys were conducted at 20 sites in Crow Creek and at 10 sites in Cooper Gulch. A suite of habitat variables was quantified including discharge, substrate, canopy cover, wetted width, bankfull width, pool/riffle frequency and area, large woody debris, and undercut banks. Stream temperature was recorded at multiple sites in each stream to investigate fine scale patterns. This presentation will cover preliminary findings and outline the response to past restoration by the fish community in Crow Creek and a unique opportunity to supplement Bull Trout.

Evaluation of Suppression Methods Targeting Non-native Lake Trout Embryos in Yellowstone Lake

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Non-native Lake Trout threaten native Yellowstone Cutthroat Trout in Yellowstone Lake, Yellowstone National Park. Suppression of Lake Trout in Yellowstone Lake has been ongoing since 1995, primarily by gillnetting. Bycatch of Yellowstone Cutthroat Trout is associated with this removal method, which targets adult and subadult Lake Trout. Additional methods effective at causing mortality in Lake Trout early life stage(s) could improve suppression effectiveness. Thus the objective of this study was to evaluate the efficacy of methods to increase mortality of Lake Trout embryos. In situ experiments tested the effect of Lake Trout carcass deposition using whole and ground carcasses on embryo mortality. Whole carcasses at a biomass density of 28 kg/m2 caused 99% (0.01 SE) mortality of embryos down to 20 cm in the substrate. Ground carcasses at 14 and 28 kg/m2 caused 100% mortality down to 20 cm and at 7 kg/m2 caused 64% (23.2 SE) mortality at the substrate surface and 99% (0.67 SE) mortality at 20 cm in the substrate. These results suggest, if implemented on a large scale, Lake Trout carcasses placed on Lake Trout spawning substrate may be an effective additional suppression method.

Preservation of Threatened Bull Trout in Glacier National Park

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The U.S. Geological Survey and National Park Service continued our research-based partnership to preserve and protect bull trout Salvelinus confluentus in western Glacier National Park (GNP) by suppressing nonnative lake trout Salvelinus namaycush and rescuing an imperiled bull trout population. In 2015, we began suppressing lake trout in Logging Lake, using methods proven successful in nearby Quartz Lake. As of 2018, gillnetting crews have removed 3,608 lake trout from Logging Lake, including 715 mature fish and 2,893 subadults. We observed yearly declines in catch rates for all mesh sizes and recaptured 27 of 32 (84 %) telemetered spawning adult lake trout while minimizing bull trout bycatch (N = 33; N = 18 mortalities). In 2014, we began to "rescue" bull trout from Logging Lake by establishing a population in Grace Lake, above a natural barrier in the same drainage. To date, 857 bull trout have been moved to Grace Lake (850 age-0 and 7 age-1+) in two major efforts. In 2014-2015, 111 bull trout (104 age-0, 7 age-1, all genotyped) were translocated from Logging Lake, and in 2017, 746 age-0 bull trout spawned from adults captured in Quartz Lake, GNP, arrived via helicopter. From 2014-2017, we recorded five recaptures of bull trout via telemetry and trapnetting and anticipate promising future results as translocation continues through 2019. Monitoring and genotyping of recaptured individuals will enhance our ability to track the vitals signs of this critical population.

Feasibility of Suppressing a Non-native Walleye Population in Buffalo Bill Reservoir, Wyoming

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

Laboratory Evaluations of Lake Trout Embryo Suppression Methods for use in Yellowstone Lake

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Introduced Lake Trout threaten native Yellowstone Cutthroat Trout in Yellowstone Lake, Yellowstone National Park. Gill nets have been used to suppress subadult and adult Lake Trout since 1995. Because survival of embryonic and larval life history stages can have profound effects on population dynamics of Lake Trout, suppression at those stages, especially if used in concert with intensive gill netting of older fish, could enhance suppression efforts. We therefore conducted controlled laboratory experiments to systematically evaluate the effects of a variety of candidate chemical physical, and biological suppression methods on different developmental stages of Lake Trout embryos and larvae. Methods that significantly increased mortality included liquid and powdered rotenone applications, fish carcass and carcass analog exposures, and sediment deposition. Sodium chloride, calcium carbonate, and gelatin applications were not effective. Field evaluation of liquid and powdered rotenone, carcass and carcass analogs, and sediment deposition is warranted to determine potential efficacy in Yellowstone Lake and other waters in the western United States where Lake Trout suppression is desirable.

Locating Lake Trout Aggregations in Yellowstone Lake to Improve Suppression Efficacy

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Suppression of Lake Trout in Yellowstone Lake is a high priority for Yellowstone National Park. Suppression efforts have removed approximately 2.3 million Lake Trout since 1995. Targeting known spawning locations is assumed to increase the efficiency of adult Lake Trout suppression during the spawning season. Historically, it was assumed that Lake Trout spawned at three locations, but recently nine additional spawning sites have been confirmed. Insight into the spawning habits of Lake Trout will be useful for suppression efforts. Lake Trout catch rates tend to be lowest during the summer; thus, targeting aggregations of tagged Lake Trout may increase catch rates during this period. The objectives of the study were: 1) identify locations of tagged Lake Trout throughout the suppression season, 2) identify spawning locations, and 3) evaluate the efficacy of targeting tagged Lake Trout to increase catch rates. Lake Trout (N = 469) were surgically implanted with acoustic transmitters from 2015 through 2017. Tracking resulted in 1,995 detections of 254 individual Lake Trout in 2016 and 2,685 detections of 379 individuals in 2017. Ten putative spawning areas were identified throughout Yellowstone Lake with the highest concentrations of Lake Trout in the West Thumb. Contract netters targeted 34 Lake Trout aggregations identified by telemetry. Targeted areas had higher catch rates indicating tracking Lake Trout during the summer is an effective strategy for increasing catch rates.

**Patterns and Limits of Smallmouth Bass Distribution in the Upper Yellowstone River

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Smallmouth bass are socioeconomically valuable sportfish that have been introduced worldwide. They were stocked in the Yellowstone River near Miles City, MT and in its Tongue and Bighorn River tributaries from the 1960s through the early 1990s. Smallmouth bass were thought to be limited to the Yellowstone River's warmer waters downstream of Billings, but recent observations of adults as far upstream as Livingston and Emigrant elicit concern, and indicate that the factors limiting their upstream extent of establishment (i.e., successful recruitment) in rivers are not well understood. We documented the presence and size of age-0 smallmouth bass by sampling with fyke nets in side channels during the summers and autumns of 2016 and 2017 to determine the upstream extent of their establishment in the Yellowstone River. We used these data to infer the likelihood of age-0 overwinter survival, which has been hypothesized to be a critical life-history bottleneck in other northern-latitude water bodies. We found age-0 smallmouth bass as far upstream as Big Timber in 2016, and Reed Point in 2017. Individuals captured near Reed Point were ostensibly long enough to overwinter in both years, but fewer individuals captured farther upstream were likely to survive. We will next test the hypothesis that overwinter age-0 survival as mediated by summer growth limits upstream establishment in the Yellowstone River.

Aquatic Invasive Species (AIS) Risk Management at a Local Level: The Whitefish AIS Management Program

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Whitefish Lake is a highly prized recreational waterbody located at the headwaters of the Columbia Basin and provides municipal drinking water to the community of Whitefish. An Aquatic Invasive Species (AIS) infestation in Whitefish Lake could impact the local economy, affect water quality and native aquatic species, jeopardize municipal drinking water infrastructure, and increase the potential for infestations in downstream waterbodies via drift.

Whitefish Lake Institute and the City of Whitefish have managed a local AIS Management Program since 2013 to prevent the introduction and spread of AIS to local lakes. Each year, the City of Whitefish has approved the program and has provided a funding commitment. The program focuses on early detection monitoring for dreissenid mussels and Eurasian watermilfoil (EWM). In 2017, the watercraft inspection program was amplified based on the Montana Fish, Wildlife & Parks' announcement in late 2016 that zebra

mussels were found east of the Continental Divide. The City of Whitefish passed an Ordinance requiring watercraft to be inspected prior to launch in Whitefish Lake and signed a Memorandum of Understanding with the State of Montana for program operations.

This presentation provides an overview of the 2017 program, lessons learned, and the challenges facing local municipalities in the wake of the 2016 zebra mussel introductions.

Investigations into water quality parameters affecting rotenone toxicity to fish

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The labels for liquid rotenone require that bioassays be conducted prior to use to determine the performance (toxicity) of rotenone in the waterbody which is being treated. While water temperature and particulate matter are well known to modify toxicity, the extent to which chemical constituents affect toxicity is poorly understood. Acute toxicity tests were conducted on rainbow trout using surface water from five sites across central Montana with varying water chemistry in order to identify chemical parameters which modify toxicity. Tests were run for 24-hours, allowing calculation of 4, 8 and 24-hr LC50 values as a means of comparing waters. Toxicity was greatest in water from Belt Creek (0.072, 0.046 and 0.043 mg/L CFT Legumine for 4, 8 and 24-hr exposures) and lowest in water from Crow Coulee (0.14, 0.12 and 0.12 mg/L, respectively for the same concentrations). Chemical parameters potentially responsible for reduced the toxicity include alkalinity, conductivity, sulfate and dissolved organic content (DOC). Further testing may seek to test additional waters and to isolate parameters which contribute to toxicity.

Evaluating basin-scale trout recruitment in a recovering river and implications for restoration

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Hard-part microchemistry is a powerful tool that can be used to determine natal origins and recruitment sources of fish. We collected otoliths from juvenile Brown Trout (Salmo trutta) from 4 mainstem and 19 tributary sites in the UCFRB identified as potential spawning locations in a previous radio telemetry study. We conduced laser ablation inductively coupled plasma mass spectrometry to measure otolith strontium isotope (87Sr:86Sr), Sr:Ca, and Ba:Ca ratios. Juvenile Otolith measurements were strongly correlated with measurements of these ratios in the water from nearby sites. A discriminant function analysis (DFA) correctly classified juvenile fish otoliths to the site of capture 79% of the time. The resulting DFA was then applied to microchemistry data from the natal portions of otoliths from 299 Brown Trout of various ages collected in the mainstem Clark Fork River to determine their natal locations. Results indicated that 59% of the fish captured in the mainstem had natal locations in tributaries. Fish from the mainstem tended to originate from tributaries near their location of capture. Contributions of individual tributaries to the

mainstem population varied widely and were often unexpected given the number of ratio tagged adults that made spawning movements into these tributaries during the telemetry study. This new recruitment information is being used to prioritize restoration and identify potential factors limiting trout numbers in the Clark Fork River.

Spatio-temporal dynamics of introgressive hybridization in river systems

Marty Kardos,
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Gordon Luikart

Introgressive hybridization with introduced species threatens the persistence of numerous native fish populations. Evaluating the threat of nonnative hybridization depends on understanding how admixture is expected to progress through time. We used individual-based, spatially explicit, genomic simulations parameterized with life history characteristics similar to westslope cutthroat trout to evaluate the temporal dynamics of hybridization in a river system with a 100 km mainstem and 10 tributaries, each with N=400 fish. Nonnative fish were stocked at the downstream end of the river system for 10-50 years. We investigated the effects of natural selection against nonnatives and hybrids and the dispersal characteristics of nonnatives on admixture at 100 years, and the time to 'genomic extinction' (defined as the absence of genetically pure native fish in the river system). The time to genomic extinction of the native species (from the entire river system) was on average >40 years after non-native introduction in all simulated scenarios, including no selection against non-natives, equal dispersal (straying) rates for native and admixed fish, and with heavy stocking consisting of 800 fish annually for the first 50 years. Strong natural selection against non-native genes, and barriers to dispersal of highly admixed fish substantially slowed the progress of admixture and delayed genomic extinction. These results show that populations of genetically pure native fish in headwater streams are likely to eventually become admixed in river systems where nonnative fish are present in the main stems, even with selection against introgression and incomplete physical barriers to nonnative dispersal.

The Continued Loss of Non-hybridized Westslope Cutthroat Trout: New Methods and Tools to Aid Conservation and Management

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Hybridization between rainbow trout and westslope cutthroat trout remains a significant conservation problem throughout Montana. We describe cost-effective genomic advances that improve our ability to describe hybridization at individual and population scales, and to accurately identify emerging threats (e.g., source populations) to remaining non-hybridized westslope cutthroat trout populations. We focus on the Flathead River basin, where we quantified recent admixture (2015 and 2016) between westsope cutthroat trout and rainbow trout across ~2500 individuals from 70 locations genotyped at ~600 species diagnostic

loci (SNPs). Rainbow trout admixture is now occurring in many locations that were previously non-hybridized, and highly admixed fish are more frequently encountered in headwater stream reaches throughout the river basin. Also evident is the genomic extinction of multiple populations in the lower river basin. Future work will use genomic data to identify emerging source populations in the upper basin, and thus, potential areas where suppression efforts may be needed. Simultaneously, ongoing projects in other river basins (Swan and Blackfoot) point to the continued loss of non-hybridized westlope populations in interconnected river basins west of the continental divide. Together, these data emphasize (1) that hybridization remains a critical threat to the persistence of westlope, and (2) the continued importance of genetic data for fish conservation and management in Montana. With this in mind, we are developing an interactive web-tool for communicating and visualizing hybridization data, the intent of which is to improve how biologists and managers can access and use genetic data for decision-making.

Effects of Invasive Hybridization on Spawning Dynamics in Yellowstone Cutthroat Trout Across a Gradient of Environmental Conditions

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Hybridization with Rainbow Trout (RBT) is threatening the continued persistence of Yellowstone Cutthroat Trout (YCT), and is expanding into former strongholds in Yellowstone National Park. Identifying environmental and genetic factors leading to hybridization, and genetically characterizing spawning populations, is a priority for management. We estimated the location and date of spawning for 273 trout with known genotypes in the Lamar River drainage. Populations of YCT in the upper drainage displayed peak spawning in mid-June, whereas spawning in hybrid populations lower in the drainage peaked in May. All but one hybrid population also contained YCT with undetectable RBT admixture. The two populations with the highest admixture were found in small tributaries conducive to early spawning success of hybrids; one is intermittent (flows April – June) and the other is inaccessible except during peak-flow in May. In contrast, hybrids spawned as late as early-July in mainstem locations where early spawning is a poor strategy. Spawning timing was linearly related to individual admixture, but fish of all genotypes displayed high variation that appeared to be influenced by local hydrology. Selective removal of hybrids from mixed populations is a promising management option that may allow YCT to increase in numbers. Preventing RBT and hybrids from colonizing small tributaries where early spawning phenotypes may be successful should also be considered a management priority.

American White Pelican (*Pelecanus erythrorhynchos*) Predation of Upper Smith River Fisheries

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Passive integrated transponder (PIT) tags from Montana Fish, Wildlife and Parks and Montana State University fishery projects have been recovered from American white pelican nesting islands within the Missouri River drainage. Over the past 28 years, white pelican populations have increased dramatically

within central Montana. At Canyon Ferry Reservoir, nest counts have improved from 13 in 1989 to 1,610 in 2016. To estimate potential tag loss by pelican predation, 811 fish were tagged in the Smith River in March and April 2017. To calculate an ingested tag recovery rate, 110 PIT tagged deceased hatchery trout were fed to pelicans on the Missouri River. Scanning of pelican nesting islands at Canyon Ferry Reservoir and Arod Lake returned 39 of the 811 wild fish tags and 8 of the 110 hatchery fed tags. Correcting for the estimated detection probability and recovery rate, white pelicans exert a 4.4% to 12.3% minimum predation rate and a 23.6% to 66% total annual predation on fish within sections of the Smith River. Studies by the Idaho Department of Fish and Game, of which this study is based on, estimated similar white pelican total annual predation rates (>20% to 60%) in the Blackfoot River drainage. Based on this survey, pelican predation on the Smith River is a contributor to tag loss from FWP and MSU studies. However, as our conclusions are based on one year of data collection, further research is required to better understand pelican predation on fish in the Smith River.

Floodplain Connectivity Analysis: A Tool for Restoration

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Stream and floodplain connectivity is an important indicator of ecosystem health in riparian environments. Well-functioning floodplains improve water quality; provide pathways for flood attenuation, nutrient and sediment retention and exchange; and provide diverse plant, wildlife, and aquatic habitat. Floodplain disconnection has occurred with human alterations to riparian habitat. Reactivation of floodplains can restore natural floodplain functions and ecosystem benefits.

Through analysis of Light Detection and Ranging data and stream bankfull indicators, we can examine stream and floodplain connectivity and identify ecosystem restoration opportunities and constraints. This approach has been applied in systems impacted by agriculture and mining. We highlight the effectiveness of this analysis for stream restoration on Flint Creek, Spotted Dog Creek, and Ninemile Creek in western Montana, and Dan Lee and Jim Brown Creeks in north-central Idaho.

We found that for floodplain vegetation, which is a proxy for riparian health and function, floodplain elevation relative to stream bankfull is a practical predictor of potential plant community composition. In addition, for systems impaired by channelization and flow diversions, floodplain connectivity analysis can identify historical channel locations that have the potential to be reactivated during restoration. Overall, this approach provides a foundation for understanding the structure and function of diverse floodplains.

Drought-Driven Changes in Migration Distance and Responses in Recruitment of the Bear Lake Strain of the Bonneville Cutthroat Trout

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Multiyear drought is projected to increase in frequency and duration in arid and semiarid regions across the world, threatening native species and ecosystem function. The effects of multiyear drought are often exacerbated by human water use, which, in lentic ecosystems, manifest in reduced lake elevation causing altered aquatic connectivity. Here, we demonstrate that decreasing lake elevation, associated with drought

and water management, increases tributary channel distance by creating an elevation-explicit tributary channel distance map. We combined long-term fish catch data and a lake elevation time series with our elevation-explicit map to model whether Bear Lake Bonneville Cutthroat Trout recruitment is related to drought-driven changes in tributary channel distance. As lake elevation decreased >6 m from full pool to the lowest historical elevation, tributary channel distance increases up to 400%. Adfluvial Bear Lake Bonneville Cutthroat Trout recruitment declined by as much as 62% during periods of drought and increased tributary channel distance. Our results quantify a relationship between lake elevation and hydrologic connectivity and demonstrate the effect of connectivity on ecologically important fish species. We demonstrate the need to understand the effects of climate and protracted drought on aquatic ecosystems and provide a methodological framework for quantifying drought effects on tributary-lake connections.

Where the Two Corners Separate!

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Strategies for learning from failure are a popular and healthy topic in the business world. Working in the complex world of "biology in the field" can lead to failures, largely due the fact that many factors that affect our project/action are unknown. I review some projects that could be argued are failures and describe some of the lessons learned from them. Stream restoration projects, management actions, recommendations based on data and studies that lacked a useful conclusion are included. Failed projects often teach us more than successful ones. As scientists we should be willing to openly present and discuss "failure" in a constructive manner.

Cessation of Cattle Grazing Brings About Rapid Stream and Riparian Recovery in the Upper Jocko River Drainage

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In 2001 the Confederated Salish and Kootenai Tribes (Tribes) began a multi-year National Environmental Policy Act (NEPA) process to examine livestock grazing levels and associated impacts in the upper Jocko River drainage. The analysis was conducted on a roughly 32,000-acre forested range unit. In addition to providing 1,800 animal unit months (AUMs) of season-long grazing, the landscape within the range unit supported important cultural, recreational, environmental, wildlife, and fisheries values and resources, including several animals listed under the Endangered Species Act. A livestock forage inventory showed that the range unit was greatly overstocked and that vegetation in open meadows and small forest openings was dominated by introduced grasses and noxious weeds. Riparian and wetland health assessments indicated widespread physical damage to streambanks and moist soils, and heavy use of riparian-wetland shrub communities. The outcome of the years-long NEPA process was the Tribes' decision to eliminate livestock grazing from nearly two-thirds (about 21,000 acres) of the range unit by shifting AUMs to two large upland parcels in the lower drainage. We will describe the lengthy, difficult, and unique process and the opportunities and creative thinking that led to the Tribes' decision and allowed for management changes.

We will also present early results from photo-point monitoring and quantitative stream and riparian health inventories, which indicate relatively rapid recovery following cessation of grazing. This recovery will be contrasted with an adjacent drainage where season-long grazing is ongoing and where stream and riparian conditions continue to degrade.

Fish Response to Contemporary Timber Harvest Practices in a Second-growth Forest

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We used a paired-watershed approach to investigate the effects of contemporary logging practices on headwater populations of coastal cutthroat trout and juvenile coho salmon in a second-growth Douglas-fir forested catchment in Oregon. Stream habitat and fish population characteristics were assessed over a 9-year period (4 years pre- and 5 years postlogging). The logged catchment was located on private industrial forestland and had been previously logged in 1966. The reference catchment was covered by an unharvested, fire-regenerated forest approximately 150 to 160 years old. A single clearcut harvest unit of the upper 40% of the treatment catchment was implemented following current forest practice regulations, including the retention of riparian buffer of standing trees adjacent to fish bearing channels. No statistically significant negative effects on coastal cutthroat trout or coho salmon occurred following logging, and in fact, both late-summer density and total biomass of age-1+ coastal cutthroat trout increased in the logged catchment following logging. Increases in age-1+ coastal cutthroat were greatest closest to the harvest area and declined downstream as distance from the logged area increased. In contrast to the previous timber harvest in the catchment when few logging regulations existed, current forest practice regulations appear to have reduced acute negative effects on coastal cutthroat trout.

French Gulch & Moose Creek Restoration Case Study

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We will present the restoration on portions French and Moose Creek and how it supports the fisheries goals in the Mount Haggin WMA. This area was mined extensively resulting in large remnant tailings piles. These piles resulted in a confined French Creek without connection to a functioning floodplain and lack of fluvial complexity. Sinuosity of the existing stream was near 1.0 and the average floodprone width was less than 22'. At the Moose Creek site remnant mining impacts were less severe but still inhibited floodplain connection.
Reaches were identified for reference and varying levels of restoration based on the degree of impacts. Over 100 surveyed cross sections of the stream were analyzed with 1D modeling to determine channel dimensions. The restoration areas were also modeled to determine shear stress values and approximate particular areas requiring increased stability and roughness to withstand up to the 4% AC flood. Pre and post project data were used to estimate percent reduction in sediment load in tons/year for TMDL allocations.

Areas of additional remnant tailings removal were identified during construction and completed to increase flood storage and riparian connection to French Creek. Construction was completed in fall 2016 ahead of schedule and under budget. Monitoring of stream response has been complete in 2017, a prolonged runoff year, with pre, design, and post-projects data for comparison.

Spring Creek Management and Restoration to Promote Climate and Drought Resiliency

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Climate change, drought, and land management practices can dramatically reduce the quantity and quality of water in Montana's streams and rivers. This adversely affects cold water organisms like trout and grayling, and the recreational and agricultural economies that rely on high quality, cold water. Proactive measures are needed to mitigate thermal pollution and preserve Montana's cold-water resources. Spring creeks are natural sources of cold, clean water, serving as thermal refugia and moderating temperatures in receiving water bodies. Consequently, spring creeks can play a critical role in climate and drought resiliency planning. A spring creek restoration project near Dillon, Montana, incorporated a several management and restoration actions to mitigate thermal impacts. Preliminary monitoring results indicate the project successfully reduced high summer stream temperatures in the Beaverhead River. Ongoing temperature and flow monitoring will evaluate the relative efficacy of these temperature mitigation measures for potential application to other locations.

Big Spring Creek: From Meandering Stream to Ditch and Back Again

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In 1961, a 5,000-foot section of Big Spring Creek near Lewistown was straightened into a 2,000-foot ditch. A hard lesson followed, with severe erosion, habitat degradation, river instability, and public outcry among the many impacts. The section became a continual point of degradation and has required extensive bank stabilization, replacement of a highway bridge, and the reconstruction of a large irrigation diversion. The substantial impacts and public costs resulting from the straightening, in addition to the public outcry, eventually led the Montana Legislature to enact the Natural Streambed and Land Preservation Act of 1975, also known as the 310 Law.

Coordinated efforts to restore the straightened section began in 2003. For the next 14 years multiple government entities, private landowners, and interest groups worked to develop a restoration plan, create a design, and raise funds to return the section to a natural meander pattern with a functioning floodplain. The project was plagued with multiple stops, starts and setbacks. The strength of the partnerships and commitment of the involved parties eventually saw the project through to completion during the winter of 2016/17. The resulting restoration project is a testament to the greater good that can be achieved by working together towards a shared vision.

Poster Abstracts

Using Forensic Geochemistry to investigate an Illgeal Fish Introduction

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Niall Clancy

Illegal fish introductions create some of the most challenging and frustrating problems for resource managers because of their potential to harm existing recreational fisheries, impact species of conservation concern, and jeopardize fishery resources. Compounding this problem is the fact that once illegally introduced fish have established reproducing populations there may be little managers can do to reverse the action. In this study, we used forensic geochemistry via fish otoliths to investigate an illegal Walleye introduction in Swan Lake, Montana, which provides critical habitat for threatened Bull Trout and supports a popular sport fishery for Kokanee Salmon and native Westslope Cutthroat Trout. Core to edge geochemical profiles of 87Sr/86Sr and Sr/Ca ratios in the Walleye otoliths revealed that these fish had been introduced to Swan Lake only a few months prior to their capture and their geochemical signature matched that of Walleye present in Lake Helena, Montana. This information confirms that Walleye reproduction has not yet been detected in Swan Lake and provides law enforcement with valuable information that would improve the chances of a conviction. This research highlights application of a tool fisheries managers can use to identify the natal waterbody source of illegally introduced fish. We hope that this forensic geochemical approach and strong penalties for those individuals convicted will reduce the prevalence of future illegal introductions.

Analysis of illegal fish introductions in Montana

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Samuel Bourret

In freshwaters, illegally introduced fishes have caused a decline in biodiversity and imperiled native species. While many states have increased preventative measures, illegal fish introductions continue to hamper native species management in many places. Thus, the ability to predict where illegal introductions are most likely to occur could be extremely useful in stopping the spread of illegally introduced fishes or in preventing such introductions in the first place. Using a database of 281 illegal fish introductions compiled by Montana Fish, Wildlife & Parks (FWP), we analyzed the composition of introductions within each of FWP's seven regions. In summary, illegal introductions were largely composed of warmwater species with 19.2% of all introductions being northern pike (Esox lucius), 18.9% yellow perch (Perca flavescens), 7.8% pumpkinseed (Lepomis gibbosus), and 5.7% largemouth bass (Micropterus salmoides). Additionally, comparison of 1) waterbody surface area 2) distance to the county seat and 3) distance to the nearest major highway for all stillwaters in Region 1 showed significant selection by 'bucket biologists' for larger bodies of water near major highways and county seats. As such, preventative measures such as warning signs, game warden patrols, and sampling for illegally introduced fish should be more heavily implemented for such waters.

Use of eDNA to monitor the abundance of spawning Yellowstone Cutthroat Trout in tributaries to Yellowstone Lake

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Invasive Lake Trout (LKT) have greatly reduced the abundance of native Yellowstone Cutthroat Trout (YCT) in Yellowstone Lake, Yellowstone National Park, thereby disrupting its ecosystem. In response, gill nets have been used to suppress subadult and adult LKT since 1995 to restore YCT to pre-LKT conditions. Standardized gillnet CPUE, angler catch per hour, and abundance of adult spawners ascending tributary streams in the spring are used annually to monitor YCT recovery; 9 to 11 tributaries are visually surveyed weekly from May through July for the presence of spawning fish. Because many spawning tributaries are remote and difficult to traverse, only a small fraction of tributaries is being assessed (YCT spawn in the upper Yellowstone River drainage and 60 tributaries around the lake). A more efficient, cost-effective method is needed for monitoring YCT spawning tributaries, particularly in remote areas. Environmental DNA (eDNA) sampling has become increasingly common and may provide managers with a more efficient tool for estimating abundances of spawning fish. We collected eDNA samples throughout the YCT spawning seasons in 2016 and 2017 from 5 or 6 tributaries and compared results to concurrent samples taken with traditional methods such as visual surveys, electronic counter tubes, and sonar imagery. Preliminary results from 2016 samples were inconclusive and indicated that variables not included in the analysis affected the amount of eDNA present in the tributaries. Samples from 2017 are currently being analyzed.

Understanding spatial uncertainty in aquatic telemetry studies: using received signal strength to estimate telemetry error

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Telemetry error is often not considered in aquatic studies. When considered, it is treated as a fixed value (e.g. 10 m) for all detections in a dataset; however, fieldwork considerations often preclude consistency in accuracy. We describe a simple procedure to use received signal strength (RSS) to estimate telemetry error. We found RSS to be an excellent predictor of distance-to-transmitter (R2 = 0.98 – 0.96) for ground-based tracking and a fair predictor (R2 = 0.47 – 0.59) for aerial tracking using controlled experiments. With calibrated models, RSS from field-collected telemetry locations can be used to first predict distances-to-transmitter, then use those estimates to represent locations as spatial confidence areas. Importantly, these spatial confidence areas are sized according to the RSS of each detection, recognizing that telemetry error is not constant. Expressing telemetry locations with spatial error facilitates more repeatable, structured, and

robust analysis of movement and habitat use. Additionally, we tested how length of transmitter antenna influenced power output, and found that factory length antennas performed poorly relative to shorter ones. While these experimental results are specifically calibrated to our equipment and study area (transmitters, antennas, environmental conditions, etc.), this procedure could be conducted as a regular part of telemetry studies to optimize equipment, train fieldworkers, and guide treatment of telemetry error.

Estimating Detection Probability of PIT Tags Consumed by White Pelicans to Improve Inferences in Fish Movement and Avian Predation Studies

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Avian predation on wild fish populations is receiving an increasing amount of attention from fisheries and wildlife managers. Often, recovery of indigestible tags is used as a method to estimate predation rates. While researchers can estimate predation rates by searching for tags on pelican nesting colonies, a proportion of tags may go undetected. During summer 2017, we sought to estimate detection probability of passive integrated transponder (PIT) tags deposited on American white pelican (Pelecanus erythrorhynchos) nesting colonies and determine what factors influence whether PIT tags are found. We hid 100 small (12 mm) and 100 large (32 mm) PIT tags in all combinations of 5 habitat types (willow, shrub/nettle, water, sand/mud, and cobble/gravel) and 2 burial depths (surface or buried 2-4 cm deep). We found 78 of 200 PIT tags resulting in an overall detection probability of 0.39 (95% CI = 0.36 – 0.42). There was little difference in detection based on depth. Large PIT tags were more likely to be found than small tags, but the effect of tag size depended on habitat. We were most likely to find tags hidden in gravel habitats, regardless of tag size. Low detection in vegetated habitats (willow and shrub) may require increasing search effort in these areas or using smaller antenna hoops to better penetrate the vegetation. Increasing the proportion of PIT tags found will influence estimates of predation and could affect inferences in fish movement and avian predation studies.

Aquatic Invasive Species in Flathead Lake

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Aquatic invasive species pose a serious threat to native species due to their ability to dominate new environments, altering ecosystem function. Aquatic invasive species are a long-running concern in Flathead Lake and on the Flathead Indian Reservation in Western Montana. Flowering Rush, *Butomus umbellatus*, an invasive macrophyte, can form dense colonies in previously unvegetated substrata, altering habitat for native Cutthroat and Bull Trout populations that require open water to spawn. Predators of native trout, such as non-native Northern Pike, prefer dense stands of aquatic vegetation for spawning and as cover for ambushing prey. Due to the increase in Northern Pike habitat caused by the introduction of flowering rush in the Flathead Lake ecosystem, the need for early detection, monitoring, and eradication of flowering rush has become increasingly important for the recovery of native fish in Flathead Lake. Monitoring of submerged aquatic vegetation (SAV) can employ different methods due to the challenges

encountered within submerged aquatic environments. This study was conducted to repeat portions of a 1985 hydroacoustic survey estimating SAV in East Bay of Flathead Lake to determine cover changes since the introduction of flowering rush, and to examine the appropriateness of four different methodologies (hydroacoustic, rake fullness, underwater video, and snorkel surveys), for measuring SAV in similar bays. The repeated hydroacoustic survey estimated 70.1% macrophyte cover in East Bay, a significant increase from the 1985 survey estimation of 17.6% macrophyte cover. Hydroacoustic and underwater video methods were found to be the most appropriate techniques for measuring SAV.

Life History Variation in Non-Native Brook Trout

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The presence of invasive Brook Trout (Salvelinus fontinalis) in the Western United States can have negative repercussions for native fishes. One potential explanation for the widespread success of Brook Trout across their non-native range is a high degree of life history plasticity, possibly allowing individuals to adjust their phenotype to environmental conditions faced in novel streams. An understanding of variation in life history strategies and population demographics of Brook Trout in creeks with varying habitat characteristics will enable more effective modeling that can be used in future efforts to eradicate established populations.

I conducted a pilot analysis of life history traits, such as size and age at maturity, of Brook Trout populations in three creeks within the lower Pend Orielle River system in Washington. The creeks varied in habitat size, productivity and connectivity to the main stem. Fish were dissected to determine sex and stage of maturity, and otoliths were extracted and aged. We predicted that individuals in the smallest, most isolated creek would tend to have earlier age at maturity, and smaller size at age. We observed the predicted shift in size at maturity. We will also present otolith-based age data. We intend to expand this work to additional western Brook Trout populations to understand phenotypic variation as it relates to the spread of this invasive species.

Lake Trout Suppression to Restore Cutthroat Trout in Yellowstone Lake

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Introduced Lake Trout (*Salvelinus namaycush*), first discovered in 1994, have negatively impacted native Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouveiri*) in 34,000 ha Yellowstone Lake, Yellowstone National Park. Suppression of the Lake Trout population via an aggressive gillnetting program continues for the conservation of Yellowstone Cutthroat Trout and to restore the natural ecology of the ecosystem. Suppression efforts in 2017 were predominantly focused in the West Thumb, Breeze Channel, Frank Island and South Arm areas with high abundance of Lake Trout. A total of 397,000 Lake Trout were removed in 2017. Over 2.8 million have been removed since 1994, with more than 1.9 million (68%) removed since 2012 due to a large surge in netting effort over the past six years. Recruitment to small mesh (1-1.5 inch

bar measure) contributed to 54% of total catch in 2017. Large mesh (1.75+ inch bar measure) had an 18,000 fish decrease in catch with a 17% increase in effort compared to 2016. Models indicate a steady decline in biomass of large adult Lake Trout within Yellowstone Lake, from ~450,000 kg to ~300,000, from 2012-2016. Long-term monitoring indicates that Yellowstone cutthroat trout abundance is improving but remains below desired conditions. Recently there has been an increase in spawning fish and bears feeding on them in spawning tributaries. These are strong signals that the ecosystem is responding positively to the large scale removal of the predatory Lake Trout.

Airborne Lidar Detection and Mapping of Invasive Lake Trout in Yellowstone Lake

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Airborne lidar has been shown to be a useful tool for detecting and profiling fish, primarily in the open ocean, and can be used to locate groups of fish. The data produced are similar to what would be obtained from a traditional acoustic echosounder, and thus can be used to identify possible spawning sites in a manner similar to that done with acoustic tracking. The use of airborne lidar to survey fisheries is not a new idea but has not been extensively applied in freshwater environments. In this study, we investigated the applicability of this technology to identifying invasive Lake Trout (*Salvelinus namaycush*) in Yellowstone Lake, Yellowstone National Park. Results of experimental trials conducted in 2004 and in 2015-16 provided lidar data that identified groups of fish coherent with current knowledge and models of Lake Trout spawning sites, and one identified site was later confirmed to have Lake Trout. Using airborne lidar for locating Lake Trout allows large areas to be rapidly mapped at reasonable cost. A typical flight can map 80 km of water per hour with a 5 meter swath. We found that airborne lidar can be successfully employed for searching and locating large-bodied fishes in large freshwater lakes and it is a promising tool for fisheries managers and researchers.

Whirling Disease in Native Cutthroat Trout Two Decades After Detection in Yellowstone Lake

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The exotic parasite *Myxobolus cerebralis* was first detected in adult Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouveiri:* YCT) in Yellowstone Lake in 1998. The impact of whirling disease

on YCT, when combined with the threat posed by invasive Lake Trout, could have drastic, negative effects. In response, studies of the mechanisms, prevalence, and locales of the infection were initiated. Between 1999 and 2005, cages with YCT fry were placed in the Yellowstone River and 12 tributaries of Yellowstone Lake for 10 days and tested for presence of *M. cerebralis*. In addition, juvenile and adult YCT collected from sites across the lake were tested. In 2012 and 2017, the procedure was repeated on 10 of these tributaries and an additional 12 others. Of the 22 tributaries tested, Pelican Creek continues to be the only stream with consistently high prevalence and severity of *M. cerebralis* infection. Samples of YCT collected lake-wide continue to vary among years with the prevalence of infection ranging from 19.6% in 1999, 10.0% in 2012, and 16.5% in 2017. Spatially, the prevalence of infected YCT samples is higher in the northern region of Yellowstone Lake near Pelican Creek, where nearly half of all infected fish within the lake were found in 2017. Over the past 20 years the overall prevalence and spatial extent of *M. cerebralis* within the Yellowstone Lake ecosystem has remained relatively stable. The (fortunate) lack of expansion of *M. cerebralis* across spawning tributaries should mitigate the overall effect of this disease on Yellowstone Lakes YCT population.

A Comparison of Methods for Aging Redside Shiners

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Redside shiners (Richardsonus balaetus) were illegally introduced into Green Canyon Lake, Granite County, Montana in the 1980s. They currently dominate the fish community composition and are highly abundant. We sought to determine redside shiner population structure in this productive system as a first step to evaluate the feasibility of different eradication and suppression actions. Previous studies have used thin sectioned otoliths to age redside shiners. Given the short and productive growing season in Green Canyon Lake, we hoped to find a faster yet reliable way to assess ages of redside shiners than thin sectioned otoliths. This study seeks to validate whether scales, whole otoliths, or polished otoliths are viable aging alternative to thin sectioned otoliths. We trapped redside shiners from Green Canyon Lake in June and extracted both sagittal otolith and removed scales dorsal of the lateral line. A subset of individuals were used to compare among methods where: (1) whole otoliths were either thin sectioned or polished and then imaged; (2) and several scales were cleaned, mounted. All images were sent to at least two independent observers for aging. Estimated ages and certainty were compared across the different otolith and scale techniques.

A Tale of Two Lakes

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Pat Bigelow, Yellowstone National Park
Chad Whaley, Grand Teton National Park
On the surface, Yellowstone Lake and Jackson Lake appear to have much in common. Both lakes are located within the boundaries of National Parks and are only 27 miles apart as the crow flies; both contain populations of native Cutthroat Trout (CT); and non-native Lake Trout (LKT). However, the fisheries within these lakes are quite different as is their management. Biologists on Yellowstone Lake have been, and are currently, undertaking intensive efforts to remove LKT from the system while no efforts are being made to this end in Jackson Lake. This apparent contradiction has caused a great deal of confusion from anglers and visitors in regards to the importance of the native CT fishery and the effectiveness of LKT suppression. There are many reasons for the contrast in management but these reasons are not easily recognized by or available to interested individuals. We hope to clarify some of these differences and provide a better understanding to anyone who is seeking answers to this tale of two lakes.

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