Colorado/Wyoming Chapter
American Fisheries Society

Managing Fisheries in a Changing Climate

2020 Annual Meeting

Laramie, Wyoming
February 25 - 27, 2020

PROGRAM

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Schedule at a Glance

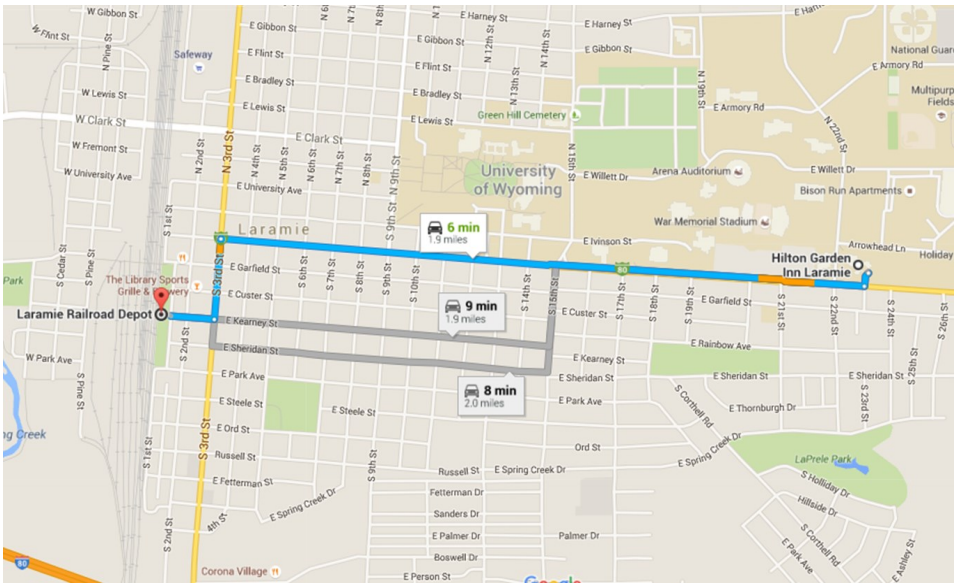
Time	Event	Location
Tuesday, February 25		
8:30 AM - 12:00 PM	Continuing Education: Project Wild	Grand Ballroom (Salons C/D/E)
12:00 PM - 1:00 PM	Lunch - on your own	
1:00 PM - 5:00 PM	Continuing Education: Project Wild	Grand Ballroom
1:00 PM - 5:00 PM	Continuing Education: Ecological Sampling and Study Design	Salons A/B
5:00 PM - 7:00 PM	Registration and Presentation Download	Grand Ballroom Lobby
6:00 PM - 10:00 PM	Welcome Social	UW Gateway Legacy Hall and Atrium
Wednesday, February 26		
7:00 AM - 5:00 PM	Registration and Presentation Download	Grand Ballroom Lobby
8:00 AM - 8:20 AM	Welcome, Presidential Message and Introduction to the Opening Session by Jason Burckhardt	Grand Ballroom (Salons C/D/E)
8:20 AM - 9:40 AM	Opening Session "Managing fisheries in a changing climate"	Grand Ballroom
10:00 AM - 11:50 PM	Contributed Papers	Grand Ballroom
12:00 PM - 1:30 PM	Lunch - on your own	
1:30 PM - 3:30 PM	Contributed Papers	Grand Ballroom
3:50 PM - 4:50 PM	Poster Session	Salons A/B
6:00 PM - 6:30 PM	Student Mentoring Presentation and Job Fair	Laramie Train Depot
7:00 PM - 8:00 PM	50th anniversary of the CSU Student Subunit	Laramie Train Depot
6:30 PM - 10:00 PM	Student-Hosted Social	Laramie Train Depot
Thursday, February 27		
7:00 AM - 5:00 PM	Registration and Presentation Download	Grand Ballroom Lobby
8:00 AM - 11:20 AM	Contributed Papers - Concurrent Sessions	Salons A/B/C/D/E
11:30 AM - 1:20 PM	Business Meeting Luncheon	Salons A/B
1:20 PM - 4:50 PM	Contributed Papers - Concurrent Sessions	Salons A/B/C/D/E
6:00 PM - 10:00 PM	Awards Banquet and Raffle	Grand Ballroom

Socials

Welcome Social - Come kick off the annual meeting from 6PM - 10PM on Tuesday, February 25 at the UW Legacy Hall located in the Marian H. Rochelle Gateway Center (across S. 22nd Street from the Hilton Hotel). Free beer and a light meal will be provided.

Student-Hosted Social - Hosted by the University of Wyoming Student Subunit

When: Wednesday, February 26
Location: Laramie Train Depot (see map below)
Transportation: Shuttle will run from the Hilton to the Train Depot and back from 5:30 PM to 10:00 PM
6:00 PM - 6:30 PM: Student Mentoring Presentation and Job Fair
7:00 PM - 8:00 PM: 50th anniversary of CSU Student Subunit Celebration
6:30 PM - 10:00 PM: Food and Free Beer



Banquet - The Banquet will be held on Thursday from 6:00 PM to 10:00 PM in UWCC Grand Ballroom. Free beer and wine will be provided and a cash bar will also be available. Everyone is invited to the social, auction, and raffle. A banquet ticket (included with registration) is required for the dinner. Dinner will be served at 6:30 PM.

Raffle - Be sure to check out the great auction and raffle items on display. Raffle tickets will be on sale throughout the meeting in Salons F/G. Cash and credit cards will be accepted.

AGENDA

Wednesday, February 26

8:00 - 8:20 **Jason Burckhardt** Welcome, Presidential Message, and Introduction to the Plenary

Plenary: Managing Fisheries in a Changing Climate

See pages 11-12 for biographies of plenary speakers

***Room:* Grand Ballroom (Salons C/D/E)**

Moderator: Jason Burckhardt

8:20 - 8:40	**Bryan Shuman** Recent Wyoming temperature trends, their drivers, and impacts in a 14,000-year context
8:40 - 9:00	**James Hurrell** The science of global climate change
9:00 - 9:20	**Annika Walters** Implications of climate change for Colorado and Wyoming fishes
9:20 - 9:40	**Scott Bonar** The climate change challenge: A call for action to the American Fisheries Society
9:40 - 10:00	BREAK

Session 1: Fish Movement

***Room:* Grand Ballroom (Salons C/D/E)**

Moderator: Rick Henderson

10:00 - 10:20	**Koreen Zelasko** Passive detection data aid estimation of Razorback Sucker *Xyrauchen texanus* survival rates
10:20 - 10:40	**Gabriel Barrile** Buy high, sell low: an ecological investment strategy for population stability in a wild amphibian
10:40 - 11:00	**Yoichiro Kanno** Characterizing stream salmonid movement at multiple spatial scales in northern Japan
11:00 - 11:20	**John Fennell** Exploring mechanisms underlying the persistence of Yellowstone Cutthroat Trout despite hybridization in the North Fork Shoshone River drainage
11:20 - 11:40	**Matthew Fairchild** The Poudre River Headwaters Project: Evaluating fish passage at a bedrock falls in the Wild & Scenic Cache la Poudre River
11:40 - 11:50	**Erin Leonetti** Yellowstone Cutthroat Trout passage in Timber Creek
12:00 - 1:30	LUNCH - on your own

Session 2: Fish Culture Innovations

***Room:* Grand Ballroom (Salons C/D/E)**

Moderator: Wayne Hubert

1:30 - 1:50	**Brad Welch** Wyoming Game and Fish kokanee captive brood stock
1:50 - 2:10	**Alysia Henderson** Improving early survival in Tiger Trout using triploidy
2:10 - 2:30	**Collin Farrell** A preliminary assessment of adult diploid and triploid Walleye in Narraguinep Reservoir, CO.
2:30 - 2:50	**Guy Campbell** Yellowstone Cutthroat Trout brood infusion
2:50 - 3:10	**Tawni Riepe** Comparison of tissues for the detection of *Renibacterium salmoninarum*, the causative agent of Bacterial Kidney Disease
3:10 - 3:20	**Tawni Riepe** Horizontal transmission of *Renibacterium salmoninarum* among inland hatchery-reared trout
3:20 - 3:30	**Sean McAlpin** Dan Speas Fish Hatchery fish quality assessments

Wednesday, February 26 - Continued

3:30 - 3:50	BREAK	
3:50 - 4:50	Poster Session	Salons A/B
6:00 PM - 6:30 PM	Student Mentoring Presentation and Job Fair	Laramie Train Depot
7:00 PM - 8:00 PM	50th Anniversary of the CSU Student Subunit	Laramie Train Depot
6:30 PM - 10:00 PM	Student-Hosted Social	Laramie Train Depot

POSTERS

Yoichiro Kanno (professional) "Recent invasion by Mosquitofish and status of native plains fishes in Arikaree River, eastern Colorado"

Jacob Chambers (student) "Patterns in the length-weight relationships in Black Crappie and White Crappie"

John Cleveland (professional) "Better understanding utilization of upper Colorado River basin tributaries by native fish using PIT tag technology"

Katrina Cook (student) "Habitat selection of a relictual amphibian population threatened by disease"

Bradlee Cotton (student) "Evaluating potential flushing flows on the Lower Shoshone River"

Audrey Harris (student) "Gene flow and spatial structure of non-native Brook Trout in the Long Draw area of the upper Cache la Poudre River basin"

Kevin Alexander (professional) "Ultraconserved genomic elements provide a phylogenetic perspective on the evolution of the chloroperlid stonefly genus *Suwallia* (Insecta: Plecoptera: Chloroperlidae)"

Christopher Lee (student) "Discovering the fingerprints of a Burbot"

Greg Lehr (professional) "Past, present and future: The 100 year history of Daniel Fish Hatchery"

Braxton Newkirk (student) "Linking density, diet, and habitat use to trophic polymorphism in age-0 Yellow Perch"

Jaide Phelps (professional) "Sulfur stable isotopes as a tool to detect consumption of stocked prey in Wyoming reservoirs"

Ashleigh Pilkerton (student) "Sediment and fisheries: Quantifying impacts of sediment releases from Willwood Dam"

Ashleigh Pilkerton and Will Rosenthal (students) "Spatiotemporal patterns of hybridization of Walleye and Sauger in the Bighorn and Wind River Sauger populations"

Jake Ruthven (student) "Evaluating the effects of Brook Stickleback on native nongame fishes in the Bighorn and North Platte drainages, Wyoming"

Dana Shellhorn (professional) "Monitoring Rio Grande Sucker and Chub populations with PIT tags"

Darrel Snyder (professional) "Illustrations depicting larval and juvenile development of Flathead Chub"

Darrel Snyder (professional) "Guide to Most Cypriniform Fish Larvae and Early Juveniles of the Middle Rio Grande, New Mexico, and Upper Rio Grande, Colorado"

Alissa Tiemann (student) "Evaluating movement patterns of Roundtail Chub and Flannelmouth Sucker in the Blacks Fork Subbasin"

Matt Webster (professional) "'Dude! Where's my pond?!' Evaluating the role of beaver activity in pond

Thursday, February 27

	Session 3A: Aquatic Invasive Species ***Room: Salons A/B*** ***Moderator: Joshua Leonard***	***Session 3B: Reclamation and Restoration*** ***Room: Grand Ballroom (Salons C/D/E)*** ***Moderator: Kendall Backich***
8:00 - 8:20	**Eric Hansen** Wyoming Game and Fish Department AIS program update	**Ben Felt** East Fork Parachute Creek reclamation: Opportunities and challenges associated with a long-term project to restore Colorado River Cutthroat Trout in a Colorado stream
8:20 - 8:40	**Kevin Gelwicks** Wyoming Invasive Mussel Rapid Response Plans	**Tom Fresques** East Fork Parachute Creek reclamation; beaver dams - lots and lots of beaver dams
8:40 - 9:00	**William Fetzer** Thirty years of dreissenid impacts on lake ecosystem: species and systems matter	**Billy Atkinson** Overview of lotic and lentic chemical reclamation projects in the Yampa River Basin, Colorado
9:00 - 9:20	**Robert Walters** Regional WID Data Sharing System - Utilizing data to reduce risk across the west	**Joe Skorupski** Stepping back to move Forward: Identifying and prioritizing Yellowstone Cutthroat Trout restoration through a collaborative public process
9:20 - 9:40	**Richard Gibbs** Utah Division of Wildlife Resources Lake Powell update	**Steve Gale** A "shallow" understanding of Meeboer Lake
9:40 - 10:00	BREAK	

Thursday, February 27 - Continued

	Session 4A: Species Interactions ***Room: Salons A/B*** ***Moderator: Chris Myrick***	***Session 4B: Where to live?*** ***Room: Grand Ballroom (Salons C/D/E)*** ***Moderator: Ashley Ficke***
10:00 - 10:20	**Dominique Lujan** Lower trophic level responses to Lake Trout suppression methods in Yellowstone Lake	**Zach Wallace** Factors affecting the distribution of amphibians in western Wyoming
10:20 - 10:40	**Jake Werner** Population demographics of Silver Carp in the Lower Kansas River, a larger tributary to the Missouri River	**Evan Booher** Distribution, habitat use, and evaluation of potential managed translocation sites for Finescale Dace in the Great Plains
10:40 - 11:00	**Kurt Fausch** Dolly Varden jaw morphology shifts when together with Whitespotted Charr in Hokkaido streams: Another mechanism for coexistence of close competitors?	**Matt Haworth** Distribution and abundance of fishes relative to environmental conditions and habitat fragmentation in the Cache la Poudre River, Colorado
11:00 - 11:20	**Kevin Rogers** Status and conservation of an undescribed lineage of Cutthroat Trout native to the southern Rocky Mountains	**Robert Zuellig** The past as a predictor: Importance of antecedent flow for explaining ecological trends in an urban Colorado stream
11:30 - 1:20	Business Meeting Luncheon - Salon 3,4/6	
	Session 5A: Improving Approaches **Room: *Salons A/B*** **Moderator: Nick Hoberg**	**Session 5B: Sportsfish** **Room: *Grand Ballroom (Salons C/D/E)*** **Moderator: Elizabeth Krone**
1:20 - 1:40	**Bryan Maitland** Non-lethal approaches for obtaining stable isotope data for diet studies of North American fishes	**Darren Rhea** The use of stationary time-lapse cameras to monitor boat-angler use on large rivers in Wyoming
1:40 - 2:00	**Nathan Barrus** Optimal baselines for stable isotope analyses in stream food webs	**Alexander Townsend** The effect of Selenium on Brown Trout larval deformity and trophic transfer of Selenium in Colorado's aquatic ecosystems
2:00 - 2:20	**Jeff Baldock** Effects of redd superimposition on observer error structure in redd counts: Implications for long-term monitoring of Snake River Cutthroat Trout in Wyoming	**Ben Vaage** Ammonia overload: Measuring the acute and chronic limits of Burbot
2:20 - 2:30	**Kevin Fitzgerald** Daily increments of otoliths aid in understanding early life history of subarctic stream salmonids	**Travis Trimble** Arctic Grayling *Thymallus arcticus* in Wyoming
2:30 - 3:00	BREAK	

Thursday, February 27 - Continued

	Session 6A: Tools for the Job ***Room: Salons A/B*** ***Moderator: John Woodling***	***Session 6B: New Frontiers*** ***Room: Grand Ballroom (Salons C/D/E)*** ***Moderator: Annika Walters***
3:00 - 3:10	**Andrea Taillacq** GAT: Geomorphic Assessment Tool	**Dan Gibson-Reinemer** Rising temperatures and the reorganization of a large river fish assemblage
3:10 - 3:30	**David Bidelspach** Watershed Response Factor: Global implications	**Mark Kirk** Assessing potential climate-induced range shifts for fish species with contemporary and historical data in the North Platte River basin, WY
3:30 - 3:50	**Brian Clarke** Applying the Stream Evolution Triangle and Stream Evolution Model in Colorado	**James Roberts** Influence of changing lake and stream thermal regimes in the Southern Rocky Mountains on Greenback Cutthroat Trout: Insights from dense sensor networks and past conservation efforts
3:50 - 4:10	**Paul Dey** Application of the Wyoming Stream Quantification Tool on Savery Creek, Wyoming	**Nick Hogberg** Using stream velocity and temperature data to model drift and development of embryonic Shovelnose Sturgeon in the Bighorn River, Wyoming
4:10 - 4:30	**Chance Kirkeeng** Improving fish passage on Big Creek	**Samantha Alford** Little fish insist to persist: How colonization and movement dynamics enhance native fish resilience
4:30 - 4:50	**Andrew Treble** Using business intelligence software to analyze and disseminate 'Big Data' in fisheries management	**Lusha Tronstad** Western Glacier Stonefly *Zapada glacier*: Wyoming's first Invertebrate listed under the Endangered Species Act
6:00 - 10:00	Awards Banquet and Raffle	

Plenary speakers

Managing Fisheries in a Changing Climate

Dr. Bryan Shuman, University of Wyoming

Professor, Department of Geology and Geophysics

Bryan Shuman is a professor in the Department of Geology and Geophysics and the director of the Roy J. Shlemon Center for Quarternary Studies. His research groups studies geologic evidence of past environmental dynamics to evaluate processes involved in current and future climate changes. He got his BA at Colorado College, and MS and PhD at Brown University in Geological Sciences. His current work focuses on paleo perspectives on climate change including Rocky Mountain snowpack changes and their hydrologic consequences during the Holocene and causes and consequences of fire-regime variability in Rocky Mountain forests. Ongoing work also focuses on documenting and mapping changes in the levels of lakes throughout North America over the past 15,000 years. Through comparison with vegetation and fire history data, geochemical data, archeological data, and climate model simulations, the results demonstrate patterns of climatic variation and attendant impacts on landscapes and societies.

Dr. James Hurrell, Colorado State University

Scott Presidential Chair of Environmental Science and Engineering

James (Jim) W. Hurrell is the Scott Presidential Chair of Environmental Science and Engineering at Colorado State University. He is a former Director of the National Center for Atmospheric Research (NCAR), where he was also a Senior Scientist in the Climate and Global Dynamics Laboratory (CGD). Jim's research has centered on empirical and modeling studies and diagnostic analyses to better understand climate, climate variability, and climate predictability. He has been extensively involved in the World Climate Research Programme (WCRP) on Climate Variability and Predictability (CLIVAR), including roles as co-chair of the Scientific Steering Group of both U.S. and International CLIVAR. He is currently a member and officer of the Joint Scientific Committee of WCRP. Jim has been involved in assessment activities of the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Climate Change Science Program (CCSP). He has served on several National Research Council (NRC) panels, and he has provided briefings and testimonies to both the U.S. Senate and the House of Representatives on climate science. Currently, Jim serves as the President of the Atmospheric Sciences Section of the American Geophysical Union (AGU). He is a Fellow of the Royal Meteorological Society (2000), the American Meteorological Society (2006), and the American Geophysical Union (2010). In 2011, Jim was honored for his contributions to climate science by giving the Fridtjof Nansen Memorial Lecture to the Norwegian Academy of Science and Letters, where he was also awarded the Nansen Medal.

Dr. Annika Walters, USGS

Assistant Unit Leader and Associate Professor, Wyoming Cooperative Fish and Wildlife Research Unit

Annika Walters is an applied aquatic ecologist with research interests in population and community ecology, fisheries, and conservation biology. She has an undergraduate degree in Ecology and Evolutionary Biology from Princeton University and a MS and PhD in Ecology and Evolutionary Biology from Yale University. She has conducted research on a variety of topics including low flow disturbance, nutrient loading by anadromous alewife, the effects of climate change and water diversion on salmon, and phenology of phytoplankton communities. She and her students are currently working across the state of Wyoming addressing topics related to multiple stressors, fish movement, and native fish conservation. She works closely with agency cooperators to address questions that can help inform the management of fishes and aquatic ecosystems.

Plenary speakers

Managing Fisheries in a Changing Climate

Dr. Scott Bonar, USGS

Unit Leader and Associate Professor, Arizona Cooperative Fish and Wildlife Research Unit

Scott A. Bonar is a Professor of Natural Resources at the University of Arizona and is leader of the U.S. Geological Survey's Arizona Cooperative Fish and Wildlife Research Unit. He has a B.S. in Science Education from the University of Evansville and a Ph.D. in Fisheries from the University of Washington. Bonar has conducted award winning research in natural resources programs of state and federal governments, universities and private industry for over 30 years, authoring over 130 publications on fisheries biology and natural resource communication. His book on communication, The Conservation Professional's Guide to Working with People was called "a must read" by the journal Ecology; "brimming with insights from hands-on experience" by Paul R. Ehrlich, Stanford University Professor and Author of The Population Bomb; and "a guidepost (which) should be a part of college curricula in every natural resources program" by Mamie Parker, former assistant director of the U.S. Fish and Wildlife Service. He was lead editor of Standard Methods for Sampling North American Freshwater Fishes, a best seller of the American Fisheries Society which involved contributions from 284 scientists from over 100 organizations across North America. He is currently President of the American Fisheries Society, the oldest and largest fisheries science organization in the world.

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2020 CO/WY AFS Contributed Papers – Abstracts

By order of presentation followed by posters

Passive detection data aid estimation of Razorback Sucker *Xyrauchen texanus* survival rates

Presenter: Koreen A. Zelasko

Koreen A. Zelasko, Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO, koreen.zelasko@colostate.edu

Kevin R. Bestgen, Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO

Gary C. White, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO

Abstract: Low capture probabilities (< 0.05) hinder the precise estimation of survival rates for endangered Razorback Sucker *Xyrauchen texanus* in the upper Colorado River basin (UCRB). Because those populations are maintained by stocking, reliable evaluations of survival are essential to management. Since 2008, PIT tag antennas have been deployed throughout the UCRB and San Juan River basin to passively document tagged fish. Detections and increased physical captures from intensive sampling were used to determine if more robust estimates of survival were possible. Encounter records of 395,488 stocked Razorback Suckers from 1995 through 2017 were analyzed with the Barker model, in which passively-collected data were incorporated as "resight" events outside the physical sampling occasions. Capture probabilities varied considerably, with lower values in the Green River subbasin (0.01–0.09) than in the Colorado River subbasin (0.02–0.33). Mean capture probabilities were all low for early years of this analysis and the same years in our previous analysis without detection data (1995–2006: 0.07 and 0.03 in this study for first year post-stocking and subsequent years, respectively, compared to 0.06 and 0.05 in the previous study). Resight probabilities increased from zero in 2008 to 0.13 in 2017. Notably, the empirical rate of physical recaptures for the entire study was 3.9%, while detection rate was nearly half that (1.8%) and almost entirely from the most recent five years of antenna use, only 22% of the study period. This analysis supported previous findings that first-year survival was lower than subsequent years and lowest for fish stocked during summer. First-year survival of fish stocked in the Green River subbasin was higher than for those in the Colorado River subbasin, contrary to our previous analysis. The most comparable model between studies resulted in a higher and more precise estimate of survival after the first year (0.85, $CV < 1\%$) compared to 1995–2006 (0.75, $CV = 7\%$). Incorporating passive detection data with physical recaptures provided more robust survival rate estimates necessary to evaluate stocking practices and recovery status for Razorback Sucker and, potentially, other PIT-tagged fishes in large river systems where capture probabilities are low.

Buy high, sell low: an ecological investment strategy for population stability in a wild amphibian

Presenter: Gabriel Barrile

Gabriel Barrile, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, 1000 E University Ave, Laramie, WY 82071, gbarrile@uwyo.edu

Annika Walters, US Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, annika.walters@uwyo.edu

Anna Chalfoun, US Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, achalfou@uwyo.edu

Abstract: The concept of portfolio effects, whereby an aggregate's stability is maintained despite variability in its components, has been recently adopted from economic theory and applied to ecological systems. In environments wherein habitat quality changes predictably, ecological theory predicts mobile animals should track high-quality resources to maximize individual fitness. In such systems, organisms should "sell" (i.e., disperse from) low-quality habitats and "buy" (i.e., colonize) high-quality habitats. "Buying and selling" habitats based on relative quality causes temporal variation in the number of individuals in component habitats, but the aggregate population may remain stable (i.e., portfolio effect). Although "buying and selling" is well-founded in portfolio theory, evaluating this strategy in practice necessitates connecting fine-scale individual movement to broader patterns of population abundance through time, which is seldom accomplished within wild populations. Herein, we use a five-year (2015-2019) mark-recapture dataset of boreal toads *Anaxyrus boreas boreas* in western Wyoming to determine whether individuals "buy and sell" breeding sites based on relative quality, and the potential influence this strategy may have on population stability. Boreal toads displayed strong site fidelity to breeding ponds when habitat remained stable. When habitat changed, however, many individuals dispersed to alternate ponds. Dispersal was associated with increased emergent vegetation at breeding sites, indicative of wetland succession after the breaching of beaver dams and subsequent draining of ponds. By tracking high-quality resources in a shifting habitat mosaic, the aggregate number of breeding individuals remained constant over time despite high variability in each component habitat. Our results provide empirical evidence to support theoretical predictions that individuals "buying and selling" habitats can achieve population stability through time. By developing a better understanding of how behavioral responses to environmental change influence demographic parameters, our study helps integrate individual movement into a more comprehensive theory of portfolio effects in ecology.

Characterizing stream salmonid movement at multiple spatial scales in northern Japan

Presenter: Yoichiro Kanno

Yoichiro Kanno, Colorado State University, 1474 Campus Delivery, Fort Collins, CO 80523-1474, yoichiro.kanno@colostate.edu

Audrey Harris and Kevin Fitzgerald, Colorado State University

Naoki Yui, Kyoto University

Wataru Mamiya, Rei Sakai, Yuri Yabuhara, Tohru Miyazaki, Shunsuke Utsumi, Osamu Kishida, and Hiromi Uno, Hokkaido University

Abstract: We studied movement of a native salmonid, White-spotted Charr *Salvelinus leucomaenis*, in a 1-km tributary in northern Hokkaido, Japan, in May-July 2018. Based on physical mark-recapture of 501 unique individuals and detection by mobile PIT antennas over monthly intervals, a majority of fish (70-80 %) stayed within 60 m of previously-released locations, demonstrating what appeared to be restricted movement patterns. However, fixed PIT antenna data showed that as much as 17% of marked individuals emigrated from the study area during the two-month study period. Probability of emigration did not depend on where in the 1-km segment individuals had been released, indicating that emigration likely

represented long-distance movement. Once emigrants made a decision to emigrate, they left the tributary within 1-3 median days by moving downstream in a unidirectional manner, based on detections at a total of three antenna arrays deployed throughout the tributary. Body size and condition explained probability of movement at some spatial scales, but not others. Our multi-scale analysis provided strong support for co-existence of short- and long-distance movement patterns, and we conclude that movement data at multiple spatial scales complement each other to characterize population-scale movement.

Exploring mechanisms underlying the persistence of Yellowstone Cutthroat Trout despite hybridization in the North Fork Shoshone River drainage

Presenter: John Fennell

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Annika Walters, U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, Laramie, WY

Catherine Wagner, Biodiversity Institute, Department of Botany, University of Wyoming, Laramie, WY

William Rosenthal, Department of Botany, University of Wyoming, Laramie, WY

Abstract: Interactions with introduced species constitute a significant threat to the long-term persistence of ecologically- and economically-important native fishes. Within the North Fork Shoshone River drainage, genetically-pure Yellowstone Cutthroat Trout persist despite extensive hybridization with non-native Rainbow Trout. Our research aims to identify the mechanisms underlying the maintenance of Yellowstone Cutthroat Trout populations in the North Fork Shoshone River; specifically, we ask whether temporal segregation exists in spawn timing between Yellowstone Cutthroat Trout, Rainbow Trout, and their hybrids. Two tributaries to the North Fork Shoshone River, Trout Creek and Middle Creek, were selected as study sites given results from previous research on the extent of hybridization within the drainage. In-migrating adults were captured, tagged with passive integrated transponder (PIT) tags, and fin-clipped to determine hybrid status using genetic sequencing. On Middle Creek, average migration timing of Yellowstone Cutthroat Trout started four weeks later than Rainbow Trout and hybrids. While no difference in initial migration timing was observed between phenotype groups on Trout Creek, PIT tag movement data showed that Yellowstone Cutthroat Trout remained in Trout Creek an average of three weeks longer than Rainbow Trout and hybrids. These results suggest that temporal segregation in spawn timing may act to maintain pure Yellowstone Cutthroat Trout populations despite sympatry with Rainbow Trout. Ongoing work aims to determine the roles water temperature and stream flow have on spawn timing in these populations. Our results have implications for fisheries management in this drainage and will add to a growing body of literature investigating the persistence potential of native fishes despite the introduction of non-natives.

The Poudre River Headwaters project: Evaluating fish passage at a bedrock falls in the Wild & Scenic Cache la Poudre River

Presenter: Matthew Fairchild

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Audrey Harris, Department of Fish, Wildlife, and Conservation Biology, Colorado State University
Julian Scott and Dan Cenderelli, National Stream and Aquatic Ecology Center, U.S. Forest Service

Abstract: The isolation management approach to native Cutthroat Trout recovery in the western U.S. relies on physical channel features, natural or constructed, to preclude invasion of non-native salmonids from target habitat patches. The Poudre River Headwaters project aims to employ isolation management through a series of barriers and non-native salmonid removal in order to restore South Platte-origin Greenback Cutthroat Trout throughout 37 miles of headwater habitat in Rocky Mountain National Park and the Roosevelt National Forest. While the effort will enhance and construct up to five barrier features through course of the project, here we focus on fish passage evaluation and design modeling of the terminal barrier for the 37 mile habitat patch, located in the Wild & Scenic designated portion of the Cache la Poudre River. Our evaluation couples a mark-recapture fish movement study with stream discharge, flow models in the context of channel topology, and known probabilistic models of Brook Trout jumping performance. In 2018, we began a three-year study to detect fish moving upstream through the bedrock falls by releasing 705 adult trout implanted with passive integrated transponder (PIT) tags in river reaches downstream of the terminal barrier and deploying a series of radio frequency identification (RFID) antennas upstream of the barrier. Concurrently, we collected stage of streamflow using a pressure transducers and generated a basic discharge rating table to approximate the discharge for any given occurrence of tagged fish crossing the RFID antennas. Detailed topographic, cross-sectional, and longitudinal profiles were captured in a geo-referenced survey and used to derive streamflow models (HEC-RAS) and commensurate probabilities of Brook Trout navigation through the various flow paths of the bedrock falls. We present data on the first year of study and prospective design approaches needed for the full suite of management objectives of the area and project.

Yellowstone Cutthroat Trout passage in Timber Creek

Presenter: Erin Leonetti

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Abstract: Timber Creek is a tributary to the Greybull River located west of Meeteetse, WY. The Greybull River drainage is an important stronghold for Yellowstone Cutthroat Trout (YSC) that supports genetically-pure populations. Numerous passage projects focusing on YSC have occurred over the past ten years in the Greybull River drainage to improve connectivity and to reduce entrainment in irrigation canals. The Timber Creek project consolidated four irrigation diversions into one and screened the irrigation diversion to prevent entrainment of fish down the canal. The previous four points of diversion pulled water out of Timber Creek by using drop boards in concrete boxes located within the stream channel, which were passage barriers. Concrete boxes were left in place, but drop boards were removed and instream rock cross vanes were added downstream of all concrete boxes to assist with upstream passage for all aquatic organisms. Completion of this project in 2014 makes Timber Creek free of fish barriers. The goal is to determine the effectiveness of the fish passage structures by addressing three objectives. First, identify the proportion of tagged fish making it upstream past all four modified diversions and determine if fish from the Greybull River are migrating upstream in Timber Creek to spawn. Second, estimate the number of tagged fish from Timber Creek that are being prevented from canal entrainment by the two fish screens. Third, estimate the proportion of tagged, resident fish that emigrate below the most downstream antenna. To achieve these objectives we installed three solar power

stations, passive integrated transponder (PIT) tag readers and antennas in spring 2018 to study the movement of the tagged fish within Timber Creek. Post-monitoring began in 2017 with a weir trap and backpack electrofishing to capture and implant a PIT tag into the peritoneal cavity of fish. Sampling continued in 2018 and 2019 with backpack electrofishing, and will continue into 2020 for the final year. A total of 1,153 fish have been caught, measured and weighed over the past three field seasons, with 635 fish implanted with a PIT tag and adipose fin clipped.

Wyoming Game and Fish kokanee captive brood stock

Presenter: Brad Welch

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Megan Mclean, Wyoming Game and Fish Department, Wyoming Game and Fish, 196 County Road 16, Lovell, WY 82431, megan.mclean@wyo.gov

Abstract: In 2016, the Wyoming Game and Fish Department decided to explore the option of a kokanee captive broodstock at the Tillett Springs Fish Rearing Station. Disease concerns with wild brood sources and the need for a consistent egg source year to year led this charge. Prior to starting, protocols and procedures were researched and identified from the only two known semi-successful captive brood kokanee programs ever developed. Based on the information gathered, several uncertainties still existed specifically with the warm 54°F water source that would be used at Tillett. The captive brood program started in December of 2016 with eyed eggs from a late-run kokanee egg source provided by the state of Colorado, sent from their Glenwood Springs Fish Hatchery. After a brief incubation time at the Story Hatchery, eggs were transferred to the Daniel Hatchery just prior to hatch. Over the next 15 months, the kokanee early rearing took place on their 47°F water source. This water temperature delayed the growth and maturation of these fish at the facility. In April of 2018, the late-run brood lot of just over 10,000 fish, at 40.5 fish per pound, were transferred to the Tillett Rearing Station. Even with the warmer water supply, the fish were kept on a controlled growth rate until reaching adult maturation at the age of three. In November of 2019, the kokanee reached adult maturity and were successfully spawned. In total, the broodstock produced a total of 2.7 million eggs, with an eye-up rate averaging around 95%.

Improving early survival in tiger trout using triploidy

Presenter: Alysia Henderson

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Steve Diekema, Wyoming Game and Fish Department, PO Box 160, Story, WY 82842

Abstract: In order to provide a unique sport fishery as well as an option for managing rough fish or stunted fish populations, Wyoming's Story Fish Hatchery began creating tiger trout in 2011. During the early years of creating these hybrids, egg survival to the eyed stage was low (30-50%). To increase survival, hatchery personnel began using pressure shocking as a means to induce triploidy. This presentation will share egg survival data from the Story Fish Hatchery before and after pressure shocking was used as a management tool, the process used to induce triploidy, and a second experiment using triploidy to increase egg performance in other hybrids at Story.

A preliminary assessment of adult diploid and triploid Walleye in Narraguinep Reservoir, CO.

Presenter: Collin Farrell

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Brett Johnson and Chris Myrick, Colorado State University

Adam Hansen, Jim White, and Mandi Brandt, Colorado Parks and Wildlife

Abstract: Walleye *Sander vitreus* is a widely distributed and important recreational fish species throughout North America, but it is not native to the western United States. Walleyes can negatively impact native species in their introduced range because of their predatory nature. Stocking Walleye is prohibited in many parts of the West, yet illegal introductions and natural dispersal are common, so managers need a means to limit the impact and spread of introduced Walleyes. Some state agencies, including those in Colorado, Montana, and Utah, have begun stocking triploid Walleyes, which are much less fertile than diploid (normal) fish. Lower fertility could help prevent the establishment of new Walleye populations in sensitive areas, and triploids may interfere with natural reproduction of undesirable diploid populations. However, very little is known about how triploid Walleyes perform in the wild. In this talk, we will present preliminary results comparing adult diploid and triploid Walleye in Narraguinnep Reservoir.

Yellowstone Cutthroat Trout brood infusion

Presenter: Guy Campbell

Guy Campbell, Wyoming Game and Fish Department, 3030 Energy Lane, Casper, WY 82604, guy.campbell@wyo.gov

Abstract: In 2014, the Wyoming Game and Fish Department initiated efforts to increase the genetic diversity of the existing Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* captive broodstock at Ten Sleep Hatchery. It had been over 10 years since any new recruitment from the LeHardy strain had been collected to augment the brood. Due to population declines the previous methods of collecting adults by dip netting in the LeHardy Rapids section of the Yellowstone River were no longer effective. In an effort to try something different, personnel worked in cooperation with Yellowstone National Park and the United States Fish and Wildlife Service on a plan to infuse “wild genes” from male Yellowstone Cutthroat Trout back into female captive broodstock. With this strategy, a number of three-year-old females were transferred each year from Ten Sleep to the Story Hatchery to delay their spawning timing and match it more closely with natural spawning time happening in the National Park. Beginning in May of 2015, and for the following three years, the plan consisted of floating two stretches of the Yellowstone River within the national park during the peak spawning period to capture male Yellowstone Cutthroat Trout through electrofishing. Once captured, milt was extracted from ripe males. Milt was stored and then transported the following day for an “infusion” spawn with the females that had been held at the Story Hatchery. Fertilized eggs were shipped to the Tillett Rearing Station isolation facility for incubation, early rearing and genetic testing. Once the disease testing was completed and the fish were given a clean bill of health, they were transferred to Ten Sleep Hatchery to be reared and used as future captive broodstock.

Comparison of tissues for the detection of *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease

Presenter: Tawni Riepe

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Abstract: Various diagnostic methods have been established to detect *Renibacterium salmoninarum* in salmonids. Such methods include direct fluorescent antibody tests (DFAT), polymerase chain reaction (PCR), and enzyme-linked immunosorbent assays (ELISA), typically performed using kidney tissue samples following the AFS Aquatic Animal Health Blue Book standards. While many methods have been effective, the type of tissue tested may affect the probability of detecting the bacteria, if present. Three lethal tissue (kidney, liver, and spleen) and three nonlethal tissue (blood, ovarian fluid, and mucus swabs) samples were collected from 800 adult Greenback Cutthroat Trout at the Colorado Parks and Wildlife Poudre Rearing Unit. All tissues were tested for *R. salmoninarum* via qPCR. To compare pathogen prevalence among tissues, we developed a hierarchical occupancy model to estimate host- and organ-level infection rates. The overall prevalence (all tissue types) of *R. salmoninarum* among the fish was 66%. Thirty-three percent of infections were detected using kidney tissue, while liver tissue detected an additional 32%. Mucus swabs represented the best nonlethal method for confirming *R. salmoninarum* presence when positive detections were obtained from other methods, although detections were low (25%). Interestingly, *R. salmoninarum* was detected using mucus swabs in an additional 16% of fish when all other tissues were negative. The infected population consisted of similar numbers of male and female fish, and detection rates by sex were not affected by the type of tissue tested. Surprisingly, one of the nonlethal methods thought to be highly sensitive for detecting *R. salmoninarum*, ovarian fluid, only detected 12% of infected female fish. The results of this study suggest that testing a combination of both kidney and liver tissues will yield a higher detection rate when performing fish health inspections and could be particularly useful in populations where the prevalence of infection is low. Mucus swabs may be used as a nonlethal alternative, but the results obtained from mucus swabs likely indicate if the source of water on a hatchery unit is positive for *R. salmoninarum*, rather than detecting asymptomatic or clinical infections among individual fish.

Horizontal transmission of *Renibacterium salmoninarum* among inland hatchery-reared trout

Presenter: Tawni Riepe

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Abstract: *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease, is found in salmonid species worldwide, with particularly high prevalence among Chinook and Coho salmon. Transmission occurs through two routes: horizontal and vertical. With vertical transmission, the bacteria is transferred maternally through the egg leading to an infection in the progeny, while horizontal transmission occurs among individuals through the ingestion of contaminated fecal matter or through direct contact with infected fish or water. In previous studies, horizontal transmission has been shown to be more important than vertical transmission for maintaining infection in Chinook Salmon. However, the relative importance of horizontal transmission in inland salmonids has received little attention. Our study examined the potential for horizontal transmission between hatchery-reared Cutthroat Trout and Rainbow Trout at an *R. salmoninarum*-positive facility, and factors affecting transmission. Cutthroat Trout were placed in sentinel cages near positive Rainbow Trout and Cutthroat Trout on the hatchery for three, 30-day periods during optimal temperatures for infection (10-18°C). Afterwards, the caged Cutthroat Trout were lethally tested for *R. salmoninarum*. Only one out of 360 potentially-exposed fish tested positive. Our data suggest that horizontal transmission may play a smaller role in maintaining infection in hatchery-reared inland trout than that seen in studies with Chinook and Coho salmon.

Dan Speas Fish Hatchery fish quality assessments

Presenter: Sean T. McAlpin

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Abstract: In 2019, the Wyoming Game and Fish Department's Dan Speas Hatchery began conducting quality assessments on fish reared at the facility. Through the use of coefficient of variation, fin index, and condition factor values, hatchery personnel are quantitatively making quality assessments of fish produced. In the past, data such as number stocked, size of fish, stocking date, and comments like the fish looked "Good" were the only parameters available in evaluating the success of a stocking event. Moving forward, regional fish managers may find that the information provided by these new assessments can help in determining proper stocking rates based on typical size variation, optimal body conditions for stocked fish to maximize growth rates, acceptable fin index values on fish released in put-and-take fisheries, etc. Within the hatchery, personnel may have the flexibility to adjust feed and growth rates, frequency of feedings, type of rearing units used, timing of stocking, etc., to accommodate requests to make a fishery more productive.

Wyoming Game and Fish Deptartment AIS program update

Presenter: Eric Hansen

Eric Hansen, Wyoming Game and Fish Department, 3030 Energy Lane, Casper, WY 82604, eric.hansen@wyo.gov

Abstract: I will briefly touch on Aquatic Invasive Species (AIS) of concern to Wyoming and the last 10 years of watercraft inspection and decontamination in the state of Wyoming. Next, I will discuss Wyoming Game and Fish Department's early detection and monitoring program, and outreach to the public. Finally, there will be a brief discussion of Wyoming Game and Fish Department's AIS program personnel by region, current updates/projects, and funding information, with future program goals and a short respite for questions/discussion.

Wyoming invasive mussel rapid response plans

Presenter: Kevin Gelwicks

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Abstract: Zebra mussels *Dreissena polymorpha* and quagga mussels *Dreissena bugensis* mussels are aquatic invasive species (AIS) that have far-reaching negative impacts on aquatic resources, water infrastructure and recreation, and can be attributed to significant economic loss. Zebra and quagga mussels are native to Eurasia and were first discovered in North America in the Great Lakes in the late 1980s. Since their initial introductions, these species have spread across most of the United States, and have been detected in Wyoming's neighboring states of Nebraska, South Dakota, Montana, Colorado, and Utah. Currently, Wyoming's AIS program is focused on outreach, inspection, and monitoring, with the overall goal of keeping invasive species such as zebra and quagga mussels out of the state. If zebra or quagga mussels are detected in a Wyoming water, immediate action will be necessary to prevent their spread to other waters. Therefore, rapid response plans are currently being developed to guide containment efforts for the 23 highest-priority waters in the state. These plans outline the steps needed to quickly mobilize personnel and equipment to provide exit inspections and, if necessary, decontaminations of all boats leaving the affected water. Plans are written for various status levels that correspond with the detection and verification process (i.e., short-term suspect, long-term suspect, positive, and infested). These plans provide guidance for the initial response to detection of zebra or quagga mussels at each of these four status levels and will act as guiding documents for initial decision-making following detection. They are not intended as long-term containment plans, but will outline the action necessary to provide short-term containment while longer term containment and monitoring plans are developed. This presentation will give an overview of Wyoming's AIS rapid response planning process, some of the benefits we see in undertaking this process, as well as some of the challenges with trying to prepare for a zebra or quagga mussel detection in Wyoming.

Thirty years of dreissenid impacts on lake ecosystem: species and systems matter

Presenter: William Fetzer

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Abstract: Introductions of non-native species can have profound effects on aquatic ecosystems by altering food web interactions and reducing fisheries stability and productivity. The invasion of zebra mussels *Dreissena polymorpha* and quagga mussels *Dreissena bugensis* into North American lakes

provides a clear example of the extent to which introductions can fundamentally alter ecosystem structure and function. At the ecosystem level, dreissenid mussel introductions are characterized by decreases in phytoplankton and zooplankton production and increases in benthic algal, macrophyte, and zoobenthos production. Combined, these changes lead to greater light penetration, elevating the importance of benthic energy pathways in supporting secondary production. Responses of fish to dreissenid introductions are more difficult to assess, showing inconsistent and mixed results. Several studies show changes in growth and abundance of fish populations following increased water clarity, while others do not. At the community level, species composition generally shifts from pelagic to littoral and benthic species. Developing a mechanistic understanding of population responses and broad-scale community patterns remains difficult because fish are mobile, utilize multiple habitats, and integrate both benthic and pelagic production. However, differential ability to adapt to changes in habitat and resource availability across species and environmental context (e.g., lake trophic status and bathymetry) may provide mechanisms to explain inconsistencies observed across species and systems.

Regional WID data sharing system - utilizing data to reduce risk across the west

Presenter: Robert Walters

Robert Walters, Colorado Parks and Wildlife, 6060 Broadway, Denver, CO 80216, Robert.Walters@state.co.us

Abstract: In 2012, Colorado Parks and Wildlife developed a database to record and analyze data relating to watercraft inspection & decontamination (WID). Since that time, the database has been adopted as the primary data collection tool for WID programs in 12 western states. By sharing data, western states have collaboratively increased communications, improved on the ground watercraft risk assessment, and collectively built a robust data set which aids in landscape-scale decision making as it pertains to AIS vector management across the west.

Utah Division of Wildlife Resources Lake Powell update

Presenter: Richard Gibbs

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Nathan Owens, Utah Division of Wildlife Resources, 318 N Vernal Ave, Vernal, UT 84078, nathanowens@utah.gov

Abstract: With the ever-increasing threat of quagga mussels at Lake Powell, what is UDWR doing that is working well, what needs to change, and what other options need to be explored to keep on top of the ever-changing dynamics at Lake Powell? Here we will discuss the necessity of automated data entry, adult mussels in ballast tanks, decontamination method alternatives, funding for an ever-expanding operation, and how to reduce watercraft inspection redundancy.

East Fork Parachute Creek reclamation: Opportunities and challenges associated with a long-term project to restore Colorado River Cutthroat Trout in a Colorado stream

Presenter: Ben Felt

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Tom Fresques, U.S. Department of the Interior, Bureau of Land Management, 2300 River Frontage Road, Silt, CO 81652, t1fresqu@blm.gov

Lori Martin, Colorado Parks and Wildlife, 711 Independent Avenue, Grand Junction, CO 81505, lori.martin@state.co.us

Abstract: The East Fork of Parachute Creek (EFPC) is located in northwest Colorado on the Roan Plateau on public lands managed by the Bureau of Land Management (BLM). EFPC was identified as a priority for chemical reclamation by Colorado Parks and Wildlife and BLM in 2007 due to the rapid invasion of non-native Brook Trout *Salvelinus fontinalis* which nearly extirpated native Colorado River Cutthroat Trout *Oncorhynchus clarkii pleuriticus* (CRCT) from the drainage. A barrier was constructed in 2013 to divide the total treatment area of 8.5 miles into two sections. Phase one of the chemical treatment, which involved treatment from the headwaters to the constructed barrier, was successfully completed in 2014 and CRCT were stocked throughout the drainage above the barrier in 2015. Phase two of the project, conducted in 2018 and 2019, involved treatment from the constructed barrier down to a large waterfall. Preparations for phase two of the project involved trapping and relocation of beaver, the breaching of over 160 beaver dams, and extensive trail clearing work for stream access. The 2018 treatment went well despite challenges presented by exceptionally low flows (i.e. chemical plume delays, diurnal variability in flows, and several sub-surface stretches of stream). In the spring of 2019, follow-up work consisting of drainage-wide electrofishing and environmental DNA sampling revealed a small area in which Brook Trout persisted. Significant depletion in Brook Trout numbers was observed in this area throughout 18 electrofishing passes conducted in 2019. Results of environmental DNA sampling were inconsistent with electrofishing observations, which complicated decision-making regarding how to best implement the re-treatment in 2019. The final Brook Trout observed in the treatment area was removed via backpack electrofishing 3.5 weeks prior to the 2019 treatment and no Brook Trout were observed during the treatment. Stream flows during 2019's treatment were much higher than in 2018, which resulted in fewer chemical timing and coverage issues. Follow-up electrofishing and environmental DNA sampling are planned for 2020 to determine the effectiveness of the 2019 treatment.

East Fork Parachute Creek reclamation: beaver dams - lots and lots of beaver dams

Presenter: Tom Fresques

Tom Fresques, United States Department of Interior, Bureau of Land Management, 2300 River Frontage Rd. Silt, CO 81652, t1fresqu@blm.gov

Ben Felt, Colorado Parks and Wildlife, 711 Independent Avenue, Grand Junction, CO 81505, benjamin.felt@state.co.us

Abstract: Beavers *Castor canadensis* and beaver dams add greatly to the complexity when planning and implementing a chemical (Rotenone) reclamation or restoration project for fish. Beaver dams provide refugia habitat for target fish, contain large amounts of sediment that Rotenone can bind to, and create ponded habitat that reduces the effectiveness and efficient movement of Rotenone in stream treatment reaches. There are many ways in which to deal with beaver and beaver dams on the landscape. In East Fork Parachute Creek, a remote, small tributary stream in the upper Colorado River basin (Garfield County, western Colorado), Colorado Parks and Wildlife initiated an ambitious chemical reclamation project in August 2018 and 2019 to treat and remove nonnative Brook Trout *Salvelinus fontinalis* from five miles of stream to restore native Colorado River Cutthroat Trout *Oncorhynchus clarkii pleuriticus*. The project, located on public lands managed by the Bureau of Land Management, entailed extensive

planning, pre-work, and coordination. Among other project complexities, the treatment reach contained >160 beaver dams. We share here the methods and partnerships we utilized to effectively remove beaver and breach beaver dams, discussion on pros and cons of these methods, and some considerations for others who may face similar habitat complexities.

Overview of lotic and lentic chemical reclamation projects in the Yampa River basin, Colorado

Presenter: Billy Atkinson

William Atkinson, Colorado Parks and Wildlife, 925 Weiss Dr., Steamboat Springs, CO 80487, bill.atkinson@state.co.us

Abstract: There has been a resurgence in the utilization of chemical reclamation projects as a fisheries management tool, both in native species conservation efforts, as well as sportfish management. Chemical reclamation projects, no matter how small in scale, are more often than not a significant undertaking. Increased efforts during pre-project planning phases, combined with novel adaptations, greatly increase the efficacy of a reclamation project and can reduce public scrutiny. Challenges to treating both lotic and lentic systems vary greatly. For example, beaver ponds frequently pose tremendous challenges to treatments, often complicating planning and implementation. Two different types of chemical reclamation projects will be discussed, both in the headwaters of the Yampa River basin. From 2008 to 2017, approximately seven miles of headwater stream systems and 33 surface acres of beaver pond habitat was treated to remove non-native Brook Trout in an effort to repatriate with Colorado River Cutthroat Trout. In 2019, a 26-surface acre reservoir, and one mile of stream habitat was treated to remove illicitly-introduced Northern Pike and restore sportfish opportunities. Barrier construction, pre-project planning strategies, implementation strategies and follow-up activities will be presented. Tactics employed to facilitate treatment, ensure the safety of applicators during treatment, and minimize risk of impacts to aquatic systems outside of the treatment area will be highlighted.

Stepping back to move forward – identifying and prioritizing Yellowstone Cutthroat Trout restoration through a collaborative public process

Presenter: Joe Skorupski

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Abstract: Conservation of Yellowstone Cutthroat Trout (YSC) often requires restoring and establishing new populations to ensure their persistence on the landscape. While the use of rotenone is a common and effective tool, it can be met with public opposition. Following heightened social opposition on two proposed YSC reintroduction projects in the Cody region, we initiated a collaborative public process to engage the public on the issue of YSC conservation. Specifically, we sought to identify a path forward for future conservation and restoration projects that balance social interests and concerns with the biology and science of YSC conservation in the Cody Region. In the end, participants recommended 16 projects

where YSC conservation and restoration could occur. We used two approaches to prioritize these projects. The first was a simple categorization approach and the second a complex matrix approach that ranked projects based on a suite of biological, scientific, and social attributes. A comparison of each prioritization approach is discussed.

A "shallow" understanding of Meeboer Lake

Presenter: Steve Gale

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Abstract: Meeboer Lake is a small, 124-surface acre, lentic fishery about 15 miles west of Laramie. This popular lake for anglers is a natural, shallow depression, with a mean depth of six feet. The shallow nature of the lake makes the aquatic community productive, but susceptible to low oxygen conditions, especially in the winter. From 1998 to 2011, Meeboer Lake experienced six winterkill events. The longest stretch the lake carried fish through the winter, during this period, was seven years (2000-2006), which coincided with the operation of a bottled oxygen aeration system and mild winters. Rainbow Trout captured in 2006 had outstanding mean length (20.3 inches) and weight (4.4 pounds) and over half were ≥ 20 inches. This highlighted the productive nature of the lake for fish that were able to survive multiple winters. Bottled oxygen prices were cost prohibitive, so solar powered aeration replaced the bottled oxygen system in 2007. Due to severe winters and technical issues, Meeboer Lake experienced three more winterkill events from 2007 through 2011. However, the Laramie Valley Chapter of Trout Unlimited paid to install electrical service and a new aeration system in 2013. In addition to the new aeration system, Grass Carp were stocked in 2013 at a rate of six per surface acre to help reduce the amount of aquatic vegetation. Fish have survived annually since 2013, but in 2016 concerns arose over lower than expected trout Wr values and angler observations of fewer aquatic insects. Conversely, angler catch rates in 2016 were the highest on record for Meeboer Lake. Further investigations since 2016 have found fewer Amphipoda in Meeboer Lake compared to other Laramie Plains Lakes, a high abundance of stocked trout, and an increasing White Sucker population. While adjustments are being made to reduce the abundance of stocked trout, it is clear there are other variables contributing to the changes in the fishery since 2005, and the improved aeration system has brought its own set of challenges.

Lower trophic level responses to Lake Trout suppression methods in Yellowstone Lake

Presenter: Dominique Lujan

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Todd Koel, Yellowstone National Park

Michelle Briggs and Lindsay Albertson, Montana State University

Hayley Glassic and Christopher Guy, Montana Cooperative Fishery Research Unit

Abstract: Lake Trout *Salvelinus namaycush* were unintentionally introduced to Yellowstone Lake and caused a 90% decline in the native Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* population. Gillnetting has been used to suppress the Lake Trout since 1995. In recent years, however,

suppression methods that target embryos of Lake Trout have been developed, including the treatment of spawning sites with Lake Trout carcasses. Carcass decomposition causes embryo mortality due to a drop in dissolved oxygen, but the effects of this method on nutrient cycling and lower trophic levels are unknown. We collected water samples and analyzed them for ammonium, nitrate, and chlorophyll a throughout the open water season in 2018 and 2019 to investigate the degree to which carcasses increased nutrient concentrations and algal biomass. Macroinvertebrates, zooplankton, phytoplankton, benthic algae, and fish were collected and analyzed for 15N to trace the nutrients from carcasses and the degree to which those nutrients are being taken up by organisms at lower trophic levels. We also deployed nutrient diffusing substrates at each site before and after carcass additions to measure the limiting nutrients. Nitrogen concentrations did not differ among sites suggesting that currents were strong in the lake. $\delta^{15}N$ values increased in biota after carcass additions indicating that nitrogen from Lake Trout carcasses was readily used; however, uptake is much higher by pelagic primary producers than by benthic algae. Nitrogen and phosphorus were co-limiting to benthic algae. Nutrient cycling was enhanced from carcasses, but these effects are likely diluted by the large size of Yellowstone Lake.

Population demographics of Silver Carp in the lower Kansas River, a larger tributary to the Missouri River

Presenter: Jake Werner

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Abstract: Since the introduction of Silver Carp to Mississippi waterways in the 1970s, they have expanded their range to encompass the majority of the basin, including much of the Missouri River. There is a paucity of information on Silver Carp in the Missouri River basin, especially in the tributaries. Tributaries in this system provide refuge for Silver Carp avoiding the high current velocities in the main channel, but little is known on how carp function in these tributaries or how connectivity with a main stem river can influence population demographics. The Kansas River is a large tributary to the Missouri River that drains most of northern Kansas and has multiple anthropogenic barriers (e.g. hydropower dams and water diversion weirs) creating varying levels of connectivity with the Missouri River. These barriers provide a unique opportunity to analyze how varying levels of connectivity with a main stem river can influence Silver Carp population demographics across the landscape. We collected Silver Carp from above and below the barriers using a suite of gears. An electrified dozer trawl outperformed conventional electrofishers in catch rates and captured greater numbers of difficult to capture cohorts. Silver Carp are restricted to the lower reach of the Kansas River (~83 rkm) because of a hydropower dam. Below this barrier, population demographics differ both spatially and temporally around a water diversion weir (~27 rkm). Adults captured above the weir occurred in lower densities but attained larger total lengths, similar to less-abundant populations along the invasion front. Drastic differences in water years over the course of this study could have caused relative weights of Silver Carp to differ temporally. Juvenile Silver Carp were scarce above the weir, indicating reproduction may be limited in this reach, but were abundant below the weir.

Dolly Varden jaw morphology shifts when together with Whitespotted Charr in Hokkaido streams: another mechanism for coexistence of close competitors?

Presenter: Kurt Fausch

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Yo Miyake, Ehime University

Abstract: Similar species that overlap in sympatry may diverge in characters related to resource use owing to evolution or phenotypic plasticity, a process termed character displacement. Dolly Varden and Whitespotted Charr overlap along streams in Hokkaido, Japan, and compete by interference for invertebrate drift-foraging positions. Previous research showed that as drift declined during summer, Dolly Varden shifted foraging modes to capture benthic prey, a behavior facilitated by their subterminal jaw morphology. We compare body and jaw morphology of Dolly Varden in sympatry versus allopatry in two locations to test for character displacement. Statistical analysis showed significant divergence in characters related to foraging, which was correlated with variation in individual charr diets. Dolly Varden in sympatry had shorter heads and lower jaws than in allopatry, and even within sites charr with these characteristics fed less on drifting terrestrial invertebrates but more on benthic aquatic invertebrates. Those in allopatry had longer heads and lower jaws, and fed more on terrestrial invertebrates. The close proximity of sites in one stream suggests that Dolly Varden may display phenotypic plasticity similar to other charr, allowing rapid response in morphology to the presence of competitors. These morphological shifts likely help them maintain positive fitness when competing with Whitespotted Charr in Hokkaido streams.

Status and conservation of an undescribed lineage of Cutthroat Trout native to the southern Rocky Mountains

Presenter: Kevin B. Rogers

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Abstract: New molecular methods have identified substantial genetic divergence within Colorado River Cutthroat Trout *Oncorhynchus clarkii pleuriticus* organized in two broad clades. This discovery has led the U. S. Fish and Wildlife Service to explore listing the less common variety (the “green” lineage) for

protection under the Endangered Species Act. In an effort to inform that decision we conducted molecular surveys on Cutthroat Trout Conservation Populations (CPs; populations <10% admixed with nonnative trout alleles) across Colorado and neighboring states to determine what remains of this lineage and where it can be found. In total, we identified 69 CPs occupying just 3% of historically-occupied habitats distributed across their putative native range in the upper Colorado, Gunnison, and Dolores river basins west of the Continental Divide. Despite this dramatic range reduction, considerable genetic diversity remains, as well as geographic structuring between these major basins. Threats facing these populations, and the probability of them persisting in a warming future was evaluated using a Bayesian Network model developed for a sister taxon, and projected out to 2040 and 2080. We also identified eight green lineage CPs east of the Continental Divide, assumed to have been founded from largely undocumented stocking efforts from west slope sources a century ago. However several pieces of compelling evidence preclude us from ruling out the possibility that this lineage was native to the South Platte and Arkansas river basins as well.

Factors affecting the distribution of amphibians in western Wyoming

Presenter: Zach Wallace

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Abstract: Effective conservation and management of amphibians requires an understanding of how environmental and anthropogenic factors affect their distributions. Previous inventories of amphibians in western Wyoming suggested the Wind River Range had low species diversity relative to the rest of the region, despite apparently suitable habitat. To understand why, we surveyed amphibians and chytrid fungus *Batrachochytrium dendrobatidis* (Bd) in montane wetlands of western Wyoming using a combination of visual and environmental DNA (eDNA) sampling, and tested hypotheses on factors influencing their occurrence and detectability using hierarchical models. Unique to this study was an interest in the potential influence of bedrock geology on amphibian occurrence through its effects on water quality. Our results suggested water quality, landscape context, and wetland characteristics had the strongest influences on amphibian occupancy. Relationships of occupancy with geology were not apparent for most amphibian species, but may have occurred indirectly through the influence of bedrock on wetland water chemistry. Boreal toads *Anaxyrus boreas* were more likely to occupy wetlands with higher calcium concentrations, which were associated with calcite sandstone bedrock, Tiger salamanders *Ambystoma mavortium* were more likely to occupy wetlands with warmer water temperatures and higher ion concentrations, Columbia spotted frogs *Rana luteiventris* occupied lower elevation sites that received more precipitation, and Boreal chorus frogs *Pseudacris maculata* occupied sites without fish in areas with greater forest cover and topographic positions that were more flat or mid-slope relative to valleys. We found no evidence that amphibian occupancy was negatively influenced by atmospheric nitrogen deposition or presence of Bd, as measured by eDNA. Visual sampling significantly outperformed eDNA for detecting all amphibian species except boreal chorus frog. Our results highlight the diversity of factors influencing amphibian habitat suitability and the value of collecting water quality data during amphibian surveys.

Distribution, habitat use, and evaluation of potential managed translocation sites for Finescale Dace in the Great Plains.

Presenter: Evan Booher

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Abstract: Aquatic systems of the Great Plains support climate relict fishes with isolated distributions reflecting long-term climatic variability and landscape change. Finescale Dace *Chrosomus neogaeus* are emblematic of this situation, as a rare native fish with a restricted range, and specific ecological factors influencing its present-day distribution are not well understood. We investigated the influence of abiotic and biotic factors, including native fish richness and occurrence of non-native predatory fishes, in assessing the current distribution of Finescale Dace in the Great Plains by means of species distribution models (SDM) with basin-scale fish and habitat data. We complement our SDM approach with an evaluation of locally observed fish and habitat data, using generalized linear mixed-effect models (GLMM) for both basin-scale and local-scale analyses. Our results show that the importance of either abiotic or biotic factors differed by two river basins comprising our study area. An abiotic variable, mean annual streamflow, was a negative predictor in the topographically diverse Belle Fourche River basin, while a biotic variable, native fish richness, was a positive predictor in the high prairie environment of Niobrara River basin. A weak negative trend of association was also apparent between Finescale Dace presence and the occurrence of non-native predatory fish that forage in nearshore, littoral environments in this basin. The occurrence of littoral predators was a negative driver of native fish richness at Niobrara River basin sites. We illustrate the utility of basin-specific approach in examining the relative importance of abiotic and biotic factors that influence the occurrence of a climate relict fish outside its core distribution in North America and use modeled species-environment relationships to evaluate the suitability of locations for managed translocations of Finescale Dace in the Belle Fouche River basin. Actions to conserve rare native fishes should consider the biotic suitability of site-level fish communities and basin-scale invasion histories in the formulation of management plans. Containment of non-native, predatory fishes will be critical towards maintenance of regional biodiversity and preservation of unique fish assemblages of the Great Plains.

Distribution and abundance of fishes relative to environmental conditions and habitat fragmentation in the Cache la Poudre River, Colorado.

Presenter: Matt Haworth

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Abstract: The Cache la Poudre River (Poudre) runs approximately 126 miles from its headwaters in Rocky Mountain National Park to its confluence with the South Platte River near Greeley, Colorado. The Poudre River has a snowmelt-driven hydrograph, and is a high gradient, cold-water river in its upstream canyon-bound reaches. After exiting Poudre Canyon, the river flows into a floodplain transition-zone characterized by lower gradient, intermediate water temperature, and mixed agricultural land use. It then passes through an urban area in the city of Fort Collins and neighboring communities, transitioning into a warm-water river after passing through the city. Human use has modified the Poudre River and its floodplain for over 150 years, and has resulted in altered channel structure, water quality and quantity, and habitat complexity and connectivity. In particular, numerous in-channel water diversion structures contribute to habitat fragmentation, which may prevent movements and upstream passage of fish most months of the year, especially in base flow periods such as November to March. In 2018 we began a multi-year study to describe fish assemblage composition and movement rates in the Poudre River in the vicinity of Fort Collins to aid managers in planning and assessment of habitat improvement and fish passage projects. We sampled fish at 13 sites along the length of our study area and captured 13 native and 14 nonnative fishes. Native taxa were numerically dominant among the over 12,000 fish collected, but biomass was dominated by nonnative salmonids. Coldwater salmonids dominated in upstream reaches and were replaced downstream with cool and warmwater taxa. We discuss fish distribution and abundance patterns relative to environmental conditions and streamflow diversions, as well as focus areas for investigations into the future.

The past as a predictor: importance of antecedent flow for explaining ecological trends in an urban Colorado stream

Presenter: Robert E. Zuellig

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Abstract: Urban streams can have highly altered flow regimes which can influence both biotic and abiotic components of these systems. We used invertebrate, fish, water-quality, streamflow, and habitat data collected at 10 sites from 2003-2016 in the Fountain Creek basin to analyze how abiotic variables (antecedent flow, habitat, and water quality) were related to trends in biological assemblages. We examined trends in biological communities and explored relationships between these trends and abiotic variables using a combination of trend tests, correlation analyses, and linear regressions. Our analysis shows that most significant ($p < 0.1$) trends decreased over the trend period where fish metrics changed on average by 40 percent, invertebrate metrics by 9.5 percent, and where antecedent streamflow was the most common explanatory variable. We also found that antecedent measures of peakflow events identified a potential threshold that limits age-0 Flathead Chub *Platygobio gracilis* survival, a species of conservation concern.

Non-lethal approaches for obtaining stable isotope data for diet studies of North American fishes

Presenter: Bryan M. Maitland

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Abstract: Food webs analyses and diet reconstruction studies using stable isotope analysis can greatly improve our ability to manage fish populations by quantitatively describing trophic interactions among species. Lethal sampling to obtain fish tissues is the standard practice in such studies, but this necessitates the sacrifice of fishes or invasive sampling methods to remove tissues. Such approaches are problematic for small-bodied non-game fishes and those of conservation concern. We examined whether non-lethal sampling of fin tissue can replace lethal fish sampling in such species. We compared fin and muscle $\delta^{13}C$ and $\delta^{15}N$ signatures in 12 species of North American freshwater fish from multiple river systems. We estimated model errors using species-specific models, global models (all species combined), and previously developed global models for European and Australian freshwater fish. Fin and muscle isotope signatures differed, but were strongly correlated for most species (r^2 values for $\delta^{13}C$ = 0.71 – 0.91, and 0.63 – 0.92 for $\delta^{15}N$). Species-specific relationships provided meaningful corrections of fin isotope ratios (error < 0.6‰). Similar models developed for European or Australian fish gave less exact muscle estimates when applied to North American species (error > 0.8‰ and 0.9‰, respectively). Our findings suggest that isotopic signatures obtained from fin tissues are an ideal surrogate for lethally-sampled tissues in native non-game fish. The best predictive models are species- and region-specific. We recommend their use in Wyoming and Colorado, and present a workflow for managers and conservation practitioners to facilitate incorporating stable isotope analyses as part of standard sampling and monitoring programs.

Optimal baselines for stable isotope analyses in stream food webs

Presenter: Nathan Barrus

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Abstract: Stable isotope analysis is used in aquatic ecosystems to reconstruct food webs and deduce trophic interactions. Because natural land cover strongly influences $\delta^{15}N$ values in consumers, suitable baselines must be established for meaningful cross-site comparisons of food webs. Our objective was to identify a taxon or Functional Feeding Group (FFG) for a baseline in mountain and prairie streams. From previously established methods, the ideal baseline will meet four criteria: 1) wide geographic distribution, 2) low within-site $\delta^{15}N$ variation among individuals, 3) $\delta^{15}N$ values are correlated with natural land cover and background $\delta^{15}N$ values, and 4) produce no systemic change in calculated consumer trophic positions with natural land cover. We collected invertebrate taxa once in June, July, and August and identified them to family and classified them to FFG. We collected higher-level consumers (i.e. fish) in August and identified them to species. Preliminary analyses indicate that for FFG sestonic filter feeders (filterers) or

algae/biofilm scrapers (grazers) and taxa within these major groups (i.e., Hydropyschidae and Simuliidae) are suitable baselines. These baselines were easy to collect and widely distributed, exhibited the lowest within-site $\delta^{15}N$ variation ($CV < 0.03$), and had $\delta^{15}N$ values correlated with natural land cover. The FFG baselines produced trophic position estimates of White Sucker *Catostomus commersonii*, Brown Trout *Salmo trutta*, Creek Chub *Semotilus atromaculatus*, Longnose Sucker *Catostomus catostomus*, and Longnose Dace *Rhinichthys cataractae* that were independent of environmental influences (nonsignificant relationship between natural land cover and calculated trophic position). The taxa baselines have yet to be analyzed to determine if they produce estimates of tropic position of consumers that are independent of natural land cover. These results are consistent with other studies from Danish lowland streams and a Canadian watershed. Because these baselines meet these requirements and are widely consumed by fish, they will be useful in identifying trophic interactions among fishes.

Effects of redd superimposition on observer error structure in redd counts: implications for long-term monitoring of Snake River Cutthroat Trout in Wyoming

Presenter: Jeff Baldock

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Abstract: Assessing population status and trends for species of recreational, commercial, or ecological value is often a primary goal of natural resource management agencies and conservation organizations. Redd counts are a commonly applied tool in fisheries science and management to estimate effective population size for salmonids. Redd counts are easy to perform, low-cost, and non-invasive, thereby allowing for greater spatial and temporal coverage in monitoring efforts than can be attained through alternative approaches. However, the validity of redd counts as an index of effective population size may be poor due to substantial sampling error, which may limit our ability to detect important trends. Populations of Snake River Cutthroat Trout *Oncorhynchus clarkii behnke* spawning in spring-fed tributaries of the upper Snake River watershed have been monitored using redd counts since the 1960s. However, high rates of redd superimposition introduce uncertainty into population estimates inferred from redd counts alone. We aim to describe observer error structure in redd counts and jointly evaluate the effect of redd superimposition on this error structure. We used a Bayesian hierarchical modeling framework to parse counting errors into two components: imperfect detection of true redd clusters and false identifications. We found that while detection probabilities are relatively low (~0.6), the variation among observers is minimal. We used a similar framework to explore how observers differ in their ability to correctly identify the actual number of redds within superimposed redd clusters. We found that observers systematically overestimate the number of redds per cluster, which may cancel out underestimates due to imperfect detection of redd clusters. The accuracy and precision of any monitoring strategy must be critically evaluated in order to guide best management practices that maintain

populations of conservation concern. This research contributes to our understanding of how fish behavior mediates bias in long-term monitoring datasets and how quantitative tools can be used to better evaluate population status and trends for Snake River Cutthroat Trout.

Daily increments of otoliths aid in understanding early life history of subarctic stream salmonids

Presenter: Kevin Fitzgerald

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Abstract: Stream salmonids are difficult to study during early life stages, yet insights to their life history are critical toward understanding population dynamics. We used daily increment formations in otoliths to retroactively estimate hatch date for two salmonid species. Our study system was a small stream (2 m wide) located in northern Hokkaido, Japan, the coldest region of country, where peak streamflow occurs in May-June from snowmelt runoff. Annual stream hydrographs in this region are very comparable to those of the mountainous western United States. Subarctic climates of this area prevent physical capture of fish during time of emergence, making otoliths a viable but underutilized tool for estimating hatch date. In July 2018, we captured 96 young-of-year (YOY) White-spotted Charr *Salvelinus leucomaenis* (total length [TL] range: 42-67mm), and 85 YOY Masu Salmon *Onchorhynchus masou* (TL range: 45-87mm). Our study objectives were two-fold. We first validated daily increment aging methods due to lack of prior literature for either species. Fifteen known-aged fish of both species were sourced from a Japanese hatchery, and sagittae were blindly read by three independent people. Variation across the three readers' estimates was <15% for all hatchery samples, and consistent with the known date-of-hatch window. Once validated, the second objective was to use daily increments to determine date-of-hatch for wild fish. Preliminary data suggest that emergence occurred prior to and during peak runoff that year. Hatch dates will ultimately be related back to individual collection locations to investigate how longitudinal variation in hatch timing may be influenced by habitat heterogeneity. The estimates from our validation successfully proved our daily increment aging methods used on wild specimens. More significant, this study demonstrates that daily increment aging in YOY salmonids can be a useful tool to characterize early life history when physical capture is not possible.

The use of stationary time-lapse cameras to monitor boat-angler use on large rivers in Wyoming

Presenter: Darren Rhea

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Abstract: Increasing concern over angler use on large rivers in Wyoming has prompted interest in regulating guided angling. Traditional methods of quantifying angler use on large fisheries in the state typically employ the use of programmed creel surveys, which are labor intensive and have become cost prohibitive. We used stationary time-lapse cameras to quantify boat angler use on large rivers in Wyoming, and developed a monitoring strategy to evaluate changes in use over time. Data was collected during 2019 on six large rivers in Wyoming. Results demonstrate the effectiveness of this technique and show some of the patterns in boat angler use throughout the state. This data, along with traditional spot creel methods, provides a practical and simple approach to monitoring boat angler use, and provides decision makers with empirical data for future management decisions.

The effect of selenium on Brown Trout larval deformity and trophic transfer of selenium in Colorado's aquatic ecosystems

Presenter: Alexander Townsend

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Abstract: Colorado has many geologic sources of selenium (Se) that are transported into aquatic systems via anthropogenic activities such as irrigation of soils and mining, and through natural weathering, erosion and sediment transport. Selenium is viewed as a contaminant at certain concentrations, so the state of Colorado needs to evaluate the effects of Se on local aquatic ecosystems in order to update current aqueous Se standards or adopt new tissue–based Environmental Protection Agency standards. We are cooperating with the Colorado Department of Public Health and Environment to study the effects of Se on fish reproduction and the movement of selenium through various food web compartments. Wild spawn takes of Brown Trout *Salmo trutta* were performed at locations throughout Colorado and the eggs were

reared under laboratory conditions. The swim-up larval fish were assessed for deformities in four categories (skeletal, craniofacial, fin and edema) and a graduated severity index was used to compare larval deformity rates with Se concentrations in parental fish egg and muscle tissues. We found no significant correlations between Se present in parental egg and muscle tissues and the prevalence of deformity in the larval fish. Samples of muscle tissue, egg tissue, water, sediment, periphyton, and invertebrates from the same set of sampling locations were analyzed for total Se. To compare Se movement through a different type of aquatic food web, eleven additional sites were selected to evaluate Se transfer to White Sucker *Catostomus commersonii*. Se concentrations were used to calculate bioconcentration factor and bioaccumulation factor steady state models. We report on some of the preliminary analyses of the prevalence of deformity in larval Brown Trout as a function of maternal Se exposure and on the findings with respect to Se transfer through the food webs.

Ammonia overload: measuring the acute and chronic limits of Burbot

Presenter: Ben Vaage

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Abstract: Burbot *Lota lota*, a candidate species for commercial aquaculture because of their palatability and optimal growth at temperatures similar to those used in trout aquaculture. However, data on Burbot environmental tolerances and requirements are sparse, especially with reference to water quality relevant to aquaculture, such as un-ionized ammonia (NH_3). We used a two-phased approach to evaluate the effects of un-ionized ammonia on the growth, performance, and survival of Burbot. We measured the acute toxicity of ammonia to juvenile Burbot (mean standard length [SL]: 144 ± 6 mm; mean weight: 27.3 ± 3.4 g) with a 96-h LC50 approach using concentrations of 0.0, 0.1, 0.2, 0.4, and 0.8 mg/L NH_3. Burbot held at 0.8 mg/L experienced 100% mortality; no mortality occurred at lower concentrations. We calculated a 96-hr LC50 of 0.58 mg/L NH_3. We then measured the 60-d growth, food consumption rate, and performance of Burbot (mean initial SL: 190 ± 6.9 mm; mean initial weight: 67.0 ± 4.5 g) reared in 0.0, 0.03, 0.06, 0.12, or 0.19 mg/L NH_3 using a 20-tank flow-through system (N = 4 replicates per concentration; 10 fish/tank) under optimal temperature (14.7°C) and dissolved oxygen (DO > 86% saturation) conditions. Ammonia concentration significantly affected daily food consumption rates, final wet weights, specific growth rates (SGR), and condition factor, with control fish showing the highest values and consistent declines in the measured values as the NH_3 concentration increased. The sole exception to this was for the SGRs, where the 0.0 and 0.03 mg/L treatments were similar. Interestingly, food conversion ratios did not differ significantly between treatments but did change over time. We observed 100% survival in all treatments except for the 0.19 mg/L treatment, where 10 fish (25%) died. Fish exposed to 0.03 and 0.06 mg/L NH_3 showed temporal acclimation to NH_3, displaying consumption and growth rates on par with control fish after ~30 days. The effective NH_3 concentration estimates for reductions of 10, 20, and 50 percent growth based on our data are: EC10 = 0.027 ± 0.002 mg/L, EC20 = 0.056 ± 0.005 mg/L, and EC50 = 0.174 ± 0.014 mg/L.

Arctic Grayling *Thymallus arcticus* in Wyoming

Presenter: Travis Trimble

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Abstract: This will be an informative summary of the Arctic Grayling *Thymallus arcticus* program in Wyoming. Originating from populations in the Upper Missouri River drainage and Yellowstone National Park, Grayling have been successful introduced to many waters of the state. Due to its unique appearance and their fighting behavior when on the end of the fishing line this fish has become very popular with the angling public. Currently, a robust population of naturally spawning Grayling can be found in Meadow Lake located in the mountains just east of Pinedale in northwestern Wyoming. Every year, the Wyoming Game and Fish Department's spawning crew installs a trap to collect adults and spawns fish to cover egg requests. Instate requests are sent directly to the Dubois Fish Hatchery incubator and out of state requests are shipped to fish and wildlife agencies in Idaho and Utah. At Dubois, the Grayling are reared to various sizes and timing then stocked by hatchery personnel in specific high mountain and community fisheries across the state.

GAT - Geomorphic Assessment Tool

Presenter: Andrea Taillacq

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Abstract: The Geomorphic Assessment Tool (GAT) is an open source package that is being developed to allow processing and assessment of cross-sectional and profile survey data. This tool is targeted toward all practitioners to improve workflow and allow users who may not have access to more costly suites to review data and quickly and consistently perform hydraulic calculations. This presentation will provide a brief overview of the software package, progress to date, and plans for future development. This tool is available for free at www.tailwaterlimited.com.

Watershed Response Factor – Global Implication

Presenter: David Bidelspach

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Abstract: Regional hydraulic geometry relationships (i.e. regional curves) have been developed for many gaged and un-gaged streams throughout the USA over the past 60 years. These relationships are valuable for documenting the degree of departure from equilibrium of unstable stream reaches and for evaluating bankfull channel geomorphic design parameters for restoration planning. Regional curves are most applicable for alluvial stream systems where bankfull terraces are formed over a long period of flood flow sediment deposition. Field variability and uncertainty in identifying bankfull terrace elevations may result in poor relationships that should be used carefully in stream assessment and restoration practice. This presentation summarizes regional curve development work by practitioners and researchers at RiverSHARED.org over the past 15 years and introduces the Watershed Response Factor (WRF) as a valuable tool for analyzing and extrapolating regional curves. The WRF is a scaling factor for the channel dimension vs. watershed area relationship with a strong dependency on total annual precipitation for the region of interest. The WRF has been applied throughout the USA, Canada, Costa Rica, Sri Lanka, and England to estimate hydraulic geometry relationships for stream assessment. WRF can be used in

Colorado and Wyoming to look at the assessment of an inner berm and bankfull channel relative to precipitation potential. The dimension of the inner berm in bankfull channels are critical for fisheries habitat suitability in Colorado and Wyoming with a range of precipitation between 6 in. per year to 55 in. per year. Being able to identify a relationship, such as the WRF, or other relationship to more quickly establish design parameters could have global implications. The WRF would be a useful tool in developing countries, places where it is not feasible to perform a regional curve assessment, or where data, access, or funding is not available. The WRF may allow stream restoration to improve the environment in these areas a possibility. This relationship informs the stream design parameters and construction, reduces construction time and cost and additionally, allows for remote project assessment and monitoring. This presentation will look at the comparison of regional curves in Colorado and Wyoming that have both been published and unpublished as related to precipitation and watershed response.

Applying the Stream Evolution Triangle and Stream Evolution Model in Colorado

Presenter: Brian Clarke

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Abstract: Diagnosing the underlying causes of watershed and stream system impairment is a significant challenge across Colorado. Recent advances in planning approaches help conceptualize addressing impairments by restoring geomorphic equilibrium. Channel Evolution Models (CEMs) and Stream Evolution Model (SEM) have long been used as tools to conceptualize how single-thread alluvial channels may respond to disturbances in the hydrologic or sediment regimes through a series of morphological adjustments. CEMs and SEM generalize these responses into an evolutionary sequence common to streams in different physiographic settings. The Cluer and Thorne (2014) SEM represents stream evolution as a cyclical, recognizing which streams advance through the common sequence, skip some stages entirely, recover to a previous stage, or even repeat parts of the evolutionary cycle. Although the SEM recognizes that each stream stage has varying ecosystem benefits, the Stream Evolution Triangle (SET, Castro and Thorne 2019) explicitly focuses on changes and interactions between the biologic, hydrologic, and geologic functions. More specifically, the SET recognizes that biologic interactions are of equal importance to the hydrologic and geologic drivers in modulating stream processes, form, and evolution. It suggests that for any given relative balance of these key drivers, there exists a geomorphically stable condition. As such, disturbances in key drivers lead to disequilibrium and evolution towards a new stable condition. The SET provides a broad, inclusive framework for qualitative forecasting of future stream forms based on the balance of hydrologic, geologic, and biotic drivers. Here, we utilize the SET as a qualitative conceptual model to identify historically-stable stream types, forms, and processes for a suite of sites and then assess how disturbances to the hydrologic, geologic, or biologic drivers lead to disequilibrium of the existing system. We then apply SEMs to characterize how channels will adjust in response to changes in the driving conditions. Semi-qualitative rubrics of stream and riparian indicators are then assessed to identify the restoration or management plan that would allow the

stream system to achieve a “location” within the SET and associated SEM stage that is in equilibrium with driving conditions and provides the greatest attainable habitat and ecosystem benefits.

Application of the Wyoming Stream Quantification Tool on Savery Creek, Wyoming

Presenter: Paul Dey

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Abstract: The Wyoming Stream Quantification Tool (WSQT) was published in July 2018 following development by the United States Army Corps of Engineers-Wyoming Regulatory Office, and an Interagency Review Team assisted by Will Harmon of Stream Mechanics. The WSQT is a spreadsheet calculator that quantifies functional lift or loss of aquatic resources between existing and expected conditions for proposed restoration or impact activities. The WSQT can also be used to determine restoration potential, develop monitoring criteria, and assist in other aspects of project planning. During summer 2019, the WSQT was applied on Savery Creek in south-central Wyoming to compare and illustrate potential improvements offered among stream restoration designs for four adjacent reaches. The authors were also interested in understanding the level of effort required to apply the tool. Restoration approach varied across reaches and these differences were reflected in SQT scores. The presentation provides an overview of the tool’s predictions for each of the restoration reaches and details results for specific metrics.

Improving fish passage on Big Creek

Presenter: Chance Kirkeeng

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Abstract: Dams and weirs alter flows and fragment habitats in many stream systems throughout the world. Fragmented stream habitats negatively impact many fish species because they often isolate populations and prevent the use of important habitats. The Upper North Platte watershed in Wyoming is designated as a Crucial Habitat Area because it provides a range of habitats and natural processes that support economically important wild trout populations. Many diversions and weirs fragment this stream network, but recent habitat improvement projects have focused on improving connectivity and fish passage. Big Creek is one of the larger tributaries to the North Platte River and is an important spawning tributary for Rainbow Trout and Brown Trout from the North Platte River. A large irrigation diversion is located on Big Creek and a study completed in 2014 identified this diversion as a barrier to fish passage, except during high-water events when larger-sized fish were able to pass. To address fish passage

concerns, the downstream section of the structure was reconstructed in 2017 with a rock ramp fishway. Post-construction monitoring in 2018 showed that the new design improved passage for Brown Trout during periods of low flow and for a greater size range of fish. The rock ramp fishway was successful at reconnecting the entire Big Creek drainage to the North Platte River and should be considered as a useful design for future fish passage projects.

Using business intelligence software to analyze and disseminate 'Big Data' in fisheries management

Presenter: Andrew Treble

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Abstract: Tableau is data visualization and business intelligence software that is already common and extremely popular in many business sectors but is not commonly used in Fisheries Analysis. Tableau allows the user to link to many different data formats and disparate sources simultaneously and in real-time. Tableau can quickly aggregate and visualize vast amounts of fisheries data, producing high-quality maps, graphs, tables, and dashboards that automatically update when new data is added to the source. Depending on the license type, this data can then be shared using secured, live-linked dashboards or standalone packaged workbooks. Using datasets familiar and relevant to fisheries biologists and researchers, the speed and utility of using Tableau to analyze a variety of fisheries data will be demonstrated during this presentation in real-time.

Rising temperatures and the reorganization of a large river fish assemblage

Presenter: Dan Gibson-Reinemer

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John Chick, Illinois Natural History Survey, Great Rivers Field Station, 918 Union St., Alton, IL 62002, chick@illinois.edu

Andrew Casper, Illinois Natural History Survey, 1816 S. Oak St., Champaign, IL 61820

Abstract: In recent decades, climate change has altered freshwater fish assemblages in North America. In the Upper Mississippi River, rapid warming over the past 25 years has been accompanied by changes in the catch rates and size structure of coolwater and warmwater fishes. We examined how changes in the number of fish and their size structure may have affected species' interactions over more than a hundred miles of the Upper Mississippi River. The trends we observed may be indicative of changes in large rivers elsewhere, particularly in areas near the transition from coolwater to warmwater assemblages.

Assessing potential climate-induced range shifts for fish species with contemporary and historical data in the North Platte River basin, WY

Presenter: Mark Kirk

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Frank Rahel, University of Wyoming, 1000 East University Avenue, Laramie, WY 82071

Abstract: Despite the wide-spread hypothesis that fish species should exhibit distribution shifts in response to climate change, few studies have explicitly tested whether these shifts have occurred for freshwater fish. A major reason is that there is a lack of spatially representative, long-term re-surveys of the same locations over time. Hence, finding a robust framework for detecting possible range shifts remains a conservation and management priority. We employed a multi-method approach, which involved a modeling and observational comparison, to determine whether both methods produced concordant results about how species have shifted their distributions. We applied our multi-method approach using historical and contemporary data on native and non-native species distributions in tributaries of the North Platte River basin of Wyoming; a system that spans a large elevation gradient. Results indicated concordance between the two approaches with similar species-specific responses. For example, there was strong support for range expansions of two non-native species (Common Carp and Smallmouth Bass) and two native species (Red Shiner and Green Sunfish). Notably, non-native species had much higher occurrences in contemporary samples compared with historical samples. Our results 1) provide important insight on how species have shifted their distributions in streams and rivers of southeastern Wyoming and 2) provide a framework for how scientists can validate observed range expansions when lacking robust historical datasets.

Influence of changing lake and stream thermal regimes in the Southern Rocky Mountains on Greenback Cutthroat Trout: Insights from dense sensor networks and past conservation efforts

Presenter: James J. Roberts

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Abstract: Mountain streams and lakes are warming with changing climate conditions. In the Southern Rocky Mountains native Cutthroat Trout have been forced to isolated headwater regions by past anthropogenic actions (i.e., habitat degradation and nonnative fishes). In particular, Greenback Cutthroat Trout *Oncorhynchus clarkii stomias* (GBCT) are threatened by current (nonnative fishes) and emerging (shifts in thermal conditions) threats to the security of these populations. To incorporate these emerging threats and assess the influence of different threats on GBCT populations, we created a database of historical and newly collected stream and lake temperature records which was used to predict current and future thermal conditions of headwater lakes and streams. The database will be used to inform a Bayesian Network model predictive of GBCT habitat suitability. Previous results suggest lake surface temperatures are warming faster than streams and that warming in some high elevation streams improves thermal habitat suitability. New and existing data suggest that the probability of Cutthroat Trout persistence in any habitat is a function of multiple interacting factors including temperature, habitat size, and presence of nonnative fishes. These results should provide information for conservation planning that includes both current and future habitat conditions, maximizing the long-term efficacy of management actions.

Using stream velocity and temperature data to model drift and development of embryonic Shovelnose Sturgeon in the Bighorn River, Wyoming

Presenter: Nick Hogberg

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Abstract: Shovelnose Sturgeon *Scaphirhynchus platorynchus* historically occurred in the Bighorn River in Wyoming, but major water development projects and alterations to the natural flow regime led to their extirpation upstream of Yellowtail Dam. The Wyoming Game and Fish Department has been working with Montana Fish, Wildlife, and Parks and Garrison National Fish Hatchery since the mid-1990s to reestablish a Shovelnose Sturgeon population by stocking progeny from wild fish captured in Montana. The section of the Bighorn River between Worland and Lovell currently contains several year classes of adult and juvenile Shovelnose Sturgeon, but it is unknown whether they are all of hatchery origin or if natural recruitment is taking place. We compiled temperature and velocity data across three years to assess the rate of larval drift and development of embryonic Shovelnose Sturgeon between a primary spawning site and the Big Horn Lake transition zone. Velocity and temperature data suggest that during a year with discharges near the 50th percentile during the larval drift period, embryos may drift from the primary spawning site to the Big Horn Lake transition zone in just over one day. About 5.2 days are needed for an embryo to develop through the free-drifting life stage at realistic water temperatures, meaning it is unlikely that embryonic Shovelnose Sturgeon can develop to the life stage that allows self-propulsion and exogenous feeding before entering Big Horn Lake. Future work should focus on examining potential spawning sites farther upstream and investigating differences in velocity in farther upstream reaches to determine whether embryos from other spawning sites have a higher likelihood of survival.

Little fish insist to persist: how colonization and movement dynamics enhance native fish resilience

Presenter: Samantha Alford

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Dr. Annika Walters, University of Wyoming, U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, 1000 East University Avenue, Dept. 3166, Laramie, WY 82071, annika.walters@uwyo.edu

Abstract: Freshwater native fish are experiencing global declines. Determining what drives native fish resilience to disturbance is crucial to understanding their persistence in the face of multiple stressors. Resilience is enhanced by a species ability to rapidly recover after a disturbance event. Fish colonization ability is affected by site-level and species-level factors, including habitat quality and movement capabilities. In order to evaluate native fish resilience in the Wyoming Range, we (1) determined if fish could colonize sites rapidly post-defaunation, (2) evaluated site-level factors affecting colonization for both species and (3) compared species movement and colonization capabilities. To address these objectives, we conducted a defaunation experiment in headwater streams of the Wyoming Range to

quantify colonization after a small-scale disturbance. Using a generalized additive mixed model framework and backward step-wise selection, we determined which of our four predictor variables best estimated fish colonization. We also estimated fish home range size and daily movement rates at sites where no experimental disturbance occurred using bi-weekly passive integrated transponder (PIT) tag detections. Mottled Sculpin *Cottus bairdii* and Mountain Sucker *Catostomus platyrhynchus* colonization in the Wyoming Range was best predicted by pre-disturbance fish abundances and the interaction between percent surface disturbance and species. Fish colonized sites within a few weeks post-defaunation and the majority of colonists were unmarked new individuals. Average daily movement rate (within 200 meter reaches) and home range size was significantly greater for Mountain Sucker than Mottled Sculpin. Native fish in the Wyoming Range exhibit rapid colonization post-disturbance suggesting one mechanism allowing these fish populations to be resilient in the face of multiple stressors. However, larger disturbance events and barriers to movement may reduce native fish persistence, highlighting the need to minimize persistent press disturbances and maintain network connectivity.

Western Glacier Stonefly *Zapada glacier*: Wyoming's first invertebrate listed under the Endangered Species Act

Presenter: Lusha Tronstad

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Abstract: The Western Glacier Stonefly *Zapada glacier* was listed Threatened under the US Endangered Species Act (ESA) in November 2019. *Zapada glacier* is known from Wyoming and Montana and is the first listed invertebrate for the state of Wyoming. This stonefly lives in cold streams (<10 °C) draining ice and snow in the alpine zone of the Teton Mountain Range of Wyoming. We have surveyed streams originating from permanent snowfields, surface glaciers and rock glaciers in the Tetons, and *Zapada glacier* appears to prefer rock glaciers. Thermal physiology experiments and gene expression suggest that *Zapada glacier* can live in warmer waters and we hypothesize that competition with other aquatic invertebrates restricts them to colder habitats near the origin of glacial streams. Similar to plants, no Wyoming state agency has statutory authority over ESA listed insects. As for vertebrates, ESA-listed invertebrates are protected on public and private lands.

2020 CO/WY AFS Contributed Posters - Abstracts

Monitoring Rio Grande sucker and chub populations with PIT Tags

Presenter: Dana Shellhorn

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Abstract: In 2019, the Colorado Fish and Wildlife Conservation Office partnered with Baca National Wildlife Refuge and Colorado Parks and Wildlife to monitor populations of Rio Grande Suckers *Catostomus plebeius* and Rio Grande Chub *Gila Pandora* in two perennial ditches on Baca NWR. We set minnow traps overnight in ten different locations in June 2019. We identified, weighed, and measured captive fish, and inserted passive integrated transponder tags (PIT tags) into fish larger than 80 mm. Using remote detection antennas placed throughout the system, data from PIT tagging efforts continue to document movement since 2015 and drive water management decisions made seasonally at Baca NWR. Nonnative Brook Trout *Salvelinus fontinalis*, were found in the 2018 survey and several sample sites were selected to determine their presence in 2019. We captured 1,129 fish and 164 recaptures in 2019. Recaptures comprised 22% of the total Rio Grande Suckers and 3% of the total Rio Grande Chubs. No Brook Trout were captured. We inserted 959 new PIT tags, bringing the total PIT tags deployed since 2015 to 5,893. Length-frequency distributions for both target species were statistically normal and showed evidence of recruitment of juveniles into adult size classes. The 2019 sampling effort increased the accuracy of the database and movement study by adding more PIT tags to the system while providing data on fish populations and habitat use versus availability. Passive sampling methods limit the size of fish captured and the type of habitat that can be sampled. Utilizing some electrofishing surveys in the future would allow examination of the distribution of all age classes and determine population health in a variety of stream habitats.

Better understanding utilization of upper Colorado River basin tributaries by native fish using PIT tag technology

Presenter: John E Cleveland

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Abstract: Various anthropogenic changes, including nonnative fish introductions, construction of dams, and diversion of water have caused native fish species of the upper Colorado River basin to decline. These species include Bonytail Chub *Gila elegans*, Colorado Pikeminnow *Ptychocheilus lucius*, Humpback Chub *Gila cypha*, and Razorback Sucker *Xyrauchen texanus*, which have all been listed as endangered. Bluehead Sucker *Catostomus discobolus*, Flannelmouth Sucker *C. latipinnis*, and Roundtail

Chub *G. robusta*, which were once widespread and abundant throughout the upper Colorado River basin, have also been in decline. Because of this, it is important to better understand these species' life cycles, which include movements and migrations throughout the mainstem Colorado River and the utilization of tributaries. One way that fisheries managers have done this is by tagging native fish with passive integrated transponders (PIT) tags and deploying PIT tag antennas to better document their movements. Four tributaries of the Colorado River between Glenwood Canyon and DeBeque Canyon (Garfield Creek, Parachute Creek, Mamm Creek, and Roan Creek) had never been monitored with PIT tag antennas. In 2019, one, three-foot (0.9144 m) diameter, portable, submersible PIT antenna was deployed in each tributary. Antennas were deployed from early spring to late summer with data collection ranging from 170 days to 24 days depending on environmental conditions. Antennas were set within 1,200 m of each tributary's confluence with the Colorado River. On a monthly basis, batteries were replaced and data was downloaded for analysis. Data collected from these tributaries can be used to better understand which species are utilizing these tributaries, identify potentially important time periods, as well as describe the movement of individuals and the connectivity of populations. With this information in hand, managers can better identify the timing of other management methods and research such as larval sampling, habitat restoration, and nonnative removal efforts.

Past, present and future: the 100-year history of the Daniel Fish Hatchery

Presenter: Greg Lehr

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Abstract: The Daniel Fish Hatchery is the second oldest fish hatchery in operation for the Wyoming Game and Fish Department. A need for a fish hatchery in the Pinedale area led to a bill introduced in 1917 by Senator Kendall, which appropriated funding to build the Daniel Fish Hatchery. Governor Kendrick signed the bill into law and the Fred Pape Ranch was selected after the land was donated by William and Rose Pape. The construction of the Daniel Fish Hatchery was completed in April of 1918 and it became operational in June of 1919, with Pape Spring being the sole water source. Over the next 100 years, the Daniel Fish Hatchery has undergone numerous renovations to expand the number of rearing units, increase fish production, and modernize the facilities and equipment to keep up with the evolution in fish culture. The expansion of Daniel Fish Hatchery could not have been possible without landowners Max and Marion Boroff donating property in 1957 to build a pump house to pump 1,400 gallons per min of well water to run through raceway rearing units. Throughout the Daniel Fish Hatchery's history, Rainbow Trout, Brook Trout, and Bear River Cutthroat Trout broodstocks were phased in and out of production at the facility. Presently, the Daniel Fish Hatchery manages the Colorado River Cutthroat Trout broodstock, one of four native Cutthroat Trout species with historical ranges in Wyoming. The cold 47°F water from Pape Spring and 44°F water from the Boroff well leads to slow fish growth; consequently, it takes upwards of 3 years to rear a catchable-sized fish and 4 years for Colorado River Cutthroat Trout to reach sexual maturity. However, the cold water has provided a niche for the Daniel Fish Hatchery in the Wyoming Game and Fish Department's helicopter stocking program, where fish are requested as fingerlings. Future possible endeavors for the Daniel Fish Hatchery include a cold

water isolation unit, the installation of a hot water heater or chiller for egg incubation, and the development of an early-run Kokanee broodstock.

Guide to most cypriniform fish larvae and early juveniles of the Middle Rio Grande, New Mexico, and Upper Rio Grande, Colorado

Presenter: Darrel E. Snyder

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W. Howard Brandenburg, American Southwest Ichthyological Researchers, L.L.C., 800 Encino Place, NW, Albuquerque, NM 87102-2606, whburg@gmail.com

Abstract: Use of collections of fish larvae and young-of-the-year juveniles to help document fish spawning sites and seasons or assess larval production, transport, distribution, nursery habitat, survival, and other aspects of early life history, requires diagnostic criteria to accurately distinguish target species from similar appearing taxa in the waters sampled. To facilitate identification of the larvae and early juveniles of eight cyprinids and four catostomids currently inhabiting the Middle Rio Grande of New Mexico (including nine native, one federally endangered, and three other NM or CO listed species, and all but 2 incidental cyprinids), we studied the developmental series of reared and collected specimens for differences in size relative to developmental state, morphology, meristics, and pigmentation. The results, including illustrated descriptive species accounts, comparative summary tables, and instructions for downloading and using the associated cyprinid, catostomid, and family computer-interactive keys, are documented as a guide manuscript in a final report to the U.S. Bureau of Reclamation (BR), Salt Lake City, Utah. Electronic (PDF) copies of the guide, as well as the datasets for the keys, are available on the Larval Fish Laboratory (LFL) website (https://warnercnr.colostate.edu/fwcb/larval-fish-laboratory/downloadable-keys-guides-bibliography/). This guide also covers most of the cypriniform fishes currently inhabiting the upper Rio Grande in Colorado (and New Mexico). Formal print and electronic publication is planned along with an associated guide to cyprinid larvae and early juveniles of the middle and lower Pecos River, New Mexico and Texas, and Rio Grande above their confluence in Texas.

Ultraconserved genomic elements provide a phylogenetic perspective on the evolution of the chloroperlid stonefly genus *Suwallia* (Insecta: Plecoptera: Chloroperlidae)

Presenter: Kevin Alexander

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Abstract: Evolutionary biologists have long sought to disentangle phylogenetic relationships among taxa spanning the tree of life, a task that seems increasingly important as anthropogenic influences have caused, and are expected to continue to cause, population declines and species extinctions, particularly in aquatic insects. Advances in DNA sequencing techniques have increasingly facilitated the ability of researchers to apply genomic methods to phylogenetic analyses, even for non-model organisms, which have historically lacked the genomic resources to do so. We used ultraconserved genomic element (UCE) data to reconstruct the evolutionary relationships of the chloroperlid stonefly genus *Suwallia*, which is distributed across the Nearctic and Palearctic. We sequenced UCEs for 64 individuals obtain from museum specimens representing 24 of the 29 described species of *Suwallia* (~83%) and closely related outgroups. In this poster, we present the first ever phylogeny for the genus, elucidating patterns of evolution within this geographically widespread and diverse group, and reevaluate the taxonomic placement of the monospecific chloroperlid stonefly *Neaviperla forcipata*.

‘Dude! Where’s my pond?!’ Evaluating the role of beaver activity in pond persistence over time

Presenter: Matt Webster

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Abstract: Understanding how the availability of suitable breeding habitat changes over time is critical for the effective management of aquatic species. In many stream systems throughout North America, beavers *Castor canadensis* strongly influence ecosystem structure and dynamics by modifying stream morphology and hydrology. The creation of ponds and wetlands by beavers provides critical breeding habitat for a variety of aquatic and semi-aquatic species. These aquatic habitats are not permanent fixtures on the landscape, but rather pond quality eventually declines and critical habitat becomes functionally lost by gradual successional processes or extreme hydrologic events. In such cases, for species reliant on beaver ponds, population persistence is contingent upon the creation of new ponds. Our objective is to determine how beaver pond availability changes over time at several streams in the Bridger-Teton National Forest in western Wyoming. We are analyzing historical aerial imagery to quantify the change in total area and number of beaver ponds over time, in streams with known beaver activity. This project will provide insight into the role of beaver activity on habitat persistence and turnover throughout riverine landscapes.

Sulfur stable isotopes as a tool to detect consumption of stocked prey in Wyoming reservoirs

Presenter: Jaide Phelps

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Abstract: Stable isotopes are a valuable tool for identifying food web linkages in aquatic systems, including energy pathways supporting fish. Carbon and nitrogen stable isotopes are commonly used to identify foraging patterns of predatory fish species, but the inclusion of additional stable isotopes could improve differentiation of prey utilization, specifically consumption of stocked fish. Research in the Great Lakes demonstrated the ability of sulfur stable isotopes to differentiate stocked from naturally-reproduced Lake Trout *Salvelinus namaycush* because stocked fish are fed a marine derived diet, enriched in sulfur stable isotopes. However, to our knowledge, no one has used sulfur stable isotopes to evaluate consumption of stocked fish in other study systems. In this study, we collected muscle and liver samples from 29 Walleye *Sander vitreus* in Alcova reservoir before and after stocking during the fall of 2019. Tissue samples were analyzed for carbon, nitrogen, and sulfur stable isotope composition. We predicted that if stocked trout are an important component of Walleye diets, we would detect an increase in sulfur stable isotope composition post-stocking. If present, this response should be greatest in liver tissue, which turns over at a faster rate than muscle tissue. Results from this research could improve our understanding of predation as a source of mortality for stocked fish and aid in the development of stocking and management practices to maximize recruitment of stocked fish into the fishery.

Illustrations depicting larval and juvenile development of Flathead Chub

Presenter: Darrel E. Snyder

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Abstract: The Flathead Chub *Platygobio gracilis* (Cyprinidae) has an extensive native range in central North America from the Mackenzie and Saskatchewan drainages of Canada to the Missouri, western Mississippi (mostly below Missouri R. confluence), and upper and middle Rio Grande drainages of the United States. Populations in much of its southern and eastern range have been declining and accorded state-endangered, threatened, or special concern status. Adults, which seldom exceed 19 cm TL, are typically found in turbid, moderate to fast-flowing, main-channel habitats of rivers and tributaries. As either a nonguarding, open-substrate, lithopelagophil or pelagophil, they broadcast spawn non-adhesive, semibouyant, 1.8-2.9 mm diameter eggs in relatively shallow flowing waters usually in late May to August at 17-25°C. Laboratory reared fish hatch in 4-7 days at 20-22°C; in the wild, recent hatchlings drift with the current. The larvae and early juveniles have not been previously illustrated or described.

Here, based on specimens reared or collected from the upper Rio Grande (NM, CO) and tributaries of the Arkansas River (CO), we illustrate Flathead Chub development from a recently hatched, 6.1-mm-TL, protolarva to a 40.1-mm juvenile. Larvae typically hatch with undeveloped mouths, oval, moderately pigmented eyes with a darker band across their greater diameter, and no or very little body pigment except above the yolk and ventrally near the vent and thereafter under the base of the finfold. The eyes rapidly darken and a large subterminal mouth soon develops. The eyes remain oval until late in the postflexion mesolarval phase. The larvae have 39-43 total myomeres, 26-29 preanal (to the posterior margin of the vent including those transected by a vertical therefrom), and 11-14 postanal (entire myomeres posterior to the vent). Larvae from more northern populations will likely have more myomeres corresponding to their greater number of vertebrae.

Recent invasion by mosquitofish and status of native plains fishes in Arikaree River, eastern Colorado

Presenter: Yoichiro Kanno

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Abstract: To understand spatial distributions of a recent invader, Western Mosquitofish *Gambusia affinis*, and native plains fishes, we surveyed 12 sites (100 m in length per site) in Arikaree River, eastern Colorado, located on The Nature Conservancy's Fox Ranch, in May and August, 2019. Using mainly backpack electrofishing and seining, we collected a total of 2,806 individuals in May and 6,683 individuals composed of seven native species and one nonnative species (i.e., mosquitofish). Mosquitofish were most typically found in slow-moving waters (backwaters in May and pools in August), and were the second most abundant species in May (597 individuals) and the most abundant species in August (3,048 individuals). Despite their high abundance, native species were also common, including state-listed Brassy Minnow *Hybognathus hankinsoni* (threatened) and Orangethroat Darter *Etheostoma spectabile* (special concern). However, Plains Killifish *Fundulus zebrinus*, a native species similar ecologically to mosquitofish, were not collected, indicative of potential negative interactions with mosquitofish. Relative composition of species changed from May to August, as the river discharge declined through summer, exacerbated by groundwater pumping for agricultural irrigation. In August, some sites retained flowing channels but others with only isolated standing waters; relative composition of mosquitofish increased at drying sites, suggesting that declining river discharge may facilitate invasion and persistence of mosquitofish. Overall, the effects of mosquitofish on native plains fishes were not clearly demonstrated, but continued monitoring is warranted given that mosquitofish invaded the study sites at Arikaree River only recently (within 1-2 years) and this nonnative species has widely affected native prairie fishes elsewhere.

Habitat selection of a relictual amphibian population threatened by disease

Presenter: Katrina Cook

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Abstract: Relictual populations are geographically isolated from the species' contiguous range due to distance or barriers, and may be particularly susceptible to threats such as habitat degradation or disease. Amphibians, in particular, have experienced catastrophic population declines and extirpations worldwide from habitat change and pathogens such as the chytrid *Batrachochytrium dendrobatidis* fungus. Understanding the habitat requirements and prevalence of disease in understudied populations is therefore essential for effective management and species' persistence. Moreover, the extent to which individual amphibians may be able to selectively lessen the negative effects of disease via microhabitat choices remains unknown. The wood frog *Lithobates sylvaticus* is a glacial relict species in Wyoming, found only within the Medicine Bow National Forest and the Bighorn Mountains. The wood frog is listed as a Species of Greatest Conservation Need in the Wyoming State Wildlife Action Plan because of a lack of information about key habitat requirements and susceptibility to disease (chytridiomycosis). We will investigate the habitat selection and disease status of wood frogs at multiple scales (macro- and microhabitats) and across multiple life stages (breeding, summer foraging, and over-wintering). We will radio-track up to 50 wood frogs in the Bighorn Mountains from breeding sites to hibernacula during the summers of 2020 and 2021. Tracked individuals will be swabbed multiple times each summer to assess their chytrid status. Habitat characteristics will be measured at each frog's relocation site and at random locations. We will also address the question of whether benthic macroinvertebrate communities can serve as a suitable proxy for the quality of breeding habitat and presence of wood frogs. Aquatic macroinvertebrates will be sampled across a range of potential and known breeding ponds and compared to observed numbers of wood frogs. Our study will provide valuable information about the habitat needs of, and disease threats to, wood frogs in Wyoming, and the efficacy of a novel approach to identifying suitable breeding habitat for amphibian species of concern.

Gene flow and spatial structure of nonnative Brook Trout in the Long Draw area of the upper Cache la Poudre River basin

Presenter: Audrey Harris

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Abstract: The Greenback Cutthroat Trout *Oncorhynchus clarkii stomias* (GBCT) is federally-listed as threatened and designated as the state fish of Colorado. We aim to use nonnative Brook Trout *Salvelinus fontinalis* as a surrogate for GBCT to quantify gene flow across the landscape and identify potential barriers to movement in the Long Draw Reservoir area. Currently, US Forest Service, Rocky Mountain National Park, US Fish and Wildlife Service, and Colorado Parks and Wildlife are working collaboratively to restore GBCT to a 60-km section of continuous stream network in the Long Draw region. A successful implementation of the Long Draw project will result in a fivefold increase of GBCT occupied habitat within its native range. The GBCT reclamation project involves major steps, including removing nonnative Brook Trout that currently dominate the area and physically isolating the area from (re-)invasion by nonnative trout. During summer and fall of 2018 and 2019, tissue samples were collected from 23 stream segments in the upper Cache la Poudre River basin located in Rocky Mountain National Park and Arapaho-Roosevelt National Forests. A subsample of 796 individuals is currently undergoing genetic analysis. We will genotype Brook Trout using 12 microsatellite loci, examine spatial population structure, and identify genetically similar clusters of sites. Our results will provide key scientific support for the reclamation of GBCT in the Long Draw area by informing strategic steps for removing Brook Trout and identifying potentially important habitat locations (e.g., source-sink dynamics) for GBCT. This research on Brook Trout gene flow and movement will have broader implications for future conservation of native Cutthroat Trout and water management in the face of climate change.

Sediment and fisheries: quantifying impacts of sediment releases from Willwood Dam

Presenter: Ashleigh Pilkerton

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Abstract: Managing sediment accumulation behind dams is a critical challenge in Wyoming. Accumulation of sediment behind dams can prevent their effective operation to meet water user needs, compromise structural integrity, and increase maintenance costs, but sediment releases can harm downstream fisheries and aquatic life. Due to the potential for sediment to cause environmental degradation and impact surface water designated uses, many states have developed surface water quality criteria targeting sediment. However, the criteria often do not reflect the requirements of the biological communities they are meant to protect and may be too restrictive for some time periods. In Wyoming, this challenge in managing sediment is exemplified by Willwood Dam, a 21.3 m (70 foot) tall concrete diversion dam located on the Shoshone River. Historically, sediment was released on an annual basis via the sluice gates, but concerns about the effects to the downstream fishery has led to operating criteria restricting releases. The accumulated sediment has made it difficult for the Willwood Irrigation District to operate the dam or conduct maintenance without unintentionally releasing large amounts of sediment, as

happened in 2007 and 2016. Managers, therefore, have been and are continued to be concerned about how to best protect and maintain downstream fisheries and other aquatic life in the Shoshone River, while also allowing the Willwood Irrigation District to deliver water to its users. Our work consists of a field study to evaluate the relationships between approaches that measure sediment releases from dams and their relevance to fisheries. We compare water column approaches (e.g., suspended sediment, turbidity) with river substrate approaches (e.g. sediment deposition in sensitive habitats, hyporheic dissolved oxygen) below Willwood Dam for a series of sediment release targets during the fall pool drawdown period. This research will better our understanding of effective metrics for monitoring sediment releases from dams and mitigating downstream impacts on fisheries, biological systems and fluvial processes.

Spatiotemporal patterns of hybridization of Walleye and Sauger in the Bighorn and Wind River Sauger populations

Presenter: Ashleigh Pilkerton

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Catherine Wagner, Department of Botany, Biodiversity Institute, University of Wyoming

Abstract: Sauger *Sander canadensis* are a species of greatest conservation need in Wyoming due to habitat fragmentation, competition with nonnative fish, and the potential loss of genetic integrity through co-occurrence and hybridization with Walleye *Sander vitreus*. Previous genetic analyses found that detecting hybrids may be challenging without known genotypes as some individuals appeared phenotypically to be one species, but were genetically hybrids. In turn, understanding the underlying mechanisms of hybridization between these species is pertinent for the conservation of native Sauger populations. In Wyoming's Bighorn and Wind River drainages, Sauger and Walleye live in sympatry, but previous studies have failed to detect hybrids, with the exception of one confirmed Sauger/Walleye hybrid in the Bighorn River in 2014. In this study, we used genomic data (> 10,000 SNPs) to identify the presence and pervasiveness of hybridization between Sauger and Walleye in the Bighorn and Wind River drainages. Importantly, fish were sampled at multiple locations and in multiple time periods, reflecting differences in life history that are known to exist. This sampling scheme also allowed for the characterization of any population structure between Sauger populations; several dams exist along the Bighorn and Wind rivers that may impede Sauger movement and result in genomic differentiation between populations. Of the 768 Sauger and Walleye sampled, only nine were found to be hybrids. Of these nine, six were captured in Boysen Reservoir between September 10 and September 13. Boysen Reservoir was also the only sampling location to show evidence of recent hybridization between Sauger and Walleye, and all individuals found to be the product of recent hybridization were phenotypically identified as Walleye. We also identified signatures of isolation-by-distance between Sauger sampled

along the Bighorn and Wind rivers. This may be attributable to the completion of the Boysen Dam in 1952 and reflect a negative effect of dams on Sauger movement. In conclusion, while hybridization is limited, there is evidence that both nonnative Walleye and migration barriers such as the Boysen Dam have measurably affected genomic variation in native Sauger populations.

Linking density, diet, and habitat use to trophic polymorphism in age-0 Yellow Perch

Presenter: Braxton Newkirk

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Abstract: Strong intraspecific competition can lead to differences in foraging and morphology among individuals within a population. This trophic polymorphism, or morphological variation associated with individual diet specialization on a subset of the total population niche breadth, is widespread in many fish populations. Here, we evaluate the effect of year-class strength, diet, and carbon stable isotope signatures on morphological divergence of age-0 Yellow Perch *Perca flavescens* collected in littoral and demersal habitats in Oneida Lake, New York. We tested this relationship before (1965, 1966, 1967, 1970) and after (2009, 2011) the introduction of zebra mussels *Dreissena polymorpha* and a productivity shift from a eutrophic to mesotrophic conditions in Oneida Lake, and across a range of age-0 Yellow Perch densities. Fish captured in demersal habitats generally consumed zooplankton, had more negative carbon stable isotope signatures, and exhibited more streamline body types. Fish captured in littoral habitats generally consumed benthic invertebrates, had less negative stable isotope signatures, and exhibited deeper body types. We are currently expanding our analyses to include stable isotope analyses of liver tissues to determine if variation in isotopic niche breadth found in littoral habitats is driven by movement from demersal to littoral habitats or high individual specialization on littoral prey items. Research findings suggests fish species that exhibit trophic polymorphism may have greater capacity to adapt foraging strategies, habitat use, and morphology to take advantage of shifts in resource availability, increasing their resilience to ecological perturbations.

Evaluating movement patterns of Roundtail Chub and Flannelmouth Sucker in the Blacks Fork subbasin

Presenter: Alissa Tiemann

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Abstract: Native fish populations have significantly declined in Wyoming. These declines are largely attributed to anthropogenic changes including irrigation diversions, altered flow regimes, habitat fragmentation and degradation, and the introduction of invasive species. Understanding the life histories of these native fish is critical to sustaining existing populations. Movement is a key component to the survival of a long-lived species. Movement enables fish to respond and adapt to changing environmental

conditions and increase their chances of survival, growth and reproductive success. Roundtail Chub *Gila robusta* and Flannelmouth Sucker *Catostomus latipinnis* are two of the native fish, endemic to the Blacks Fork subbasin, that have been affected by habitat alteration and invasive species. While some life history data exists for these two species, limited spatial data has been collected. Research shows these fish are likely utilizing tributaries at some point in their life cycle, however, there is a limited understanding as to how and when these fish are using main-stem and tributary habitat. Our research intends to identify the following movement behaviors: (1) determine seasonal movement patterns to understand critical habitat requirements (ie. seasonal habitat, thermal refuge) and (2) determine the timing of spawning movements into tributaries and how flow and temperature cues relate to these movements. Understanding movement patterns of Roundtail Chub and Flannelmouth Sucker will provide a better foundation to the future management and conservation of these fish.

Evaluating the effects of Brook Stickleback on native nongame fishes in the Bighorn and North Platte drainages, Wyoming

Presenter: Jake Ruthven

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Joshua Leonard, Wyoming Game and Fish Department

Abstract: Developing management plans aimed at conserving rare or threatened species is a central focus of modern fishery management. As such, understanding the mechanisms behind native species declines is of critical importance. The introduction of nonnative species can be a threat to native fishes through predation, competition, and disease transmission. However, our knowledge of the complex interactions between nonnative and imperiled fishes is lacking for many invasive species. Brook Stickleback *Culaea inconstans* is an aquatic invasive species in Wyoming that poses a potential threat to native nongame fishes. Our research seeks to elucidate (1) the current status of Brook Stickleback on the Wyoming landscape, (2) habitat associations and diet of Brook Stickleback and (3) the potential effects of Brook Stickleback on the survival and growth of species of greatest conservation need. We will present data on the current distribution of Brook Stickleback and their overlap with native species. We will also propose methods for evaluating the effects of Brook Stickleback on native nongame fishes and seek feedback ahead of the 2020 field season. Understanding how native nongame fishes are potentially affected by Brook Stickleback through the mechanisms of predation and competition will help to inform management strategies and preserve native fish diversity in Wyoming.

Evaluating potential flushing flows on the lower Shoshone River

Presenter: Bradlee Cotton

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Abstract: The lower Shoshone River (LSR) between Buffalo Bill Dam and Willwood Dam, a blue-ribbon stream home to multiple trout species, requires annual stocking due to minimal natural spawning. Spawning habitat quality is directly related to the caliber and abundance of bed sediment which is determined by hydraulic stresses. Here we analyze the discharge-dependent hydraulics under current water management strategies in the LSR to inform potential flushing flows for facilitation of natural spawning. We continuously monitored two sets of paired pool-riffle sites between May and September 2019 over a range of hydraulic conditions, 750 cfs to 3,500 cfs. In addition, six sets of synoptic hydraulic and geomorphic measurements were made during that period. Data collected include bathymetric profiles, vertical water velocity profiles, suspended sediment concentrations, water surface slopes, and bed sediment surveys. Fine sediment is input into the LSR via tributaries and irrigation return canals and is transported in suspension or deposited interstitially within gravels of the bed. Suspended sediment concentration does not have a strong relationship with discharge, and deposition is likely to occur when fine sediment delivery does not coincide with periods of high flow. Once deposited, fine sediments are unlikely to be entrained and transported until the gravel bed is remobilized. The critical stress for transport of the median bed gravel (D_{50} = 7.8 cm) is 38 Pa. Velocity profiles show that stresses exerted on the riverbed exceed the critical stress between 2,300 cfs and 3,500 cfs depending on reach morphology. Embeddedness may be a limiting factor for sediment transport within the LSR, but our observations provide no direct evidence for or against this. Successful flushing flows would require discharge levels that mobilize the bed (> 2,300-3,500 cfs) and that are maintained for a duration determined by the transport capacity of the LSR to completely remove fine sediment. Appropriate durations will be estimated in the next phase of our investigation. We note that the median size of available gravels in the main channel are approximately double the ideal size of spawning gravels but that hydraulic conditions in secondary channels locally sorts appropriate patches of ideally sized gravels.

Patterns in the length-weight relationships in Black Crappie and White Crappie

Presenter: Jacob Chambers

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Abstract: Black Crappie *Pomoxis nigromaculatus* and White Crappie *P. annularis* are important sportfish across much of the United States. These abundant panfish live in a myriad of waterways ranging from rivers to northern lakes. The two species often have slightly different habitat preferences, with White Crappie generally thriving in turbid waters. However, there has been little research done on the length-weight relationships of each species where they overlap. Using electrofishing data collected by the USGS Upper Mississippi River Restoration Program Long Term Resource Monitoring program, I compared length-weight relationship of both White and Black crappie. White Crappie appear to display a higher weight at length than Black Crappie.

Discovering the fingerprints of a Burbot

Presenter: Christoher B Lee

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Abstract: The use of individually-identifiable markings in the form of fingerprints has been used for over a century to identify humans. Similarly, individual animals can sometimes be identified by unique coloration patterns or features. When modern identification systems can distinguish between individuals of a species, such data can then assist studies in mark-recapture, population dynamics, recruitment, capture probability, estimate of survival, migration routes, and broodstock management. This study analyzed the distinctive coloration patterns of age-2+ Burbot *Lota lota* using the individual identification program Wild-ID to test the hypothesis that Burbot have unique mottling patterns. We compared the mottling patterns of individuals (n = 30) from a captive population using Wild-ID to determine if they did have distinctive individual markings. The areas of interest were the tail, dorsal section from the first dorsal fin to the eyes, and a lateral view starting from the second dorsal fin down to the lateral line then down to the start of the caudal tail. Our results showed that each individual Burbot possessed distinctive patterns, irrespective of location. This supports our hypothesis that Burbot are uniquely and identifiably patterned. This finding opens the avenue for additional research on the persistence of Burbot coloration patterns and could potentially be used as a cost-effective option for remotely identifying Burbot in laboratory settings or field settings where clear images of the fish can be obtained.

Rainbow Trout management on the Colorado River near Glenwood Springs

Presenter: Kendall Bakich

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Abstract: The Colorado River between Glenwood Canyon and Silt has been the focus of a management study of Rainbow Trout *Oncorhynchus mykiss* stocking and recruitment to optimize angler opportunities in a renowned fishing destination. Local aquatic biologists' management efforts have focused on enhancing fishing opportunity by increasing the abundance of Rainbow Trout and re-establishing wild reproduction following the devastating impacts of the introduction of whirling disease (WD). An increasingly popular fishery, the Colorado River downstream of Glenwood Springs offers angling opportunity almost year-round, particularly during colder seasons when the climate remains relatively mild and sunny days are frequent. Trout populations are managed through restrictive harvest and protection of spawning habitat through angling closures during critical periods. In the last few years, management biologists have stocked a WD-resistant Rainbow Trout hybrid that is aggressive when feeding, resistant to WD, and exhibits greater tolerance of warm water temperatures inherent in the river during the summer. Biologists have documented growth and persistence of these fish in the reach. We have detected the presence of wild Rainbow Trout that may also be increasing in abundance. Despite a variety of challenging summer conditions that include low flows, abnormally high water temperatures and large-scale sediment events related to intense rains, these fish appear to be successfully contributing to the fishery. Colorado Parks and Wildlife's stocked Rainbow Trout hybrids have exhibited excellent growth rates, some of which have put on as much as 254 mm (10 inches) in their first year in the river and a number have persisted in the reach for more than three years. Furthermore, anglers in creel surveys and

through regular individual accounts are reporting excellent fishing conditions all around and particular enthusiasm for the large Rainbow Trout and "cutbows" that put up an exciting fight on the line.