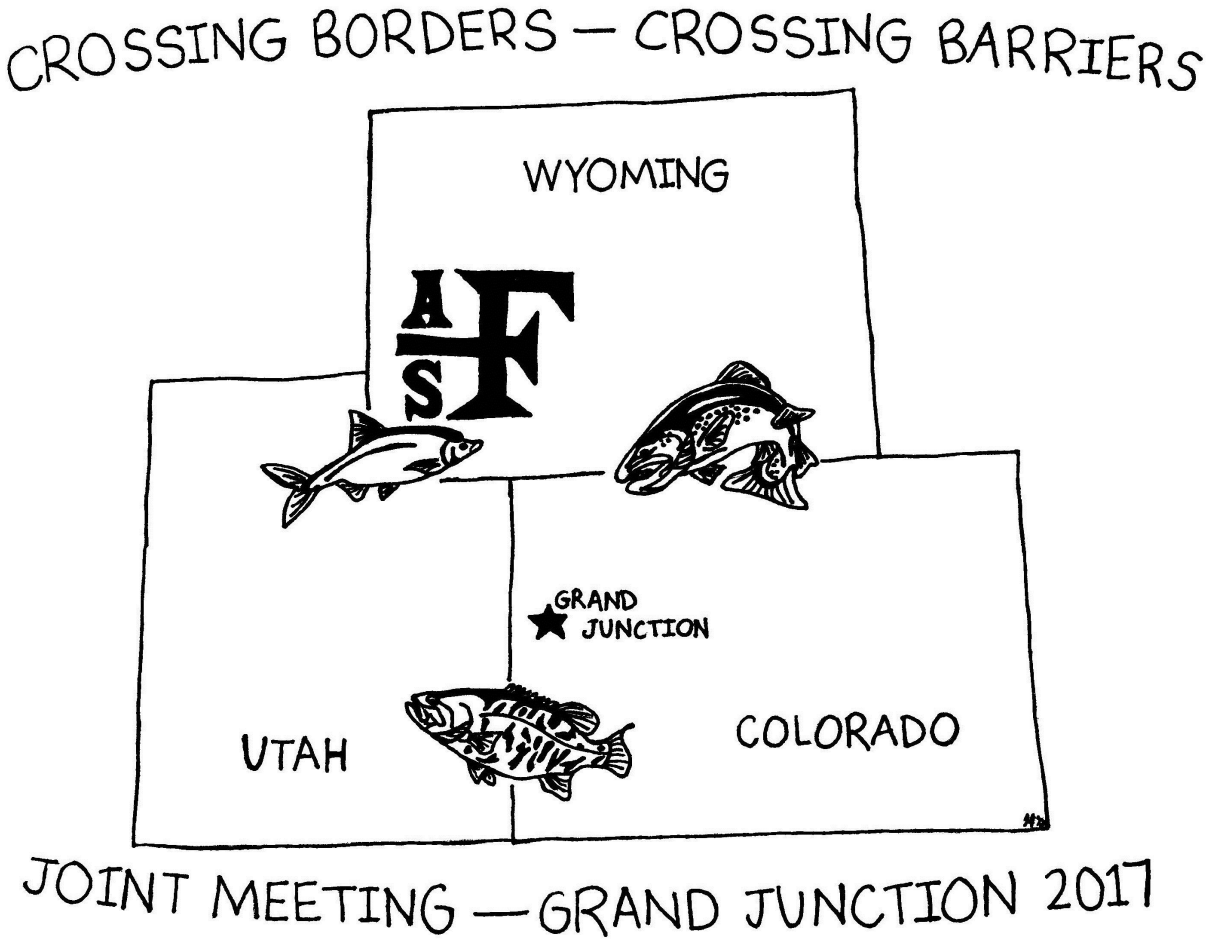
2017
UTAH and COLORADO/WYOMING Chapters
of the
American Fisheries Society



Grand Junction, Colorado
February 21-23, 2017

PROGRAM

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Virgin River Chub ($2,000+)

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Colorado River Cutthroat ($500+)

Utah

CO/WY

Bonneville Cisco ($200+)

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Vortex Optics

Snowy Range Ski Resort

Living Planet Aquarium - Salt Lake City, UT

Be sure to check out the great auction and raffle items on display in the Colorado/Mesa room. Raffle tickets will be on sale throughout the meeting.

Utah and Colorado/Wyoming Chapters of the American Fisheries Society Officers 2016-2017

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Joint Meeting Committees

Arrangements - Ben Brown and Benjamin Felt

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Awards - Jason Burckhardt and Bryan Engelbert

Continuing Education - Dan Kowalski and Diana Miller

Fundraising - Calvin Black, Paul Gerrity, Bobby Compton, and Matt Kondratieff

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Nominating - Bobby Compton

Student Liaison - Eriek Hansen

Website - Joe Skorupski

Joint meeting logo (on cover) designed by Hayley Glassic, Utah AFS Chapter.

Schedule at a Glance

Tuesday, February 21

Time	Event	Location
1:00 PM - 5:00 PM	Continuing Education - Environmental DNA (eDNA) sampling for freshwater species: a practitioner's perspective on its development, characteristics, and application	Bookcliff/Columbine
1:00 PM - 5:00 PM	Continuing Education - Advances in PIT Technology	Kokopelli
12:00 PM - 7:00 PM	Registration	Foyer
6:00 PM - 10:00 PM	Welcome Social	Horizon/Monument

Wednesday, February 22

6:30 AM - 8:00 AM	Buffet Breakfast	Kokopelli and Aspen
7:00 AM - 5:00 PM	Registration	Foyer
7:00 AM - 5:00 PM	Presentation Download	Registration Table
8:00 AM - 8:10 AM	Opening remarks and presidential message by Cassie Mellon and Rick Henderson	Grand Ballroom
8:10 AM - 9:50 AM	Plenary Session	Grand Ballroom
9:50 AM - 10:00 AM	Western Division Message by Travis Neebling	Grand Ballroom
10:20 AM - 12:00 PM	Contributed Papers - Concurrent Sessions	Bookcliff/Columbine or Horizon/Monument
12:00 PM - 1:30 PM	Lunch	Foyer
1:30 PM - 3:10 PM	Contributed Papers - Concurrent Sessions	Bookcliff/Columbine or Horizon/Monument
3:30 PM - 5:00 PM	Poster Session	Foyer
5:30 PM - 6:30 PM	Student Mentoring Program and Job Fair	Suplizio Field
6:30 PM - 10:00 PM	Student-Hosted Social	Suplizio Field

Thursday, February 23

6:30 AM - 8:00 AM	Buffet Breakfast	Kokopelli and Aspen
7:00 AM - 5:00 PM	Registration	Foyer
7:00 AM - 5:00 PM	Presentation Download	Registration Table
8:00 AM - 11:20 AM	Contributed Papers - Concurrent Sessions	Bookcliff/Columbine, Horizon/Monument, or Grand Parlor
11:30 AM - 1:00 PM	Business Meeting Luncheon	Utah - Bookcliff/ Columbine; CO/WY - Horizon/Monument
1:00 PM - 5:00 PM	Contributed Papers	Bookcliff/Columbine, Horizon/Monument, or Grand Parlor
6:00 PM - 10:00 PM	Banquet	Grand Ballroom

Looking for the abstracts? Scan this here with your mobile device.

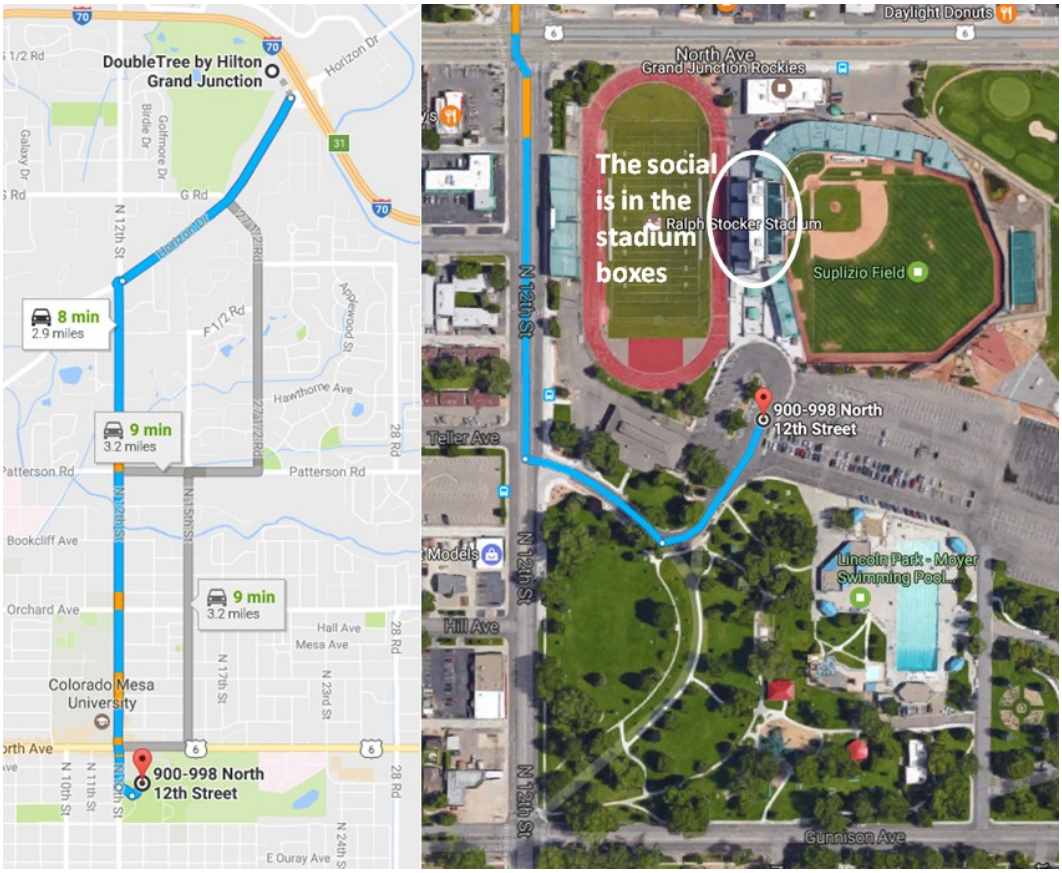
Meals and Socials

Breakfast - For registered guests of the DoubleTree by Hilton Hotel, a buffet breakfast will be provided on the mornings of February 22, 23, and 24 in the Kokopelli and Aspen rooms. Breakfast costs are included with your room reservation. If you are not a registered hotel guest, you are welcome to breakfast for $10/meal. Payments can be made at the hotel registration desk.

Lunch - Lunch will be provided to all meeting attendees on February 22 and 23 in the Foyer. There will be a sandwich buffet on February 22. On February 23, there will be boxed lunches for the Business Meeting Luncheons.

Welcome Dinner/Social - Come kick off the annual meeting from 6:00 PM - 10:00 PM on Tuesday, February 21 in the Horizon/Monument Room at the Double Tree by Hilton Hotel. Dinner will be provided. All are welcome to attend.

Student-Hosted Social - Hosted by the Colorado Mesa University Student Subunit - All are welcome to attend the social on Wednesday, February 22 at Suplizio Field (see map below). Shuttles provided by MAVrides and the DoubleTree will run from the DoubleTree to Suplizio Field from 5:00 PM to 10:00 PM. A Mentee Program Presentation will be held from 5:30 PM - 6:00 PM, followed by a Mentoring Job Fair from 6:00 PM - 6:30 PM. Food will be served from 6:30 PM to 10:00 PM. Food is provided by Famous Daves. Vegetarian options will also be provided.



Banquet - The Banquet will be held on Thursday from 6:00 PM to 10:00 PM in the Grand Ballroom. Everyone is invited to the social, auction, and raffle. A banquet ticket is required for the dinner. Dinner will be served at 6:30 PM.

AGENDA

Wednesday, February 22

8:00 - 8:10 **Cassie Mellon and Rick Henderson** Opening Remarks and Presidential Message

Plenary Session
Room: Grand Ballroom
Moderator: Cassie Mellon and Rick Henderson

8:10 - 8:35	**Paul Burnett** Building collaboration in the Weber River through the Weber River Partnership
8:35 - 9:00	**Wendy Estes-Zumpf** Rocky Mountain Amphibian Project: a collaborative effort to monitor amphibians in the Rocky Mountain Region
9:00 - 9:25	**Dave Speas** Use of passive integrated transponder technology in recovery of endangered fish in the Upper Colorado and San Juan river basins
9:25 - 9:50	**Michael Young** The aquatic eDNAtlas: an open-access, all-lands database for all species in the American West
9:50 - 10:00	**Travis Neebling** Western Division AFS Message
10:00 - 10:20	BREAK

Time	***Session 1A: Advances in Passive Integrated Transponder (PIT) Technologies Room: Bookcliff/Columbine Moderator: Trina Hedrick***	***Session 1B: The Water Front Room: Horizon/Monument Moderator: Chris Penne***
10:20 - 10:40	**Michael Fiorelli** Remote PIT technology: a tool to better understand Roundtail Chub life history traits	**Ben Holcomb** Water quality studies bridging to fish and wildlife programs
10:40 - 11:00	**Ben Stout** Improving our ability to estimate vital rates of endangered fishes on the San Juan River using novel applications of PIT tag technology	**Annika Walters** Which fish species are most vulnerable to warming stream temperatures associated with climate change?
11:00 - 11:20	**Brian W. Hodge** PIT technology elucidates the biological effectiveness of a fishway	**Andrea Taillacq** Water crossing state lines a closer look at the Rio Grande compact
11:20 - 11:40	**Timothy D'Amico** Stonecat ecology in St. Vrain Creek	**Jordan Anderson** Evaluating the distribution of estrogenic effects below wastewater treatment plants: estrogen persistence and fish movement
11:40 - 12:00	**Kevin Thompson** Short-term retention of PIT tags in Catostomid suckers through a spawning event	**Mark C. Belk** Response to drought in an assemblage of stream fishes: general predictors or species-specific responses?
12:00 - 1:30	Lunch - Foyer	

Wednesday, February 22

Time	*Session 2A:* *Why the Fish Crossed the Barrier* *Room:* *Bookcliff/Columbine* *Moderator:* *Steve Gale*	*Session 2B:* *The Lakefront Loungers* *Room:* *Horizon/Monument* *Moderator:* *Bryan Engelbert*
1:30 - 1:50	**Elizabeth Krone** Crossing barriers: evaluation of a rock ramp fishway at a water diversion on a plains stream	**Kent Sorenson** Willard Bay Reservoir: the making of Strawberry Reef
1:50 - 2:10	**Jason Kline** Crossing barriers: fish passage of Rio Grande Sucker and Chub through redesigned irrigation structures on the Baca National Wildlife Refuge	**Hayley Glassic** The influence of drought-induced lake level fluctuations on fish migration and the Bear Lake strain of the Bonneville Cutthroat Trout *Oncorhynchus clarkii utah*
2:10 - 2:30	**Cole Brittain** Monitoring behavioral patterns of the Rio Grande Sucker and Chub adapting to desertification on the Baca National Wildlife Refuge	**Scott Tolentino** Long term assessment of the Bonneville Cisco *Prosopium gemmifer* population in Bear Lake, UT/ ID 1989-2016
2:30 - 2:50	**Tyler Swarr** Steep grade ahead - developing fishway design criteria for small-bodied Great Plains fishes	**Chris Penne** Age structure and mortality of northern Utah Black Bass: determining realistic management objectives using mortality caps
2:50 - 3:10	**Ashley Hillard** Surf's up fishes: evaluating fish passage at the Gore Canyon Whitewater Park on the upper Colorado River	**Joshua Verde** Lake Powell food web structure: predicting effects of Quagga Mussel
3:10 - 3:30	BREAK	
3:30 - 5:00	Poster Session - Foyer	
5:30 - 6:30	Mentoring Program and Job Fair - Suplizio Field	
6:30 - 10:00	Student-Hosted Social and Dinner - Suplizio Field	

Thursday, February 23

	Session 3A: ***The Fish Shack*** ***Room:*** ***Bookcliff/Columbine*** ***Moderator:*** ***Russ Japuntich***	***Session 3B:*** ***Colorado River Recovery Program*** ***Room:*** ***Horizon/Monument*** ***Moderator:*** ***Andrew Treble***	***Session 3C:*** ***A Little of Everything*** ***Room:*** ***Grand Parlor*** ***Moderator:*** ***George Weekley***
8:00 - 8:20	**Benjamin Swigle** The effects of post-flood recovery on trout fisheries in the Big Thompson River, Colorado	**Thomas Chart** The Upper Colorado River endangered fish recovery program: 29 years of collaborative conservation	**Wes Gordon** The good, the bad, the ugly
8:20 - 8:40	**Colton Finch** Physical habitat constraints for trout in burned streams	**Kevin R. Bestgen** Defining needs for native fish conservation in the Upper Colorado River Basin	**Lindsy Ciepiela** Estimating behavioral diversity of salmonids in the Upper North Platte River using otolith microchemistry
8:40 - 9:00	**Ron Koth** Managing channel incision through legacy sediments in the Hill Country of the Upper Mississippi River valley	**Matthew J. Breen** Active floodplain management in a permanently altered system: benefits of "larval trigger" flow releases at Stewart Lake, Utah	**Stephen Siddons** Movement of Channel Catfish in the Red River of the North: crossing borders and barriers
9:00 - 9:20	**Christopher Kennedy** Habitat changes of a cutthroat trout stream following stochastic events	**Richard Staffeldt** Evolving nonnative fish control efforts in the middle Green River	**Robert Al-Chokhachy** Climatic variation and linkages to patterns of Yellowstone Cutthroat Trout growth, condition, and behavior in headwater streams: implications for isolated populations
9:20 - 9:40	**Kendall Bakich** Angler attitudes and behavior in relation to whitewater parks on two Colorado Rivers	**Christopher Michaud** Walleye management on the Green and Colorado Rivers	**Danielle Van Vliet and Maria Hansen** Rainbow Trout strain hybridizations as a management strategy to control bacterial coldwater disease
9:40 - 10:00	BREAK		

Thursday, February 23

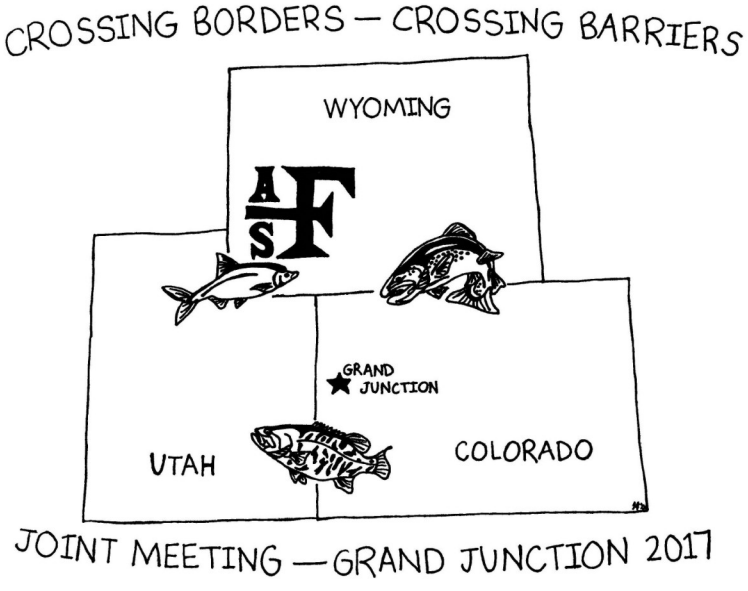
Time	*Session 4A: The Fish Shack* *Room: Bookcliff/Columbine* *Moderator: Matt Kondratieff*	*Session 4B: Colorado River Recovery Program and Sucker Salvation* *Room: Horizon/Monument* *Moderator: Wes Gordon*	*Session 4C: The Adipose Fin* *Room: Grand Parlor* *Moderator: Natalie Boren*
10:00 - 10:20	**Emily Gates** Evaluating the impact of stream restoration of Brown Trout *Salmo trutta* habitat and available feeding positions in the Upper Arkansas River, Colorado	**Darek Elverud** Status of Colorado Pikeminnow in the Colorado River	**Liz Mandeville** Hybridization between Yellowstone Cutthroat Trout and Rainbow Trout in the North Fork Shoshone River drainage
10:20 - 10:40	**Jedidiah Thompson** How does a stream restoration after a flood event and barrier removal affect fish abundance, condition and movement?	**Edward Kluender** Hybridization among native and nonnative catostomids in the Green River in Colorado and Utah 2002-2016	**Darren Rhea** Seasonal movements among fragmented populations of Colorado River Cutthroat Trout in the Cottonwood Creek drainage
10:40 - 11:00	**Scott Shahverdian** Cheap and cheerful restoration efforts to address degraded stream function: an overview of project goals and approaches	**M. Tildon Jones** Gila monitoring in Dinosaur National Monument, Colorado and Utah, 2009-present	**Clint Brunson** Discovery of a fluvial population of Bonneville Cutthroat Trout in the highly fragmented Weber River
11:00 - 11:20	**Nick Bouwes** Using alternative restoration approaches to improve habitat and increase salmonid production: results from large-scale ecosystem experiments	**Jenn Logan** Augmentation of a Bluehead Sucker *Catostomus discobolus* population utilizing captive reared fish	**R. Paul Evans** The whole genome sequence and chromosome structure of a Cutthroat Trout
11:30 - 1:00	Business Lunch: Utah - Bookcliff/Columbine and CO/WY - Horizon/Monument		

Thursday, February 23

Time	*Session 5A: The Boreal Toad Chirp* *Room: Bookcliff/ Columbine* *Moderator: Harry Crockett*	*Session 5B: Sucker Salvation* *Room: Horizon/ Monument* *Moderator: Morriah Fickes*	*Session 5C: The Final Hour* *Room: Grand Parlor* *Moderator: Tory Eyre*
1:00 - 1:20	**Larissa Bailey** Identifying drivers of local extinction in an amphibian-pathogen system	**Summer Stevens** Tributary use by spawning native catostomids in Roubideau Creek, Gunnison River Basin, CO	**Kevin Landom** Compensatory demographic response of invasive Common Carp to removal management strategies in a large, eutrophic shallow lake
1:20 - 1:40	**Larissa Bailey** Determining optimal management strategies for amphibian populations challenged by disease	**Bryan Maloney** Evaluating optimal rearing habitat for the Bluehead Sucker *Catostomus discobolus*	**Jason Burckhardt** A multi-jurisdictional effort to remove nonnative trout and restore native Yellowstone Cutthroat Trout in the upper Soda Butte Creek drainage, Montana and Wyoming
1:40 - 2:00	**Kevin Wheeler** Paunsaugunt Plateau Boreal Toad Conservation	**Chance Broderius** How "we" are saving the Weber River Bluehead Sucker population	**Justin Terfehr** Designing fish barriers for reintroduction of native fish species
2:00 - 2:20	**Brad Lambert** Influence of environmental and site-specific conditions on Boreal Toad survival and recruitment	**Michael Mills** Working towards recovery: an update on June Sucker recovery efforts	**Matt McKell** The combination of mechanical and chemical removal techniques to restore and enhance native cutthroat trout in a small drainage in northwestern Utah
2:20 - 2:40	**Cody Edwards** A Boreal Toad stronghold in the Bonneville Basin Desert, Utah	**Tom Fresques** Removing barriers: an example for 3 species in Tabeguache Creek, Colorado	**Mike Slater** Mill Creek Bonneville Cutthroat Trout restoration project
2:40 - 3:00	**Andrew Gygli** Enhancing detection of native Wyoming and Colorado amphibians through environmental DNA and visual surveys	**Brian Hickerson** Evaluation of potential translocation sites for Hornyhead Chub	**Jereme W. Gaeta** Efficacy, ecological consequences, and fishery performance of triploidy in Walleye *Sander vitreus* fishery management throughout the Intermountain West: a new research project
3:00 - 3:20	BREAK		

Thursday, February 23

Time	Session 6A: The Boreas Brag Room: Bookcliff/Columbine Moderator: Harry Crockett	Session 6B: Happy Hour Room: Horizon/Monument Moderator: Jerrad Goodell
3:20 - 3:40	**F. Boyd Wright** An investigation of the utility of eDNA sampling as a method to survey for Boreal Toads	**Jamie Reynolds** Impeding the population growth trajectory of invasive Northern Pike *Esox lucius* in Utah Lake, UT: a modeling approach
3:40 - 4:00	**Gabe Barrile** Boreal Toad habitat selection in relation to livestock grazing and disease prevalence	**Bryan M. Maitland** The fate of juvenile salmonids stranded in Alaskan off-channel flood ponds
4:00 - 4:20	**Erin Muths** How do boreal toads move across the landscape? Implications for spread of disease	**Morriah Fickes** Condition indices: sensitivity and use in nonsalmonid species
4:20 - 4:40	**Sarah Corey-Rivas** Population-level immune gene adaptations and differential tolerance to Bd fungus among Boreal Toads	**James Whelan and Ian Gowing** Mapping an invasive aquatic weed (Eurasian Watermilfoil) in Fish Lake, Utah, using an Unmanned Aerial Vehicle (sUAV)
4:40 - 5:00	**Valerie McKenzie** Field trial: manipulating the Boreal Toad skin microbiome to increase pathogen tolerance	**Natalie Day** Contaminants in the Upper Colorado Basin: the forgotten stressors, mercury and selenium
6:00 - 10:00	Banquet - Grand Ballroom	



POSTERS

Tyler Arnold "Investigating morphometric differences across and among Artic Char populations in lakes on the North Slope, Alaska"

Christopher Craft "Apple Valley - a collaborative approach to stream restoration"

Timothy D'Amico "PIT tag retention in a small-bodied native catfish *Noturus flavus*"

Kenen Goodwin "Compensatory response of Common Carp *Cyprinus carpio* fecundity following removal efforts in Utah Lake, UT"

Thomas Hafen "Growth of Bluehead Sucker under different temperature and flow regimes"

Alice Healy "Road Beaver Creek (Gunnison County, Colorado) watershed management and monitoring for possible cutthroat trout reintroduction"

Shai Kamin "Bioaccumulation of selenium and mercury in fish tissues of an urban watershed and reservoir, Denver, Colorado"

Stephen Klobucar "At the forefront: evidence of the applicability of using environmental DNA to quantify the abundance of fish populations in natural lentic waters with additional sampling considerations"

Alex LeCheminant "Movement dynamics and survival of hatchery-reared Colorado River Cutthroat Trout post-stocking"

Hunter Lucas "Comparing ontogenetic shifts of Bear Lake Sculpin *Cottus extensus* and a nearby congener species"

Spencer Miller "Predicting internal parasite communities from ecological traits of hosts: a test using rockfish *Sebastes sp*. from Alaska waters"

Kristina Morben "Quantifying proximate body composition in Catostomids using bioelectrical impedance analysis"

Brittany Nordberg "The evolutionary history of Lake Tanganyika's Nile Perch species"

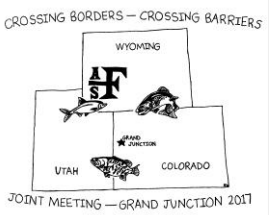
Duane Sowards "Double-crested cormorant foraging responds to fish stocking in suburban ponds in Northern Utah"

Tyler Swarr "An alternative to the "build it, monitor it, does it work?" approach to designing fish passage structures: design, construction, and operation of a full-scale indoor research fishway"

Jedidiah Thompson "How does a stream restoration after a flood event and barrier removal affect fish abundance, condition and movement?"

Richard Walker "Physiological responses of fishes to stressors associated with oil and natural gas development"

Michael Young "Sculpin Qwest: cataloging the diversity of *Cottus* in western North America"



2017 UTAH and COLORADO/WYOMING Chapters of the American Fisheries Society Contributed Paper Abstracts (in order of presentation)

Building collaboration in the Weber River through the Weber River Partnership

Paul Burnett, Trout Unlimited, 5279 South 150 East, 801-436-4062, pburnett@tu.org

Abstract: The Weber River supports a wide diversity of values important to the people of Utah by providing drinking water to 21% of Utah's population, acting as a critical landscape and water source for thousands of agricultural producers and providing economic value to our local economies as the third-most popular stream fishery in the State. This watershed supports integral habitat for Bonneville cutthroat trout and bluehead sucker, and has been severely impacted by land management actions and direct stream channel modifications as a result of flood control, irrigation diversions and transportation infrastructure. These actions have synergistically simplified over 60 miles of a historically complex river floodplain system. Concurrently, the development of diversions, dams, impoundments and road crossings have resulted in 396 fish migration barriers throughout the watershed, fragmenting the aquatic habitat. Underlying the physical habitat degradation, water demands continue to increase. Consequently, the BCT and BHS are seriously threatened by these habitat impacts. Nevertheless, their survival in razor-thin habitat margins emphasizes the resilience of these native species and continues to elevate them in priority as conservation targets because their status is so tenuous. Conservation actions to benefit BCT and BHS have been at the forefront of our efforts within the Weber River because of their high interest among anglers and significant conservation value. Despite the river's intrinsic value within our communities and economy, the Weber River is one of Utah's most degraded and at-risk river basins due to widespread watershed degradation in both the mainstem and tributary systems.

To begin addressing the broad array of challenges described above, a collaborative approach in the Weber River Watershed has been developed by agencies, NGO's and individuals with diverse backgrounds and interests through the formation of the Weber River Partnership. The Weber River Partnership has been in existence as a voluntary, informal partnership since 2013, when a steering committee developed and wrote the Weber River Watershed Plan, which was completed in 2014. In this presentation, I describe the opportunities, accomplishments and challenges of this partnership and how we have worked collaboratively to improve our watershed and build broad partnerships.

Rocky Mountain Amphibian Project: A collaborative effort to monitor amphibians in the Rocky Mountain region

Wendy Estes-Zumpf, Wyoming Game and Fish Department, Laramie, WY 82070, Wendy.Estes-Zumpf@wyo.gov

Joseph Ceradini, Wyoming Natural Diversity Database, University of Wyoming, Laramie, WY 82071, jceradin@uwyo.edu

Zachary Walker, Wyoming Game and Fish Department, Lander, WY 82520, zack.walker@wyo.gov

Brenna Marsicek, University of Wyoming Biodiversity Institute (formerly), bmarsicek@madisonaudubon.org

Abstract: Amphibians are declining globally; however, efforts to manage amphibians are frequently hindered by a lack of data on the status of local populations as well as inadequate funding for surveys. The Rocky Mountain Amphibian Project (RMAP) monitors amphibians by coordinating surveyors from multiple agencies and organizations to conduct annual monitoring surveys. Standardized surveys in predefined areas (catchments) are conducted on Forest Service lands in Wyoming and northern Colorado each year. The monitoring initiative began in 2012 and has expanded to include over 350 wetland sites in 70 catchments. In order to make the project sustainable, we began involving citizen scientists in 2014 to augment surveys conducted by biologists and technicians. Partners now include the Wyoming Natural Diversity Database, Wyoming Game and Fish Department, Medicine Bow-Routt National Forests, Bridger-Teton National Forest, Colorado Natural Heritage Program, University of Wyoming Biodiversity Institute, Wyoming Geographic Information Science Center, The Nature Conservancy, Trout Unlimited, USGS Amphibian Research and Monitoring Initiative, Teton Conservation District, and Boy Scouts of America.

Coordinating annual survey efforts of over 100 participants from two states, federal and state government agencies, and the public sector is no insignificant task. Challenges faced include recruiting, training, and coordinating a diverse array of surveyors, ensuring data integrity, database consolidation and analysis, and dissemination of results. We discuss lessons learned during this process, steps taken to overcome challenges, and the quality and quantity of data produced through this collaborative effort.

Use of passive integrated transponder technology in recovery of endangered fish in the Upper Colorado and San Juan river basins

Dave Speas, U.S. Bureau of Reclamation, 445 West Gunnison Ave Suite 221 Grand Junction CO 81501-5711, 970-248-0604, dspeas@usbr.gov

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Mark McKinstry, U.S. Bureau of Reclamation, 125 S. State St. Room 8100, Salt Lake City, UT 84138, 801-524-3835, mmckinstry@usbr.gov

Kevin McAbee, U.S. Fish and Wildlife Service, Upper Colorado Endangered Fish Recovery Program, 44 Union Blvd., Lakewood, Colorado, 80225, 303-482-7425, kevin_mcabee@fws.gov

Julie Stahli, .S. Fish and Wildlife Service, Upper Colorado Endangered Fish Recovery Program, 44 Union Blvd., Lakewood, Colorado, 80225, 303-236-4573, julie_stahli@fws.gov

Abstract: In recent years, use of passive integrated transponder (PIT) technology in the Upper Colorado and San Juan river basins has evolved from the use of PIT tags to identify individual fish in active mark/recapture investigations to use of stationary passive interrogation arrays (PIAs) and other types of antenna technology for a variety of monitoring purposes. To date, at least 18 PIA or temporary flat plate antenna installations have been deployed throughout the two river basins in an effort to answer a variety of questions related to recovery of endangered fish and/or ecology of non-listed native fish. Most of these systems were installed during the last five years and have already collected a considerable amount of endangered fish PIT data. Existing applications are intended to document fish use of tributaries, restored off-channel habitats, and fish passage structures; identification of barriers to fish movement, documentation of fish entrainment in canals, collection of ancillary tag data and/or documentation of spawning activity are also common purposes of PIA or submersible antenna deployment. Other innovative approaches which have yielded some success as data collection tools include floating PIT surveys and use of portable, submersible antennas to augment mark/recapture population estimates. While PIA systems and other PIT technology collectively result in collection of large amounts of individual tagged fish data, questions remain as to integration of data from these systems with other data types as a means to improve population and survival estimation, uncertainties about sampling efficiency, the role(s) of such technologies in future recovery or conservation efforts, ability of programs to cover operation and maintenance costs, and data acquisition and stewardship of PIT data. The recent establishment of an online PIT database covering the Upper Colorado and San Juan river basins (Species Tagging, Research and Monitoring System, STReaMS; https://streamsystem.org/) should facilitate widespread data sharing among researchers working in a diverse array of conservation settings. While the scope and extent of PIT technology usage in the San Juan and Upper Colorado river basins have their origins in multi-agency programs with a diverse range of intended purposes, increasing amount and accessibility of PIT data should greatly enhance our understanding of threatened and endangered fish life history and conservation needs.

The Aquatic eDNAtlas: an open-access, all-lands database for all species in the American west

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Abstract: Protecting aquatic biodiversity this century will require unprecedented levels of coordination among natural resource organizations and the public. The combination of realistic stream temperature scenarios from NorWeST—the West-wide stream temperature modeling project—with traditional fish sampling data from thousands of sites led to the Climate Shield models that predict and project habitat occupancy by bull trout and cutthroat trout and promote efficient, effective conservation. Expansion of this approach to include all species is now underway through the application of environmental DNA (eDNA) sampling at thousands of sites annually. Each sample can be analyzed for many species and

serves as a near-permanent record of biodiversity. To fully exploit this biodiversity archive, reduce redundant sampling, and promote data sharing, the National Fish & Wildlife Foundation has funded the Aquatic eDNAtlas project to develop a comprehensive interagency database, sampling template maps, and a website to ensure standardization of eDNA data collections while providing access to samples collected in association with the National Genomics Center for Wildlife and Fish Conservation (NGC). Data posted to the eDNAtlas website will be provided online in flexible digital formats that enable efficient use for many purposes that include species status assessments, trend monitoring, distribution modeling, detection and tracking of nonnative species invasions, and assessments of habitat restoration efforts. The website and database will be launched in 2017 and will be updated quarterly with data or samples sent to the NGC.

Remote PIT technology: A tool to better understand roundtail chub life history traits

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Abstract: Roundtail chub *Gila robusta* only occupy 45% of their historical range in the Colorado River basin and are listed as a Tier I Sensitive Species in the state of Utah. Historically, roundtail chub were the second most abundant species in the White River. Recent investigations (2009 to 2016) have shown drastic reductions in roundtail chub abundance in Utah portions of the White River. Population estimates (42.5 to 47.5 mile reach) were attempted in 2012, 2013, 2014, and 2016 but were unsuccessful due to low numbers of recaptures, which contrasts with both bluehead sucker *Catostomus discobulus*, and flannelmouth sucker *Catostomus latipinnis* population estimates which were successful with excellent confidence intervals. Previous estimates consisted of three pass mark-recapture raft electrofishing and a combination of netting techniques (trammel and hoop netting). Annual fall young-of-year seining surveys (2009-present) have shown similar trends with reduced numbers of roundtail captures. The most recent three pass population estimate performed in 2016 only encountered a total of 67 roundtail chub, with zero recaptures. This is in contrast to a total of 2,700 bluehead and flannelmouth sucker captures. In conjunction with our population estimates in 2016, we deployed two remote submersible PIT tag antennae for a total of 31 days and detected 22 individual fish. Of these 22 fish, a total of nine were roundtail, making it the most abundant species detected by the antennae. The roundtail chub detected were originally tagged from 2008 to 2016 and were never recaptured using active capture methods. Although recapture has proven difficult using more traditional sampling techniques, passive recapture is possible for roundtail on the White River. The White River also has a river-wide antenna that is constantly operating. Future plans on the White River include using a combination of remote PIT antennas, and the river wide antenna to better understand vital roundtail chub life history traits. We plan to deploy a total of five remote submersible antennas in 2017 to investigate temporal patterns in a variety of habitats. We hope that these antennas will provide information on habitat use, demographics, and movement of roundtail chub in the White River.

Improving our ability to estimate vital rates of endangered fishes on the San Juan River using novel applications of PIT tag technology

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Abstract: Accurate estimates of vital rates are essential for tracking and understanding the remaining challenges and successful recovery of endangered species. The razorback sucker *Xyrauchen texanus* and the Colorado pikeminnow *Ptychocheilus lucius* are federally endangered fish historically found in the San Juan River. Population abundance of both fishes appears to have increased, but the degree of improvement is unknown. Our overall goal is to provide robust estimates of survival and trend and to identify influential management actions. Passive Integrated Transponder (PIT) tags to allow researchers to track movement and estimate vital rates of fish. Mobile PIT tag antenna systems (e.g., on a floating raft) have recently been developed to increase resight rates. Although promising, mobile systems present new challenges to estimation techniques. Tags, not fish, are detected thus increasing the chance that shed tags or dead fish with tags are being detected which could lead to dramatic over-estimation of survival. To address this key limitation, we constructed a preliminary rule set for classification of detected tags based on distance and direction moved between detections. Our field study consisted of five passes on a 273 kilometer section of designated critical habitat on the San Juan River. PIT tags were seeded in the river in order to quantify dead/shed tag movement. Live fish movements were identified by matching tag detections with live capture data. We report on preliminary results of a two year project at its midpoint, and how those results have already substantially changed our perspective on potential PIT tag movement in river systems. We found that high flows increased the mean distance moved of seeded tags from 30.8 meters (σ=37.5m) to 206 meters (σ=396.6m). Initial analysis indicate that live fish movements are much less susceptible to high flows. We expect that refinement of our rule set will enhance our ability to distinguish between live fish and dead tag detections, and this method may be extremely useful in censoring data and increasing annual fish resighting numbers. Collectively these techniques should improve the accuracy and precision of estimates of vital rates and provide new information about post stocking location and habitat association while simultaneously decreasing the resources needed to achieve these results.

PIT technology elucidates the biological effectiveness of a fishway

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Abstract: Fishways provide an intriguing but largely unvalidated means for facilitating passage around instream obstacles. To improve the reliability of fish passage structures, biologists and engineers need more information about the rates of, and reasons for, fishway success and failure. We used passive integrated transponder (PIT) technology to evaluate the biological effectiveness of a fishway constructed to restore passage of Colorado River Cutthroat Trout *Oncorhynchus clarkii pleuriticus* (CRCT) in Poose Creek, Colorado. Study objectives were to determine 1) fishway efficacy—whether or not the fishway restored fish passage, 2) approach efficiency—the probability that a fish encountered the fishway, 3) attraction efficiency—the probability that a fish near the fishway located its entrance, and 4) passage efficiency—the probability that a fish entering the fishway navigated successfully through it. In 2012-2015 we PIT tagged and released 554 CRCT at Poose Creek, and in 2015-2016 we operated four stationary antenna arrays to monitor CRCT movement in and around the Poose Creek fishway. We used MARK and variations of the Cormack-Jolly-Seber model to evaluate fish encounter histories and derive efficiency estimates. Overall, 4% of the CRCT tagged and released in Poose Creek approached the fishway, and 100% of those that approached it succeeded in entering and navigating through it. Detection probabilities were 100% across antennas and years. While a relatively small number of encounters restricted our scope of inference, our results suggest i) that the Poose Creek fishway was effective in restoring passage of CRCT, and ii) that our study design was effective for qualifying and quantifying fish passage performance.

Stonecat ecology in St. Vrain Creek

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Abstract: Of the 25 species in the Noturus genus, the ecology of Stonecat *Noturus flavus* is relatively unknown, especially at the western extent of its North American distribution. While studies have hinted at possible habitat preferences and movement ecology of Stonecats, there have not been comprehensive analyses of Stonecat life histories. There are two Stonecat populations in Colorado, including a population of particular interest in St. Vrain Creek, a transition zone stream running through

the city of Longmont. Because the St. Vrain Stonecat population is the only extant population in a Colorado transition zone stream, understanding the habitat preference and movement of this cryptic species is paramount. We have PIT tagged Stonecats (n = 338; size range of 79 – 225 mm TL) and are using a combination of static and mobile PIT tag antennae to characterize their habitat preferences and movement ecology over an 5.3 km long section of St. Vrain Creek. To date, the greatest distance a Stonecat has moved is 2.4 km, and Stonecat prefer riffles (p = 0.652) to pools (p = 0.169) or runs (p = 0.179). The management implications of our increased understanding of Stonecat ecology will be discussed.

Short-term retention of PIT tags in catostomid suckers through a spawning event

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Abstract: Passive integrated transponder (PIT) tags are commonly used to individually identify fish, track movements, and accumulate data that can be used to estimate certain vital rates in fish populations. It is assumed that PIT tags do not hinder survival or alter behavior, and that tags are retained through the duration of the study. While these assumptions have been verified for many species, other species have exhibited poor retention or survival, or altered behavior. In this study, we evaluated short term tag retention in PIT-tagged fish and recapture rates of tagged and untagged fish in wild populations of migrating and spawning Bluehead Sucker *Catostomus discobolus* and Flannelmouth Sucker *Catostomus latipinnis*. We trapped fish as they entered a spawning tributary of the Gunnison River near Delta, CO, USA. We abdominally injected PIT tags and externally marked 2,645 native suckers; another 2,660 were given an alternate external mark but were not PIT tagged. In both cases Bluehead Sucker outnumbered Flannelmouth sucker. We recaptured about 30% of tagged Bluehead Sucker and 14.4% of tagged Flannelmouth Suckers as they exited the tributary and found a PIT tag retention rate >> 99% for both species. Moreover, we recaptured a greater proportion of PIT-tagged fish than control fish for both species (26.4% of Bluehead and 9.3% of Flannelmouth suckers that were untagged but marked). The untagged, recaptured population of suckers may have been sampled with replacement since fish were not individually identifiable. We did not identify any tag loss in females suggesting that tags were not expelled with eggs while spawning. Abdominally injected, 12.5 x 2 mm PIT tags are an effective way of marking these species.

Water Quality studies bridging to fish and wildlife programs

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Abstract: Water quality criteria are periodically updated to ensure the most recent science evaluating aquatic life toxicity is incorporated into regulations. A recent example is the update to ammonia criteria which has important ramifications to freshwater mussels and early life stages of fish. As a result, a few important baseline studies have begun to determine historic and current locations of freshwater mussels in Utah and Colorado and the locations and spawning times of fishes in Utah. These fundamental studies will serve as the foundation for not only water quality agency application in Utah and Colorado, but life history and status for these states' respective fish and wildlife agencies. The primary goal of these studies is to compile and organize available historic data, literature, and museum specimens into a database that can serve as a central repository for baseline data. It is hopeful that this goal may also serve as a statewide template for securing future data. The goal of this talk is to introduce these studies more formally to the state fish and wildlife programs so that baseline assembly efforts can be anticipated and that feedback can be received to maximize benefits from these outputs.

Which fish species are most vulnerable to warming stream temperatures associated with climate change?

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Abstract: Climate change is leading to warmer stream temperatures and altered fish distributions. One challenge for mitigating and managing these changes is predicting which fish species are most vulnerable to warmer stream temperatures. Recent works suggests that the high-elevation mountain streams inhabited by cold-water species are relatively insensitive to warming and may actually serve as climate refugia. However, vulnerability, or the susceptibility of a species to harm, is a function of both exposure and sensitivity. Our goal is to examine both the expected magnitude of climatic warming at sites that a fish species occupies (exposure) and the thermal tolerance of the fish species (sensitivity) to evaluate the vulnerability of fishes to stream warming in a high-elevation state – Wyoming. We combine occurrence data, modeled stream temperature data for both current and future time periods, and fish species thermal tolerance metrics for 35 fish species to assess the proportion of currently occupied sites that will become unsuitable for a species on the basis of future temperature predictions and the fish's physiology. We find cold-water salmonids are most vulnerable to climate change because even at the slower rate of warming experienced in high-elevation streams, warming at many of their currently occupied sites will exceed their thermal tolerances.

Water crossing state lines a closer look at the Rio Grande compact

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Abstract: Interstate compacts govern the water delivered to the borders of states in the arid west. The Rio Grande compact, signed March 18, 1938, determines how much water is to be delivered to New Mexico by Colorado and to Texas by New Mexico. The Rio Grande compact was based on data collected from a short timeframe, 1927 to 1936. The hydrography from this timeframe is compared with other historic and more recent periods. The irrigation practices during the development of the Rio Grande compact flood irrigation, differ from the irrigation practices today, sprinkler and some drip irrigation. This change has resulted in changes to how the Rio Grande compact is administered. A hydrographic analysis of some of the primary gages related to the Rio Grande compact was performed to evaluate how water use practices affect the water delivered to the borders of Colorado.

Evaluating the distribution of estrogenic effects below wastewater treatment plants: estrogen persistence and fish movement

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Abstract: Endocrine disrupting contaminants (EDCs) are a large group of chemicals that can impair normal endocrine function. Concern over EDCs has grown due to studies that indicate EDCs are widespread below wastewater treatment plants (WWTPs) and have measurable effects in both terrestrial and aquatic animals. Our goal was to gain a better understanding of the distribution of estrogenic effects downstream of WWTPs in the South Platte River drainage. To better understand the distribution of potential effects, we estimated the downstream persistence of estrogenic exposure and evaluated observed differences in responses to estrogen between wild and laboratory Fathead Minnows *Pimephales promelas*. To evaluate the persistence of estrogenic effects downstream of WWTPs, male Fathead Minnows were caged at two WWTPs where estrogenic effects were consistently observed in previous caging experiments. Our experimental design consisted of one cage placed upstream of the effluent, one cage placed in the effluent, and four cages placed downstream of the effluent. The cage intervals for the downstream cages were 400 m, 800 m, 1600 m, and 3200 m downstream of the WWTP effluent. Ten male Fathead Minnows were added to each cage and left for one week, at which point the cages were removed, the fish euthanized, and livers extracted for Vitellogenin (Vtg) analyses. Vitellogenin is an egg yolk precursor protein that indicates estrogen exposure when expressed by male fish and the presence of Vtg mRNA was used as a biomarker for exposure. Analyses of downstream persistence of Vtg are ongoing, but we hypothesize that Vtg expression will decrease downstream due

to degradation by organic or environmental processes. To evaluate previously observed Vtg differences between laboratory and wild fish exposed in streams, we conducted a laboratory study. We compared the Vtg response in two laboratory and three wild populations of Fathead Minnows exposed to 17α ethinylestradiol for seven days in separate stainless steel four liter tanks. Laboratory and wild populations expressed similar increased levels of Vtg compared to controls. Similar expression of Vtg indicates that differences seen between fish in the field are likely due to avoidance of contaminants by wild fish.

Response to drought in an assemblage of stream fishes: general predictors or species-specific responses?

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Abstract: Several studies have addressed responses of assemblages of stream fishes to disturbance. Drought and attendant low flows are a common disturbance in streams, and drought almost always results in decreased diversity of the assemblage. However, it is unclear as to whether stream fishes respond to drought based on general ecological traits such as size or functional niche, or whether species respond in species-specific ways unrelated to their ecology. We documented the response to drought from 2011-2015 by an assemblage of stream fishes in Yellow Creek located in southwestern Wyoming. Stream fish abundances were most strongly correlated with the Palmer drought Severity Index score summed from May through September and lagged by one year. Functional niche (habitat and trophic level) did not predict patterns of response to drought. On the contrary, body size was a significant predictor of abundances – small size classes exhibited a steeper slope of decline with drought compared to larger size classes. Beyond the size effect, species exhibited species-specific responses to drought. Abundances of mountain sucker *Catostomus platyrhynchus* were unaffected by drought. Abundances of speckled dace *Rhinichthys osculus* and northern leatherside chub *Lepidomeda copei* exhibited a steeper slope of decline with drought compared to redside shiner *Richardsonius balteatus* and mottled sculpin *Cottus bairdi*. Response to drought appears to be mostly a result of reduced or failed recruitment of offspring during low flow years across all species. Predictions from climate change models suggest that systems that are based on snow accumulation may shift to rain-driven systems. Consequently, if drought severity or duration increase such that periodic dewatering occurs, northern leatherside chub are likely to decline to extinction in small streams such as Yellow Creek.

Crossing barriers: evaluation of a rock ramp fishway at a water diversion on a plains stream

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Abstract: Longitudinal fragmentation due to water diversions is a pervasive human impact on stream fish habitat in the plains ecoregion of the South Platte Basin (SPB) in Colorado. Flooding during September 2013 damaged or destroyed more than 160 diversion structures across the SPB, including the Fossil Creek Reservoir Inlet Diversion (FCRID) on the Cache la Poudre River. The rebuilt diversion incorporated a rock ramp fishway with a 5% slope and strategically placed roughness elements to facilitate passage for a range of fish species. The fishway was evaluated using PIT tagged fish and radio frequency identification (RFID) antennae placed on each end of the passageway to detect directionality of fish movement. The evaluation included a three day enclosure study in which PIT tagged fish were placed in a small enclosure open only to the downstream fishway entrance. Following removal of the enclosure, RFID antennae were left in place for a three month period to evaluate utilization of the fishway under natural conditions. Water depths and velocities were measured across a range of flows to evaluate hydraulic conditions within the fishway. All species that survived tagging and placement in the enclosure exhibited successful passage through the fishway during the enclosure study, including Brassy Minnow *Hybognathus hankinsoni*, Brown Trout *Salmo trutta*, Creek Chub *Semotilus atromaculatus*, Green Sunfish *Lepomis cyanellus*, Largemouth Bass *Micropterus salmoides*, Longnose Dace *Rhinichthys cataractae*, Longnose Sucker *Catostomus catostomus*, and White Sucker *Catostomus commersonii*. Following removal of the enclosure, movements through the fishway were documented for Brown Trout, Longnose Dace, Longnose Sucker, and White Sucker. Hydraulic conditions in the fishway met design criteria for fish passage across a range of flows. However, a hydraulic jump formed at the fishway entrance during higher flows, which may have impaired utilization of the passageway by small-bodied, weaker swimming species. This evaluation demonstrated that a variety of fish species with a range of body sizes were able to successfully ascend the fishway at the FCRID. However, additional research is needed to better understand the timing, magnitude, and importance of fish movement in plains streams of the SPB.

Crossing Barriers: Fish passage of Rio Grande sucker and chub through redesigned irrigation structures on the Baca National Wildlife Refuge

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Abstract: The Baca National Wildlife Refuge is home to an aboriginal population of Rio Grande sucker *Catostomus plebeius* and Rio Grande chub *Gila pandora*. The lands that encompass the refuge started as a Spanish land grant, used mostly for cattle grazing beginning in 1860. The ranch changed ownership over the next century and half, mostly for cattle ranching, but also for mining, gas exploration, and residential development. Eventually bought by The Nature Conservancy and transferred to Fish and Wildlife Service, the 92,500 acre refuge contains 5 perennial creeks, over 400 irrigation structures and diversions and complex water rights associated with the structures. In 2015, USFWS contracted SWCA Environmental Consultants to map these structures along with aquatic habitat around them, and identify potential fish passage issues on the refuge a. In 2016, SWCA began an extensive PIT tag monitoring program to document seasonal fish movement, potential fish passage issues on existing structures and to monitor the success of three stream restoration projects to replace perched structures on the refuge. Preliminary data show fish are utilizing the new structures and are successfully navigating downstream and upstream to reach potential overwinter habitats.

Monitoring behavioral patterns of the Rio Grande sucker and chub adapting to desertification on the Baca National Wildlife Refuge

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Abstract: Climatic variances and human interference have manipulated the closed hydrological basin of the San Luis Valley, affecting the natural drainages and survivability of aboriginal species of the Rio Grande Sucker *Catostomus plebeius* and the Rio Grande Chub *Gila pandora*. For more than 100 years, large sections of the stream have been dewatered and modified forcing native aquatic species to adapt to abnormal flow regimes within atypical habitat. U.S. Fish and Wildlife and Colorado Parks and Wildlife are cooperating to document the habitat constraints of the last indigenous population of Rio Grande suckers and chubs in the state of Colorado. Using a remote antenna and tagging system deployed in perennial streams on Baca National Wildlife Refuge, we are monitoring migration patterns of aquatic species, and starting to identify which irrigation structures preclude fish passage into upstream areas. In 2015-2016, 1492 fish were tagged with Passive Integrated Transponder tags. Movement patterns appear to be influenced by seasonal flooding and temperature variation. As a result, connectivity is currently being restored to the natural creek bed through the implementation of several barrier removal projects stimulating migration to both natural spawning habitat and winter refuge. In 2016, 3 barrier removal projects allowed 6 miles of creek upstream to be accessed simultaneously providing downstream pools for over wintering. Only 14 native fish were recaptured in 2016 prior to barrier removal projects and portable antennae array deployment. In conjunction, the longest migration interval documented was 1.4 miles. The 2016 projects increased both the frequency in fish recapture

rate and distance in which they traveled. The long term survival of the Rio Grande Sucker and Chub in Colorado depends on how well the physical integrity and hydrological process of each stream can be maintained or improved upon on the Baca National Wildlife Refuge.

Steep grade ahead – Developing fishway design criteria for small-bodied Great Plains fishes

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Abstract: There is growing global recognition of the need to improve the longitudinal connectivity of lotic systems, frequently through the use of fish passage structures (fishways). When designing fishways in the past, biologists and engineers focused primarily on strong swimming, often anadromous, species such as salmonids and clupeids. However, the majority of riverine species in the interior of the United States are neither salmonids or clupeids and may not be as effective swimmers. This increases the likelihood that such species could be excluded by fishways designed using salmonid criteria, whereas biologists realize that it is important to exclude as few species within an assemblage as possible. This study measured the effects of grade (slopes of 2 – 10%, in 2% increments) on the passage success of three Great Plains fish species: Arkansas Darter *Etheostoma cragini*, Stonecat *Noturus flavus*, and Flathead Chub *Platygobio gracilis* in a 6.1-m long rock ramp research fishway fitted with multiple PIT tag antennas to detect full or partial passage success. Passage success over the full 6.1-m fishway for all species increased as slope decreased; Stonecat and Flathead Chub passage success was 100% at slopes of 2 and 4%. Arkansas Darter success was much lower than the other two species, but approached 40% at 2% slope. The results of this study provide valuable design criteria by identifying fishway slope and length combinations that allow passage of these representative small-bodied Great Plains fishes.

Surf's up fishes: evaluating fish passage at the Gore Canyon Whitewater Park on the upper Colorado River

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Abstract: With more whitewater parks (WWP) than any other state, Colorado has become the epicenter for WWP development in the United States. While WWPs have recreational and economic benefits for boaters and local communities, their impact on fisheries and aquatic ecology remains poorly understood. Some WWPs have been proposed to procure recreational in-channel diversion (RICD) water

rights that may protect instream flows from future water development. However, the potential effects of these water rights on aquatic ecosystems have not been investigated. Previous research has shown that the increased water velocity and decreased depth necessary to create a recreational play wave can degrade fish habitat and impair upstream passage. This study evaluates the impact of WWP construction on fish passage for Brown Trout *Salmo trutta*, Mountain Whitefish *Prosopium williamsoni*, White Sucker *Catostomus commersonii*, and Mottled Sculpin *Cottus bairdii* at the Gore Canyon WWP on the upper Colorado River. Baseline channel morphology was surveyed in September 2014 prior to construction. Post-construction surveys were conducted in July 2015 for the entire study reach. Additional post-construction surveys were conducted in November 2015 and March 2016 for a limited extent near the WWP structure. Topographic and hydraulic data were collected using survey grade GPS and an Acoustic Doppler Current Profiler (ADCP). Survey data were used to develop two-dimensional hydraulic models with River2D to evaluate changes in depth and velocity at the WWP structure between pre- and post-project conditions. Results from hydraulic modeling will be compared to depth and velocity criteria for each species to evaluate fish passage impairment across a range of flows. These results will be used to develop design guidelines for WWPs that optimize both recreational and ecological benefits.

Willard Bay Reservoir; The making of Strawberry Reef

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Abstract: Willard Bay Reservoir, a freshened arm of Great Salt Lake, is generally lacking in physical habitat elements. Previous attempts to augment natural features with tire reefs, Christmas trees and brush piles have resulted in mixed, and often unintended, effects. Outlined in this presentation are the needs, obstacles, methods, process and results of the project designed to give angles another option in a rather featureless basin. The goal of projects such as this is to provide features that sportfish will orient to and provide additional, well known areas for anglers to target those fish.

The influence of drought-induced lake level fluctuations on fish migration and the Bear Lake strain of the Bonneville Cutthroat Trout *Oncorhynchus clarkii utah*

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Abstract: Multiyear droughts are projected to increase in frequency and duration within arid regions across the world. In Utah, multiyear droughts have historically been associated with declines in Bear Lake water levels and disconnection between the lake and spawning tributaries. Fishes, such as the Bear Lake strain of the Bonneville cutthroat trout *Oncorhynchus clarkii utah*, a species of concern and the only natural adfluvial population of cutthroat in Utah and Idaho, need tributary connectivity to spawn as adults and out-migrate as juveniles. We tested whether lake level declines increase the tributary length and the migration distance of cutthroat by creating an elevation-explicit tributary map. UDWR gillnetting surveys (spanning 1995 – 2014) were combined with the tributary map in a mixed-effects framework to describe O. clarkii catch per unit effort as a function of fish age and tributary distance at varying

elevations. Bear Lake elevation from 1995 – 2014 ranged from 1801.25m to 1804.5m above sea level. We found that spawning tributaries can become completely disconnected from the lake when lake elevation falls below 1802 m above sea level. From 1995 – 2014, migrating cutthroat were exposed to tributary lengths ranging from 1.2km to 3.49km with a complete lack of connectivity during 7 spawning seasons within the dataset. However, no statistical relationship exists between tributary distance during the spawning season and year class strength. After evolving in the Great Basin, the population of O. clarkii in Bear Lake may be resilient under future climate change scenarios if the only threat to their habitat is an increase in tributary distance.

Long term assessment of the Bonneville Cisco *Prosopium gemmifer* population in Bear Lake, UT/ID 1989-2016

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Abstract: Hydroacoustic estimates of the Bonneville Cisco *Prosopium gemmifer* population in Bear Lake began in 1989 and has continued though current time. The Bonneville Cisco hyrdroacoustic assessment techniques were initially (1989-1995) developed by Utah State University and since that time, all hydroacoustic monitoring was assumed by the Utah Division of Wildlife Resources (UDWR). The annual population estimates have been compiled into a long-term data set, which allow the UDWR to monitor the population changes and compare and contrast these fluctuations to lake water levels, predator stocking, and/or other management changes. The data also show some promise in being able to track stronger year classes of Bonneville Cisco throughout their lifetime as well as recognizing difference in length/frequencies in some of the years. Bonneville Cisco numbers were relatively stable from 1989-1999 and averaged approximately 3-4 million fish. In 2000, their numbers increased, and although more variable, they stabilized at approximately 7-8 million fish from 2001-2014. In 2015-2016, the Bonneville Cisco numbers have declined to numbers similar to those observed from 1989-1999. It appears the Bonneville Cisco population fluctuations may be correlated with the number of stocked of juvenile Bonneville Cutthroat Trout, but more statistically analyses are necessary. The Bonneville Cisco population does not appear to be correlated with water levels.

Age structure and mortality of northern Utah black bass: determining realistic management objectives using mortality caps

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Abstract: Age structure, total annual mortality and mortality caps were estimated for black bass populations in three northern Utah Reservoirs sampled between 2011-2016. Age structure was characterized by examining the relative frequency of ages in each bass population. Total annual mortality was then estimated for each population by pooling age data over multiple years and calculating the slope of a weighted catch curve. Mortality caps were estimated over a range of different management objectives in order to determine whether or not each bass population could realistically attain common prescribed management objectives for size structure that are associated with quality fishing and population balance. Age structure at each reservoir was dominated by bass ages four and

younger, while the maximum age varied between 7-13 among the three reservoirs . Total annual mortality rates for all reservoirs ranged between 33-56%. Mortality cap modeling indicated that two out of the three reservoirs could realistically meet commonly prescribed management objectives for bass size structure. When combined with traditional age and growth data, mortality caps appear to be a useful tool for evaluating the current status of northern Utah's black bass populations and establishing realistic management objectives for the future.

Lake Powell food web structure: Predicting effects of Quagga Mussel

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Abstract: Invasive species are a major concern for existing food webs in aquatic ecosystems. Negative effects of invasive species include competition with existing species and disruption of nutrient cycling. In 2012, the Quagga Mussel *Dreissena rostriformus bugensis* was introduced into Lake Powell and is expected to move throughout the reservoir in the near future. Stable isotope analysis is a powerful tool for characterizing food webs and trophic interactions. To predict the long-term effects of Quagga Mussels, we sampled primary producers, primary consumers, prey fish species, and predator fish species in Lake Powell and analyzed them for stable isotope ratios of carbon and nitrogen. Quagga Mussel are positioned to disrupt the pelagic arm of the food web by interfering with the link between phytoplankton and herbivorous zooplankton. This will likely have negative impacts on pelagic sport fish such as Striped Bass *Morone saxatilis*. Quagga Mussel may also boost benthic productivity in the littoral zone by diverting nutrients from the water column to the benthos. This may have positive impacts on littoral fishes that feed on mollusks such as Bluegill *Lepomis macrochirus* and Green Sunfish *Lepomis cyanellus*.

The effects of post-flood recovery on trout fisheries in the Big Thompson River, Colorado.

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Abstract: Severe flooding impacted rivers and streams in the Colorado Front Range during September 2013. Following the flood, rebuilding infrastructure was given top priority and permitting processes were suspended or expedited to facilitate reconstruction activities. In many cases, emergency reconstruction activities led to degradation of stream functions and aquatic habitat. Degradation was often associated with the creation of trapezoidal and heavily armored channels. Initial monitoring following the flood showed variable impacts to fish populations, with changes in trout abundance ranging from -58% to +69% impacted by flood flows but not further altered during emergency reconstruction. Monitoring sites that underwent substantial channel alterations during emergency

reconstruction had an average change in trout abundance of -95%. Contrary to understanding flood flows did not decimate trout populations in the Big Thompson drainage, rather post-flood channel reconstruction was the primarily conduit responsible for the diminished abundance. This presentation will build upon results from initial pre-flood monitoring efforts by incorporating post-flood fisheries data collected immediately after the flood as well as 1-3 years post flood during the fall of 2014-2016. Providing an emergency river channel blueprint that addresses natural channel design and dimension prior to the next major flood could greatly improve the efficiency and effectiveness of emergency flood response while reducing long-term maintenance and stream restoration costs.

Physical habitat constraints for trout in burned streams

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Abstract: Wildland fire is a natural process in forested western watersheds, and fire has shaped the evolution of native salmonids for millennia. Wildfire severity is not constant through space or time, and the corresponding impacts to aquatic habitat are similarly varied. Post-fire debris flows and channel reorganization often create visually dramatic habitat alterations. However, habitat quality for salmonids is an aggregate of physical conditions and the limiting factor in burned watersheds may not be visually apparent. Our objective was to identify which of a suite of physical habitat characteristics best predicts the biomass of salmonids between burned and unburned watersheds. We measured stream temperature, width, depth, and velocity; vegetative cover and large woody debris; flood interval; substrate diameter; and trout biomass at ten different 100-meter index sites (seven burned, three unburned) in south-central Utah. We then used a linear mixed-effects model to determine which habitat attributes best predict biomass of Bonneville cutthroat trout stocked into burned streams or wild rainbow and brown trout from unburned control streams. We determined that percent canopy cover was the strongest predictor of salmonid biomass at each site (and was correlated with flood interval and large woody debris), followed by mean water depth and velocity; the final model included year as a random effect, but not site. Water temperature of burned streams was not a significant predictor, likely because it remained just under the critical thermal maximum for Bonneville cutthroat trout. Climate in the southwest is predicted to continue warming and drying with associated increases in fire activity; in the future it will be increasingly important to identify the physical attributes that contribute the most to native salmonid biomass. Quantitative descriptions of the relationship between habitat and biomass will ensure that limited habitat funds are efficiently distributed and will improve our understanding of the population viability and ecology of these culturally and economically important fishes.

Managing channel incision through legacy sediments in the Hill Country of the Upper Mississippi River valley

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Abstract: Land management practices in Upper Mississippi River Valley Hill Country from 1840-1950 often yielded high sediment loads from farm fields to streams and valleys. In the Hill Country or Driftless Region of Minnesota, Wisconsin, Illinois and Iowa native topography and farming practices helped transport sediment from upland fields to the lower valleys, resulting in several feet of sediment building up in a given valley. This legacy sediment is still impacting streams today and in many cases streams channels are incised as they have downcut through the sediments but have yet to reconstruct their own floodplains. For Valley Creek in Afton, MN and Pine Creek near Rushford, MN, the option to completely re-route the respective streams to re-establish floodplain connections was not available as landowner interests and other restrictions forced alternate solutions. Within this presentation we will discuss the pros and cons of different approaches to floodplain reconnection, channel re-routing, raising the channel bed, and floodplain excavation. We will also discuss the landowner interests and other restrictions, including ultimate flood elevations, easement restrictions, and upstream impacts that ultimately drove the solutions for these streams.

Habitat changes of a cutthroat trout stream following stochastic events

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Abstract: West Creek, within Rocky Mountain National Park, contains a population of the Federally Threatened greenback cutthroat trout. In 2010 a wildfire burned 1,200 acres of the headwaters of this drainage and in 2013 this drainage experienced massive flooding which visibly altered habitat within the drainage. Prior to the wildfire habitat data was collected on this stream as part of a research project looking at which habitat variables were most important to translocations of cutthroat trout. To assess the changes to the habitat of West Creek following these two stochastic events the creek was resurveyed using this researcher's protocol. Residual pool depth, instream cover (large woody debris (LWD), boulders and undercut bank), spawning gravel and temperature were measured in 2016. In addition canopy cover, which was visibly altered by both the fire and flood, was measured.

Preliminary results indicate that the habitat variables that were most affected by the stochastic events were a reduction in LWD and undercut bank. Prior to the fire 84.8% of pools contained LWD compared to 36.4% post-flood and 76.8% of pools contained undercut bank pre-fire compared to 27.3% post-flood. In addition the mean M30AT; the mean of the average daily water temperature for the 30 warmest days of the summer, which is a measure for cutthroat trout growth and recruitment, increased from pre-fire to the period between the fire and flood and increased again post-flood. Fish population densities post-fire were similar to what they were prior to the fire; however, the upstream extent of fish within West Creek may have moved downstream by 1.5 miles. Post-flood fish densities plummeted with only 16 fish captured by electrofishing within the whole drainage. These data show that the fish habitat was altered and fish densities greatly reduced following these stochastic events.

Angler attitudes and behavior in relation to whitewater parks on two Colorado Rivers

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Abstract: Whitewater park (WWP) development in Colorado is increasing at a staggering rate. Many rivers have not just one, but multiple structures constructed or proposed in single and multiple locations. Anglers in Colorado are significant contributors to our recreational economy and can be the cornerstone of local tourist economies. Colorado Parks and Wildlife (CPW) conducted creel surveys around one constructed whitewater park and near two proposed locations on the Colorado and Roaring Fork Rivers. The goal of our surveys was to evaluate the perceptions and opinions of anglers on the construction of WWPs, as well as impacts to their angling behavior. Angler reports of fishing near structures or vacating the area altogether differed depending upon year, resident status, and location. Angler attitudes also changed over time presumably as awareness of and experience with WWPs increased. Proximity of anglers to the location of the whitewater structures is also described. Future surveys will be repeated following construction of the WWP on the Roaring Fork River.

The Upper Colorado River Endangered Fish Recovery Program: 29 years of collaborative conservation

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Abstract: The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) was established in 1988. The Recovery Program is a partnership of local, state, and federal agencies, water and power interests, and environmental groups working to recover four endemic , federally endangered species of Colorado River fish (Colorado Pikeminnow *Ptychocheilus lucius*, Humpback Chub *Gila cypha*, Razorback Sucker *Xyrauchen texanus*, and Bonytail *Gila elegans* while water development proceeds in accordance with federal and state laws and interstate compacts. The Recovery Program partners implement recovery actions that are categorized in six major program elements: instream flow management, habitat development, nonnative fish control, native fish propagation, research and monitoring, and information and education. The author will review major accomplishments and remaining challenges under each program element, and will summarize progress to recovery for each of the four species.

Defining flow needs for native fish conservation in the upper Colorado River basin

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Abstract: Global trends for freshwater fishes indicate a declining and highly endangered fauna, especially for species in large rivers. Native large-river fishes in the warmwater Colorado River Basin are well-adapted to the extreme primeval physical environment but fare poorly in a highly modified system that features altered timing and magnitude of flows that are often colder and clearer than historical regimes. Abundant invasive fishes also threats posed from competition, hybridization, or predation. As a result, most large river fishes are rare and require conservation actions to persist. In the Green River basin, long-term research indicated a mismatch between timing and magnitude of peak flows from Flaming Gorge Dam and presence of Razorback Sucker *Xyrauchen texanus* larvae that were supposed to benefit. Later and higher flow releases at the Gorge resulted in river-floodplain wetland connections, subsequent transport of larvae into them, and production of substantial numbers of juvenile suckers, which may close the life-cycle gap. Adult Colorado Pikeminnow *Ptychocheilus lucius* in the Green River, the largest known population, have declined by nearly 50% in recent years due to reduced survival of adults and especially, reduced survival of young. Another long-term dataset suggests that moderate summer baseflows may increase survival of young Colorado pikeminnow to bolster adult populations. Finally, abundance of invasive smallmouth bass *Micropterus dolomieu* has increased dramatically, to the detriment of native fishes. Smallmouth bass early life stages are sensitive to flow and temperature fluctuations and reproductive success of adults may be reduced by short-term spike flows from Flaming Gorge Dam, thereby increasing recovery prospects for native fishes. Flow release flexibility is needed to assist with recovery of endangered fishes. Additional conservation issues are discussed but the specter of decreased water supplies, from extended drought or climate change, does not bode well for native fish conservation in the Colorado River Basin.

Active floodplain management in a permanently altered system: benefits of "larval trigger" flow releases at Stewart Lake, Utah

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Abstract: Endangered Razorback Sucker *Xyrauchen texanus* have declined in the Colorado River basin as impoundment-related flow alteration has reduced access to off-channel wetland habitats and nonnative species have proliferated. For decades, survival of wild-spawned Razorback Suckers to juvenile stages has been negligible, and populations have been maintained by stocking of hatchery-raised fish. Since 2013, however, the management of Stewart Lake, a gated wetland on the middle Green River near Jensen, Utah, has served as a promising model for the re-coupling of larval Razorback Suckers with productive off-channel wetland nursery habitats. In a cooperative multi-year effort by federal and state agencies called the Larval Trigger Study Plan, light trapping is being used to detect the presence of larval Razorback Suckers in the river, triggering increased releases from Flaming Gorge Reservoir, temporally

matching peak flows to the period of larval drift. In 2013 and 2014, after two and three months of entrainment, respectively, hundreds of juvenile Razorback Suckers were returned to the Green River. After a mild winter and the earliest larval emergence on record, the 2015 cohort of Stewart Lake Razorback Suckers was smaller than expected, but a number of age-1 fish spawned in 2014 were recaptured in 2015, confirming over winter survival. Riverine conditions were more favorable in 2016, filling the wetland to capacity, and we successful utilized a supplemental water source to maintain water quality well into October. As a result, 2,110 wild-spawned juvenile razorbacks (mean = 103.3 mm total length) were released to the Green River upon draining, 1,767 of which were PIT tagged to further document recruitment towards larger size classes. Additionally, 2016 marked the second consecutive year of wild reproduction (in Stewart Lake) by endangered Bonytail *Gila elegans*, which was previously undocumented. Age-1 Colorado Pikeminnow *Ptychocheilus lucius*, another endangered species, also benefitted from project design and associated operations at Stewart Lake. Here we discuss proven strategies for active floodplain management, now a requirement with permanently altered flow regimes in the Green River sub-basin, in order to benefit early-life stage recruitment of Razorback Suckers and other endangered Colorado River fishes.

Evolving nonnative fish control efforts in the middle Green River

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Abstract: A growing complement of nonnative fish species in the upper Colorado River basin (UCRB) presents one of the most serious threats to imperiled native fishes. Out of more than 50 species of nonnative fishes, three predatory species are of major concern and have been the focus of intensive mechanical removal efforts: Smallmouth Bass *Micropterus dolomieu*, Walleye *Sander vitreus*, and Northern Pike *Esox lucius*. Over the last 15 years, these efforts have been increased in scope and honed for efficiency throughout the UCRB. Here we consider the effectiveness of nonnative fish control by the Utah Division of Wildlife Resources in the middle Green River for each of these piscivorous species. Smallmouth Bass captures have decreased markedly since 2013, presumably due to multiple years of environmental conditions unfavorable to Smallmouth Bass recruitment (high spring peak flows, cooler spring/summer temperatures), combined with our targeting of “hotspots” and disruption of known spawning grounds. Walleye are an emerging threat in the system, and have become the focus of dedicated removal efforts since 2014; annual captures have remained steady in recent years. Currently riverine recruitment is limited, despite identification of a spawning area in 2015 located in Dinosaur National Monument. Steps are being taken to eliminate local reservoir sources of Walleye (rotenone treatments, screening). Adult Northern Pike have been effectively targeted with early spring fyke-netting while attempting to spawn in backwaters, tributaries, and off-channel wetlands, with the exception of a successful cohort following extended spring peak flows in 2011. This talk will evaluate the effectiveness of our nonnative mechanical removal methods based on trends in capture rates in recent years.

Walleye management on the Green and Colorado rivers

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Abstract: Walleye *Sander vitreus* are a large-bodied predatory fish native to portions of the United States and Canada east of the continental divide. This popular sport-fish was introduced to waters far outside its native range beginning in the late 1800s. By the mid 1960s Walleye populations had been established in several reservoirs within the Colorado River Basin, however, they were rarely encountered in the rivers themselves. This changed in 2007 when a rapid increase in Walleye encounters within the lotic habitats of the Upper Colorado River Basin began. Between 1992 and 2006 annual basin-wide Walleye captures averaged 16 per year, between 2007 and 2016 this average had increased to 302 fish per year. Encounters peaked in 2013 with 721 fish and have gradually declined over the past 3 years. The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) considers Walleye a threat to the continued existence of four endangered fish species in the Upper Basin. The U.S. Fish and Wildlife Service and the Utah Division of Wildlife Resources began a targeted control effort in 2014 on two sub-reaches of the Green River and one on the Colorado River. During the 2016 field season targeted Walleye removal efforts were focused on habitats frequently occupied by this species and timed during spring or spring and fall when capture efficiency is at its highest. Walleye were also removed as ancillary captures during Colorado Pikeminnow abundance estimate passes and projects targeting Smallmouth Bass. A total of 345 Walleye were encountered and removed in 2016 within the Upper Colorado River Basin. In addition to mechanical removal, headway was made in the establishment of permanent infrastructure intended to contain source populations within the reservoirs they inhabit, the replacement of fertile Walleye with triploid conspicifics in these reservoir populations and the promotion of angler harvest of Walleye in reservoirs containing these source populations.

The good, the bad, the ugly

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Abstract: Illegal introduction of Burbot Lota lota to the Green River drainage is a concern for fisheries managers in Wyoming. Native to the Big Horn and Tongue river systems, Burbot are a species of greatest conservation need in their native range. However, after crossing west of the continental divide

into the Green River system, rapid population growth and population impact on desirable sport and native fish populations have been documented, suggesting Burbot are behaving like an invasive species. The topics highlighted in this presentation will include: 1) how Burbot were thought to be introduced west of the continental divide 2) detection/range expansion in the Green River drainage 3) impacts and concerns to sport and native fisheries, and 4) management efforts currently underway.

Estimating behavioral diversity of salmonids in the upper North Platte River using otolith microchemistry.

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Abstract: As natural and anthropogenic disturbances increase in magnitude and frequency the ability of populations to rebound from disturbance will be critical to their overall success and longevity. A growing body of evidence suggests there is a positive relationship between the amount of diversity displayed by a single population and the resiliency of that population to disturbance. By tracing natal origins, time spent in rearing streams and spawning site fidelity of individual salmonids in the Upper North Platte River, a sustainable wild trout fishery, we were able to identify the behavioral diversity displayed by Brown and Rainbow Trout in this system. We found 69% of Rainbow Trout and 61% of Brown Trout captured in the mainstem of the North Platte River were born in a tributary to the North Platte River and all uniquely identifiable regions within the watershed were used for spawning. As well 43% of captured spawning Rainbow Trout had strayed from their natal origin for spawning. Our results indicate the North Platte River sport fishery is robust to point disturbances with the fishery's resiliency likely linked to the behavioral diversity of the population as well as continued access to a mosaic of spawning and rearing habitat. Furthermore, our research provides evidence that within-population diversity, particularly behavioral diversity related to movement and life history strategies, may be an important mechanism underlying resilient riverine fisheries.

Movement of Channel Catfish in the Red River of the North: crossing borders and barriers

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Abstract: The Channel Catfish Ictalurus punctatus fishery in the Red River of the North (Red River) is a well-known destination for trophy catfish with fish that are larger and longer lived than populations in other parts of North America. This fishery is managed by two states and one Canadian province under

varying regulations. While past studies have documented basin wide and interjurisdictional movements by Channel Catfish in the Red River, the extent of movement that occurs is unknown. We conducted a large-scale mark-recapture project in the lower Red River from 2012-2015 to document movement patterns of Channel Catfish greater than 200 mm. Movement was quantified with multistate models in Program MARK in an effort to determine overall movement patterns within the watershed, movement across the United States-Canada border, and movement through a suspected barrier on the lower Red River in Manitoba. We tagged 13,892 catfish in the Red River basin in Manitoba, Canada and compiled 553 recaptures. Channel Catfish successfully passed upstream through a dam on the lower Red River and moved upstream into the United States, and larger individuals (>650 mm) were most likely to make long-distance movements. We also documented Channel Catfish moving into and out of Lake Winnipeg, at the terminus of the Red River. Documenting and quantifying movement rates across borders and barriers in the Red River will help properly manage this economically valuable Channel Catfish population.

Climatic variation and linkages to patterns of Yellowstone Cutthroat Trout growth, condition, and behavior in headwater streams: implications for isolated populations

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Abstract: Despite large amounts of public land and relatively high elevations, recent analyses indicate considerable changes in temperature and hydrologic patterns within the Greater Yellowstone Area (GYA). Given, the strong influence of climate and hydrologic regimes on the phenology, demographic, and life-history patterns of inland trout, there is growing concern as how changes in climate may influence native trout populations. Understanding factors influencing the demography and vital rates of headwater populations is an important step in designing effective management and conservation strategies. To address this uncertainty, we initiated a mark-recapture field study in 2011 in multiple tributaries in Spread Creek, WY and the Shields River, MT to empirically quantify how climatic change will influence populations of Yellowstone cutthroat. We used individual mark-recapture methods with multiple sampling events within and across years to evaluate how climate may be linked with patterns of condition, growth, survival, and behavior. We specifically evaluated length-weight relationships, summer and winter growth, condition, and how stream temperature and streamflow may influence these parameters across populations. Our results indicate the importance of streamflow in driving fish growth and condition in our study streams. Surprisingly, we also found measures of fish condition during the late fall to be significantly lower than during the summer, likely driven by the low discharge during summer months. Our movement data indicated emigrants from tributary streams to have significantly lower condition than resident fish, suggesting the importance of condition in factors influencing emigration. For fish that remain in headwater streams (i.e., residents), we find considerably lower

survival for larger fish, suggesting selection towards smaller individuals. Cutthroat trout growth during the summer appears to be dominated by growth in length vs. weight. However, we found surprisingly high levels of growth in mass during the winter-spring period, likely an evolutionary adaptation for spring-spawning fish. Together our results provide important insights into the factors influencing the demographic and life-history patterns of headwater populations of cutthroat trout.

Rainbow Trout strain hybridizations as a management strategy to control bacterial coldwater disease

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Abstract: Flavobacterium psychrophilum, the etiological agent of bacterial coldwater disease (BCWD), is a devastating bacterial pathogen of salmonid populations worldwide. Bacterial coldwater disease is the leading cause of mortality in Rainbow Trout *Oncorhynchus mykiss* in Utah State hatchery systems, and has a large impact on the program due to fish loss and costs of treatment and control regimes. Unfortunately, there is no commercial vaccine to prevent this disease so alternative strategies continue to remain of importance in control efforts. As part of the ongoing attempts to manage BCWD in Utah State fish hatcheries, the Utah Division of Wildlife Resources imported a strain of Rainbow Trout from West Virginia (RTWV) that has been selectively bred for increased resistance to BCWD. To further utilize the resistant fish strain (RTWV), a series of experimental trials creating cross-strain hybrid Rainbow Trout were conducted to determine if the BCWD-resistant trait could be passed on to other fish strains. Three Rainbow Trout strains (Hofer-Harrison (RTHH), Fish Lake Desmet (RTFD), and Heritage Erwin (RTHE)) were independently crossed with the RTWV strain to produce hybrid strains. The offspring were then subject to experimental infection trials using a *F. psychrophilum* strain that is known to be highly virulent (CSF-259-93). We evaluated relative percent survival after challenge with live *F. psychrophilum* as a measure of heritability assessment for BCWD-resistance. The results demonstrated increased survival of cross-strain hybrid fish (i.e., RTWVxRTHH, RTWVxRTHE, and RTWVxRTFD) as well as increased days-to-death when compared to corresponding pure strain counterparts (i.e., RTHH, RTHE, and RTFD). The implications of these trials are far reaching within the Utah State fish hatchery program as the use of these hybrid strain crosses have the ability to help mitigate the risk of BCWD outbreaks.

Evaluating the impact of stream restoration on Brown Trout *Salmo trutta* habitat and available feeding positions in the upper Arkansas River, Colorado

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Abstract: Historic land-use activities and transbasin water diversions degraded the quantity and quality of trout habitat in the Upper Arkansas River (UAR) near Leadville, CO. Metals pollution derived from historic mining activities led to a settlement under the Natural Resource Damage Assessment provisions of the Comprehensive Environmental Response, Compensation, and Liability Act. Following remediation addressing water quality issues, habitat restoration was conducted for an 11-mile reach of the Arkansas River and Lake Fork as partial compensation to the public. Colorado Parks and Wildlife was responsible for restoration and monitoring on approximately 5 miles of public lands. Restoration treatments focused on stabilizing stream banks, promoting diverse stream morphology, reducing erosion and downstream sedimentation, enhancing overhead cover for trout, and creating diverse instream habitat including pools, riffles, and bars. Instream construction activities began in July 2013 and were completed in August 2014. To evaluate the effectiveness of habitat restoration, three control and treatment sites were established prior to restoration to support a Before-After-Control-Impact study design. Baseline surveys were conducted in 2013 prior to construction, and post-construction surveys were conducted in 2014 and 2016. Survey data were used to develop two-dimensional hydrodynamic models with River2D to estimate weighted usable area (WUA) for adult, juvenile, fry and spawning Brown Trout *Salmo trutta* across a range of discharges. Habitat suitability curves for velocity, depth and channel substrate were used to determine WUA. Model results were also used to evaluate impacts on the number of feeding positions for Brown Trout. Water depths and velocities were used to identify feeding positions that maximized foraging opportunities, while minimizing energy expenditures and predation risks. Results were analyzed with ANOVA, and indicate that restoration treatments significantly increased WUA for adult, fry, and juvenile Brown Trout by an average of 14%. No significant changes in WUA were observed at control sites. Comparatively, restoration activities increased the number of feeding positions by 34% from 2013 to 2014 at treatment sites; however, this increase was not statistically significant. Feeding positions at control sites significantly decreased by 35% from 2013 to 2016. Preliminary results indicate that stream restoration improved Brown Trout habitat in the UAR.

How does a stream restoration after a flood event and barrier removal affect fish abundance, condition and movement?

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Abstract: The North Fork of the Big Thompson River, CO incurred a 500-year flood event September 2013. An instream, riparian restoration and barrier removal project was completed in 2015 for a 2.5-mile reach of the North Fork of the Big Thompson River upstream of Drake, Co. The restoration was planned and completed by Big Thompson River Restoration Coalition, Wildlands Restoration Volunteers, FlyWater Inc. and Eco-Hydro Consulting. The objective was to create a more resilient, healthy, and functioning river corridor to restore and enhance geomorphic and ecosystem function in this reach of the North Fork by: 1) Improving river function, 2) Rehabilitate ecological function, 3) Fish habitat improvement, and 4) Fish migration improvement. The design of this project will rely on Leopold's riffle-pool-run sequence within 5 to 7 stream widths concept (Ayres Associates 2015 and McNally 2014). The primary objective of my research project was to evaluate and analyze brown trout abundance, condition and movement in response to the stream restoration and removal of in-stream barrier of the North Fork of the Big Thompson River. A secondary objective was to monitor how stocked rainbow trout disperse from a single stocking point and how their abundance and condition respond to the restoration reach. Five experimental sites were established within the 2.5-mile restoration reach. Each site was surveyed in October 2014 and 2016 using 2 pass electrofishing depletion method one year before and after the stream restoration and barrier removal. August 2015 and 2016, fish were tagged within and around the 5 sites before and after the stream restoration and barrier removal. The stream restoration and barrier removal was completed in December 2015. Brown trout abundance increased in 2 of the five sites. Average Condition (K) of Brown trout decreased in 3 of 5 sites, and the other 2 site average only differed by one-one hundredth. Movement of tagged fish was extremely minimal and almost all movement detected was down stream movement and only one upstream. This stream restoration and barrier removal shows promise for fish abundance, condition and movement. However, future sampling should occur to monitor abundance, condition, and possible movement as the stream matures years after the restoration.

Cheap and cheerful restoration efforts to address degraded stream function: an overview of project goals and approaches.

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Abstract: Given the scope of degraded streams throughout the Western United States, alternative restoration approaches that are efficient and can be used to treat larger sections of streams for a given cost than in the past, must be pursued if we hope to make significant strides to restore stream processes and recover species of concern. Here we describe several restoration approaches to address various impairments and objectives across a variety of ecosystems. Project areas range across alpine, high elevation meadows, and desert wadeable streams. We give examples of how we work with beavers or wood structures to influence stream processes. We use these restoration approaches to effect stream hydrology, geomorphology, and riparian areas to improve habitat for fish, amphibians, sage grouse, and vegetation. We also describe efforts to work with land-owners to improve forage for livestock using these tools. We also use/design restoration projects to quantify the effects of projects on local hydrology and investigate how these effects may scale up to larger spatial scales.

Using alternative restoration approaches to improve habitat and increase salmonid production: results from large-scale ecosystem experiments.

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Status of Colorado Pikeminnow in the Colorado River

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Abstract: Multiple pass population estimates of Colorado Pikeminnow *Ptychocheilus lucius* in the Colorado River began in 1992. The five year sampling rotation includes three consecutive years of sampling followed by two years when sampling does not occur. Sampling begins at Government Highline Dam near Cameo, Colorado and continues downstream to the confluence of the Colorado and Green rivers. Approximately 180 miles of river are sampled per pass with four or five passes being completed each year when flows are sufficient. Boat mounted electrofishing units are the primary gear utilized to capture Colorado Pikeminnow. Trammel nets are also utilized in flooded backwater habitats during periods of elevated river flows. The most recent estimates of adult Colorado Pikeminnow abundance in the Colorado River indicate a downward trend and significantly lower abundance of adult Colorado Pikeminnow compared to estimates for some previous years. Total number of all life stages of Colorado Pikeminnow combined is similar to previous years. The lack of recruitment for an extended period of time has likely resulted in the decrease in the adult abundance.

Hybridization among native and nonnative catostomids in the Green River in Colorado and Utah 2002 – 2016

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Abstract: Native catostomids are faced with a suite of threats in the Colorado River basin, particularly the encroachment of nonnative White Suckers *Catostomus commersonii*). White Suckers hybridize with Flannelmouth *C. latipinnis* and Bluehead suckers *C. discobolus*, and produce viable offspring. Introgressive hybridization is especially extensive between white and flannelmouth suckers, resulting in degradation of Flannelmouth sucker genetic purity where the species are sympatric. We have sampled the fish community of the Green River in Brown's Park National Wildlife Refuge and Dinosaur National Monument since 2002 to document catostomid hybridization patterns. Analysis of catostomid abundance shows White Sucker abundance is greatest in upstream reaches nearest Flaming Gorge Dam and declines downstream. Abundance of hybrids also declines in a downstream manner, indicating White Sucker abundance may drive hybrid abundance. These trends follow an increasing temperature gradient, indicating Flaming Gorge Dam creates habitat and thermal conditions that favor presence of white suckers over native catostomids. White Suckers and White x Flannelmouth Sucker hybrids are the dominant taxa in Brown's Park, and hybridization has resulted in localized extirpations of Flannelmouth

and Bluehead suckers in other rivers in the Upper Colorado River Basin. A further complication is accurate field identification of hybrid suckers, which is particularly challenging considering the gradient of morphological characteristics caused by introgressive hybridization. Conservation of native catostomids should include White Sucker control as a key part of management programs, and those programs should approach the intricacies of hybrid identification with rigor.

Gila monitoring in Dinosaur National Monument, Colorado and Utah, 2009-present

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Abstract: To better assess status and apparent decline of Humpback Chub Gila cypha in the rivers of Dinosaur National Monument, we began a program in 2009 to sample all Gila spp. during nonnative fish removal projects. We PIT tagged adult Roundtail Chub G. robusta during specific sampling passes in the Yampa River, and during all passes in the Green River. In 2015-2016, we also deployed submersible PIT tag antennas in two locations in the Yampa River to detect previously tagged chub. Results show Roundtail Chub are reproducing and recruiting in this reach of the Yampa River, and that Green River chub are using the Yampa River for spawning. Comparisons of catch rates for the recent period to past studies also indicated a decline in abundance of Roundtail Chub in this reach. Despite declining catch rates of Roundtail Chub in the Yampa River, this population maintains higher catch rates than adjacent river reaches and likely contributes to the persistence of Roundtail Chub in the Green River immediately downstream. Few, if any, Humpback Chub were captured during the course of this study, although captures of stocked Bonytail G. elegans have been increasing in recent years. Given recent genetic analyses that indicate Yampa River Roundtail Chub might be a unique lineage worthy of management as a separate stock, Dinosaur National Monument is an important area for the conservation of the species.

Augmentation of a Bluehead Sucker *Catostomus discobolus* population utilizing captive reared fish.

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Abstract: Once common in the Yampa River of northwestern Colorado, native Bluehead Sucker *Catostomus discobolus* are now encountered infrequently in the mainstem river and tributaries upstream of Lily Park, approximately 55 miles west of Craig, CO. Drought conditions, predation by non-native fish species, hydrologic changes, and competition and hybridization with non-native suckers have contributed to Bluehead Sucker population declines. The Three Species Range-Wide Conservation Agreement and Strategy (2006) established conservation actions to expand populations through transplant activities or reintroductions into historic habitats. In 2010, Colorado Parks and Wildlife (CPW) acquired Bluehead Sucker broodstock from the Yampa River near Lily Park. These fish were transported to CPW's Native Aquatic Species Restoration Facility and spawned successfully for the first time in 2012. Milk Creek, a tributary of the Yampa River located 14 miles southwest of Craig historically supported populations of Bluehead Suckers. While a small native population remains, efforts to augment this population began in 2015 with the release of 2,800 captive reared Bluehead Suckers. An additional 2,500 captive reared fish were also released into Milk Creek in 2016. Fish were reared to a minimum length of 7" and implanted with passive integrated transponder (PIT) tags. Due to elevated water conductivity, erratic stream discharge, and challenging physical habitat conditions, capture of fish by traditional survey methods is difficult within Milk Creek. To increase our detection of stocked Bluehead Suckers and aid in assessment of survival and movement, submersible passive interrogation arrays (PIAs) were also deployed. This presentation will focus on the release of these fish and subsequent monitoring efforts to evaluate the utilization of captive reared fish to augment native Bluehead Sucker populations.

Hybridization between Yellowstone Cutthroat Trout and Rainbow Trout in the North Fork Shoshone River drainage

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Abstract: Native Yellowstone cutthroat trout are sympatric with introduced rainbow trout in the North Fork Shoshone River in Wyoming and elsewhere throughout their range. These species are known to hybridize, but the extent and spatial variability of hybridization have not yet been well characterized using genetic data, although morphological analyses suggest substantial hybridization and introgression. Hybridization can have variable outcomes, and different threats to native fish exist depending on the specifics of hybridization dynamics. Threats can include genetic homogenization of species, loss of

genetically distinct native fishes, or demographic processes that result in fewer native fish produced. Because spatial variability in hybridization is unknown, it is unclear where, if anywhere, populations of pure Yellowstone cutthroat trout persist within the North Fork Shoshone drainage, and what threats hybridization poses to the native species. We sampled juvenile Oncorhynchus from 26 tributaries of the North Fork Shoshone in September 2016, and are currently working on genomic analyses of hybridization. Here we present preliminary data from three tributaries, Clearwater, Blackwater, and Eagle Creeks. Full results from all tributaries are anticipated in spring 2017, and will provide a more complete picture of hybridization dynamics in the North Fork Shoshone and its tributaries.

Seasonal movements among fragmented populations of Colorado River Cutthroat Trout in the Cottonwood Creek Drainage

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Abstract: We used radio telemetry to evaluate seasonal movements among fragmented populations of Colorado River Cutthroat Trout (CRC) in Cottonwood Creek, a tributary to the Green River. Movements of CRC within study segments followed a similar pattern throughout the year, though the frequency and distance varied among the groups. Cutthroat trout inhabiting the upper segment of South Cottonwood Creek moved the greatest distances throughout the year, while CRC within North Cottonwood Creek moved the least. Seasonal movements were among the lowest observed for inland trout species. Movements of CRC inhabiting different segments of both creeks did not overlap at any point throughout the year, indicating that fragmented habitats within the Cottonwood Creek drainage have likely affected metapopulation dynamics. Recommendations to restore, and limit further fragmentation of habitats within the drainage will help reconnect populations.

Discovery of a fluvial population of Bonneville Cutthroat Trout in the highly fragmented Weber River

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Abstract: The presence of large Bonneville Cutthroat Trout *Oncorhynchus clarkii utah* in the lower Weber River prompted the Utah Division of Wildlife Resources (UDWR), Utah State University, and Trout Unlimited to complete a study to characterize the life-history of this population. Between 2011 and 2016, over 2,200 Bonneville Cutthroat Trout were marked with Passive Integrated Transponder (PIT)

tags and 5-9 Passive Instream Arrays (PIA) were placed into 4-8 tributary streams each year. Bonneville Cutthroat Trout have moved into each of the tributary streams and have traveled up to 27 km to spawn in a given year. These data verify that a fluvial population remains in the lower Weber River. Six mainstem and 10 tributary barriers to fish movement have been identified; however, PIT-tag recapture and PIA data indicate that some of these barriers are more permeable than originally believed during some flow regimes or depending on how some in-stream structures are operated. For example, 29 fluvial Bonneville Cutthroat Trout have been documented to move upstream past a major Weber River mainstem structure during times of the year when operation favored fish passage. To date, one mainstem and three tributary structures have been modified to allow fish passage and other barriers targeted for fish passage are being prioritized using data from this study.

The whole genome sequence and chromosome structure of a cutthroat trout

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Abstract: The current understanding of phylogenetic relationships in cutthroat trout is a historical combination of morphology, geographic distribution, behavior, and the analysis of subsets of molecules from isozymes (proteins) to DNA polymorphisms (e.g., RFLP, AFLP, microsatellite, SNP, and single locus sequencing). Using three emerging DNA sequencing technologies, the BioNano Irys System, the Pac Bio, and the Illumina sequencing platforms, we have obtained reference-quality genome sequence of the putative South Platte Greenback cutthroat trout from Bear Creek, Colorado. Once fully assembled, this de novo reference genome will be one of just a handful of platinum-quality genomes for non-model organisms. We will use the Bear Creek scaffold to assemble genomes for the remaining cutthroat trout subspecies having 64 chromosomes (Bonneville, Colorado River, Yellowstone, Rio Grande, and Lahontan). We will also attempt to assemble the Coastal and Westslope cutthroat trout genomes, although their different chromosome numbers may require developing independent reference genomes. This will allow phylogenetic reconstructions based on whole genome analyses. But more significantly, it will allow the development of markers directly associated with physiological, morphological, and ecological traits among and within subspecies.

Identifying drivers of local extinction in an amphibian-pathogen system

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Abstract: Emerging infectious diseases are an increasingly common threat to wildlife, and emergence is often driven by changes in host susceptibility, pathogen infectivity, or the environment. Chytridiomycosis, caused by the fungal pathogen Batrachochytrium dendrobatidis (Bd), is an emerging infectious disease that has been linked to amphibian declines around the world. Declines of boreal toads *Anaxyrus boreas boreas* in the Southern Rocky Mountains are largely attributed to chytridiomycosis. Local extirpation of boreal toads has been observed at several sites throughout the Southern Rocky Mountains, but other populations within this region persist with Bd. Understanding the drivers of population-level susceptibility to disease can help inform management actions and guide reintroduction efforts or habitat manipulations. Using a large-scale historic dataset collected by the collaborators of the Boreal Toad Recovery Team, we explored several potential drivers of disease dynamics in the boreal toad-Bd system: climate differences, genetic isolation of populations, amphibian community diversity, and habitat permanence. We found evidence that boreal toad extinction risk is highest at intermediate elevations where temperatures may be optimal for Bd growth. Our work provides useful information for natural resource managers striving to make decisions in amphibian-Bd systems.

Determining optimal management strategies for amphibian populations challenged by disease

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Abstract: Global amphibian declines and local extirpations have been linked to the pathogenic chytrid fungus, *Batrachochytrium dendrobatidis* (Bd). Although much has been learned since the emergence of Bd, there is sparse guidance for selecting conservation strategies targeted at affected populations. We developed a predictive decision-analytic model that combines empirical knowledge of boreal toad *Anaxyrus boreas boreas* and Bd metapopulation dynamics with expert judgment regarding the effects of management actions, to select amongst potential conservation strategies. We identified optimal strategies that balance tradeoffs in maximizing boreal toad persistence and landscape-level distribution, while considering financial costs. The implementation of optimal management strategies should reduce the expected decline of occupied toad breeding sites in the Southern Rocky Mountains from 53% to 21% over 50 years. Our findings are being incorporated into a revised Boreal Toad Conservation Plan to guide immediate conservation efforts. Our online modeling application facilitates model use by managers and provides a template for applying the approach to other host-pathogen systems.

Paunsaugunt Plateau Boreal Toad conservation

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Abstract: The isolated Boreal Toad population on the Paunsaugunt Plateau in south-central Utah has undergone declines in adults and juveniles as well as eggstrands or tadpoles since monitoring was initiated in 1994. This may be attributed to chytrid fungus, which was first documented in 2001, but may have been present earlier. Habitat degradation, specifically beaver abandonment of dams and ponds, has also likely played a role. Multiple studies have shown that the Paunsaugunt Plateau population is genetically distinct from other populations, possibly even representing a separate subspecies or species. To protect this genetically unique population from possible extirpation, the Utah Division of Wildlife Resources and Dixie National Forest, in cooperation with other partners, have developed a conservation plan and are implementing actions to conserve the boreal toads and protect and restore habitats on the Paunsaugunt Plateau.

In 2008, an assurance population was established by collecting portions of egg strands from breeding sites on the Paunsaugunt Plateau and raising the toads in captivity. Between 2008 and 2016, portions of 22 eggstrands were successfully raised in captivity, resulting in 170 toads from 13 sibling lots. They are currently being held at six institutions, including zoos, aquariums, and the UDWR-managed Wahweap Warmwater Hatchery.

Beaver were reintroduced to the East Fork Sevier River in 2012, resulting in improved and expanded breeding habitat that Boreal Toads have used. Head-started Boreal Toad metamorphs are being released in these new habitats. Beaver dam analogues are being installed along the creek, slowing erosion where the creek bed has been incised and raising the water table. Aspen and willow stands near historic beaver habitats are being restored and protected from livestock and wildlife grazing. A pond created to control erosion is being repaired to provide additional habitat for expansion and reintroduction. It is hoped that these actions will alleviate threats to the Boreal Toad population and result in an expanding, larger population.

Influence of environmental and site-specific conditions on Boreal Toad survival and recruitment

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Abstract: Effectively addressing the problem of amphibian declines is hampered by a myriad of challenges. One such challenge for many species is a lack of understanding of the mechanics of

amphibian demography and thus an inability to adequately predict the effect of management actions. Often in the case of amphibian decline studies, unreliable estimates of demographic parameters result from short-term or small data sets. However, as long-term data sets become available, our ability to provide confident estimates increases. We used 14 years of mark-recapture data collected from an ongoing research effort at three boreal toad breeding sites in central Colorado to estimate survival and recruitment. A Pradel reverse-time model was used to assess how environmental and site-specific conditions act on the demography of a population of boreal toads to bolster our understanding of this rapidly declining species. Adult survival was consistently high at the three sites whereas recruitment was more variable and markedly low at one site. We found that active season moisture, active season length and depth of breeding shallows were important factors in recruitment success. To effectively determine management actions, it is useful to have an understanding of how different demographic components contribute to population dynamics.

A Boreal Toad stronghold in the Bonneville Basin Desert, Utah

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Abstract: The boreal toad *Anaxyrus boreas* population in the Grouse Creek Mountains, West Box Elder County, Utah, may be the largest and strongest remaining in the State of Utah. This population is unique because they occur at lower elevations (5080-6780 ft), in a desert environment (annual precipitation of 10-12"), and on mixed landownership (BLM, SITLA, and private). This population, which consists of more than 10 breeding sites, has been extensively studied for the past 20 years with 1,792 boreal toads being PIT-tagged since 1999. The Utah Division of Wildlife Resources and BLM have documented 34 boreal toad movements of 0.6-4.7 miles between breeding sites across a sagebrush/juniper landscape and longevity of up to 16 years. Because extensive movements between populations have been documented, these populations are now considered to be part of a boreal toad metapopulation and are not isolated as previously believed. Population estimates of breeding adult boreal toads on a given year demonstrate that localized breeding populations range from a few toads to larger sub-populations of more than 100 toads. Other efforts to expand the range and protect boreal toads in the Grouse Creek Mountains include habitat improvement projects and introductions into new habitats. Breeding habitat has been enhanced at seven boreal toad breeding locations, resulting in more consistent breeding and recruitment. Boreal toads were introduced into two springs and reproduction has been documented in 7 of 8 and 2 of 4 years post stocking. All life stages of boreal toad were repatriated with the majority being age-1 toads which have been re-sampled repeatedly through time allowing the development of a growth curve for this population. Chytrid fungus monitoring in 2006, 2009, and 2013 indicate that this population is not infected with Batrachochytrium dendrobatidis (Bd).

Enhancing detection of native Wyoming and Colorado amphibians through environmental DNA and Visual Surveys

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Abstract: Long-term monitoring of amphibian populations is an essential management need as amphibian biodiversity is declining more rapidly than other vertebrate taxa. Of the five native amphibians on the Medicine Bow-Routt National Forest in Colorado and Wyoming, three are state Species of Concern or Greatest Conservation Need (boreal toad, northern leopard frog, wood frog; boreal chorus frog and barred tiger salamander excepting), due in part to a lack of quality data. Data for these rare, cryptic, or difficult to identify species are susceptible to imperfect detection (false negatives and/or false positives). Imperfect detection can confound accurate presence/absence surveys for target species and lead to inaccurate and imprecise estimates of occupancy, predicted species distributions, and potentially misinform management actions. We aimed to improve our ability to effectively survey and monitor amphibians by maximizing species specific detectability estimates by incorporating multiple survey methods in an occupancy modeling framework. Over two seasons we surveyed sites contained within wetland catchments (2015=20 catchments; 2016=15) across the Medicine Bow-Routt. In two surveys per visit and two visits per catchment per year, we performed 384 visual encounter (VES) and 466 environmental (eDNA). We collected eDNA samples and VES simultaneously to ensure survey cohesion. We then used quantitative real-time PCR to determine species presence based on eDNA surveys. After correcting for environmental factors influencing the probability of detecting each species in an occupancy modelling framework, we determined the optimal combination of VES and eDNA methods to maximize each species' detection probabilities. The benefit for each species varies with its abundance and behavior: detection estimates for ubiquitous species like boreal chorus frogs are not enhanced greatly with both survey types, while more rare and cryptic species like wood frogs exhibit greater and more precise estimates. This multi method survey framework may greatly enhance our ability to accurately detect amphibians and potentially other aquatic organisms.

Tributary use by spawning native catostomids in Roubideau Creek, Gunnison River basin, CO

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Abstract: Species specific movement within tributaries and possible temperature cues of spawning Bluehead Sucker Catostomus discobolus and Flannelmouth Sucker C. latipinnis are still poorly understood. A permanent PIT-tag passive interrogation array (PIA) was used to track upstream and downstream movement of tagged native suckers in Roubideau Creek, a tributary of the Gunnison River in southwest Colorado, near its mouth. Temperature loggers were placed in Roubideau Creek (at the PIA) and in the Gunnison River (about 10 mi downstream of Roubideau Creek confluence). The PIA was active year-round beginning February 18, 2015. Average fish residency time was calculated between upstream and downstream detections from the first detection through the peak of the downstream movements. The first detections for both species in 2015 and 2016 were on March 15th as weekly average water temperatures varied from 7.5-11°C. Downstream movements peaked in early June and concluded in early July with weekly average temperatures varying from 12-20°C. Average residency times were longer for Bluehead Suckers (33 days in 2015 and 49 days in 2016) than for Flannelmouth Suckers (23 days in 2015 and 35 days in 2016). Average weekly stream temperatures were similar between Roubideau Creek and the Gunnison River throughout the time of peak sucker use of Roubideau Creek and its tributaries for spawning. There was much more overlap in temperatures during spawning use for these native suckers than previously reported. We observed spawning to be mostly completed prior to average weekly temperatures reaching 15°C, lower than generally reported for Bluehead Sucker in the Colorado River Basin. In 2015 Flannelmouth Suckers showed earlier movement out of the creek than Bluehead Suckers. However, this observation was not repeated in 2016.

Evaluating optimal rearing habitat for the Bluehead Sucker *Catostomus discobolus*

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Abstract: Changes to riverine ecosystems that alter physical and thermal habitat available to freshwater species may cause populations to experience recruitment bottlenecks. Bluehead suckers *Catostomus discobolus* (BHS) now occupy only 47% of their historical range and the Weber River (northern UT) population is experiencing a likely recruitment bottleneck. The Weber River represents a unique drainage and habitat for BHS (high-gradient alpine river) that has become highly degraded with many dams and diversions altering fish habitat and flow and thermal regimes. Our objectives were to determine whether rearing habitat (thermal and physical) available in the Weber River may limit the BHS population. We sampled all backwaters within and just downstream (< 1 km) of associated spawning reaches for juvenile sucker and habitat characteristics. To complement field studies, we conducted laboratory experiments to evaluate juvenile BHS growth response to different treatments of water temperatures and velocities (11.5-19°C, 0.004-0.18 m/s). In the Weber River, juvenile sucker

abundance increased significantly with maximum depth of backwaters (18 sucker in shallowest backwater, 378 sucker in deepest backwater; range: 19-87 cm). Laboratory experiment results indicated that juvenile BHS growth was greatest in the intermediate temperature and slowest velocity treatment, and greatest in slow-velocity treatments across all trials. Collectively these results suggest juvenile BHS in the Weber river are limited by the availability of deep, slow backwater habitat, but are not thermally limited. By evaluating factors that may limit juvenile BHS recruitment, this study will provide a template for future restoration efforts directed at rearing habitat for this imperiled population.

How "we" are saving the Weber River Bluehead Sucker population

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Abstract: Known populations of Bluehead Sucker *Catostomus discobolus* occur in the Colorado, Snake, Weber, and Bear river drainages. Recent genetic work has demonstrated a distinction between Bonneville Basin/Snake River (BB/SR - includes the Weber River) and Colorado River Basin Bluehead Suckers and this information even provides species distinction between the two groups of Bluehead Sucker. These results may result in a petition to list the BB/SR sub-population as threatened or endangered under the Endangered Species Act. In Utah, "healthy" BB/SR populations exists in the small portion of the Snake River Drainage in the Northwestern part of the state, a declining population exists in the Weber River, and no Bluehead Sucker have been found in the Bear River Drainage. The Utah Division of Wildlife Resources (UDWR) and partners are focusing significant resources to reverse the decline of the Weber River Bluehead Sucker population. Specifically, these efforts have focused on locating and monitoring remaining sub-populations, re-connecting habitat by providing fish passage at irrigation diversion/power structures, locating and characterizing important spawning reaches, characterizing the few, remaining juvenile rearing habitats, and determining brown trout diet through isotope analyses. All of these efforts should benefit the Weber River Bluehead Sucker populations; however, our fear is that these populations are sufficiently depressed to the point that positive population level effects will not be realized. To further increase Weber River Bluehead Sucker population densities, the UDWR recently completed a draft captive brood propagation plan and stream side egg collections will begin as early as the spring of 2017.

Working towards recovery: an update on June Sucker recovery efforts

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Abstract: The June Sucker *Chasmistes liorus*, a fish endemic to Utah Lake, has been listed as an endangered species for the past 30 years. Those 30 years have been marked with numerous threats to the species' survival, including the dewatering Utah Lake tributaries, impacts from non-native species, and the destruction of habitat. In the 1990's, the wild population of June Sucker was estimated at less than 1,000 individuals and experts predicted that without extraordinary measures the species would go extinct. The June Sucker Recovery Implementation Program (JSRIP) was formally initiated in 2002 with

the dual goals of recovering the June sucker so that it no longer requires protection under the Endangered Species Act and allowing the continued use and development of water within the Utah Lake basin. Today, thousands of adult June sucker migrate up the tributaries of Utah Lake as part of annual spawning runs and produce millions of larval fish. While the JSRIP has celebrated the population increase, considerable threats to the species' continued survival remain. Increasing demands for water present challenges in providing adequate water to support spawning fish, the introduction of non-native fish pose predatory threats on the species, and restoring adequate habitat requires large scale projects within an increasingly urban area. As a new recovery plan for the species is drafted by the Fish and Wildlife Service, the JSRIP must maintain an adaptable approach to address the existing threats and prepare for future challenges in order to achieve its goals.

Removing barriers: An example for 3 species in Tabeguache Creek, Colorado

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Abstract: In Tabeguache Creek, a tributary stream in the lower San Miguel River basin, Montrose County, Southwest Colorado, the Colorado Parks & Wildlife (CPW) and Bureau of Land Management (BLM) assessed fish community differences above and below a large concrete water diversion structure that functioned as a barrier to upstream fish movement under most flow regimes. The stream is used seasonally by spawning adult Bluehead Sucker *Catostomus discobolus*, Flannelmouth Sucker *C. latipinnis*, and Roundtail Chub *Gila robusta*, collectively called the 3 Species, that reside year round in the San Miguel River. Based on the results of fish sampling, including the lack of competitive or hybridizing species, and the projected benefits of reconnecting over eight miles of preferred spawning and nursery habitat for 3 Species fishes, the BLM completed due diligence and removed the structure in the spring of 2014. Colorado Parks & Wildlife and BLM sampling conducted after barrier removal documented increased use and range expansion by these native fishes above the former barrier site. We report here the pre and post project fish sampling data, and the barrier structures removal, and discuss the benefits of this type of habitat work for 3 Species, as well as considerations for others contemplating similar work.

Evaluation of potential translocation sites for Hornyhead Chub

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Abstract: Hornyhead Chub are a Species of Greatest Conservation Need in Wyoming where they are restricted to 26 kilometers of stream habitat in two rivers. Glacial relict populations of Hornyhead Chub have been extirpated from Colorado, western Nebraska and Kansas. Because of this severely restricted distribution and a history of stochastic events causing population extirpations, there is interest in establishing new Hornyhead Chub populations through translocation. We evaluated 12 potential translocation streams within the plausible historic range of Hornyhead Chub in the North Platte River drainage, Wyoming. Fish community and habitat data were collected at 24 sites on translocation streams and compared to 21 sites on the Laramie River that currently support Hornyhead Chub populations. On the basis of fish community and habitat similarity to sites with robust Hornyhead Chub populations, we were able to identify streams not likely to support translocations and streams to investigate further during our 2017 field season.

Compensatory demographic response of invasive common carp to removal management strategies in a large, eutrophic shallow lake

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Abstract: Mechanical removal is a central component to aquatic invasive species management strategies. Ultimately, the demographic response of invasive populations to removal determines the efficacy of such management strategies. An invasive Common Carp *Cyprinus carpio* population has severely degraded the ecosystem and threatened recovery objectives for the federally endangered and endemic June Sucker *Chasmistes liorus* in Utah Lake, UT, a large, shallow, eutrophic lake. Managers initiated a large-scale mechanical carp removal effort during 2009 to alleviate their detrimental effects on the ecosystem and impediments to endangered species conservation. In this study, we evaluated the potential response of a suite of carp demographic parameters to large-scale mechanical removal. From September 2009 through December 2016, an average of 138 tons of adult carp were removed each month, for a cumulative total of nearly 12,000 tons removed over the seven plus year period. Our assessments of monitoring data showed that, although carp densities decreased consistently from 2012 through 2016 due to removal efforts, the population structure recently shifted to larger adult individuals. Proportional stock density of memorable sized carp increased substantially from an average of 14 over the years 2012 through 2015, to 37 during 2016. The body condition of adult carp also increased over recent years, and the mean weight of adults increased from 2.85 kg during 2015 to 3.69 kg during 2016. Preliminary evaluations of back-calculated length-at-age data showed an increase in carp growth rates, particularly for the relatively younger age-classes. Our results revealed a compensatory response to removal efforts, likely driven by a severe reduction in interspecific competition, which has been particularly dramatic over recent years. Our findings underline the utility of monitoring demographic attributes during invasive species management, and provide managers with the means to quantify invasive species demographic response to ongoing removal strategies.

A multi-jurisdictional effort to remove nonnative trout and restore native Yellowstone Cutthroat Trout in the upper Soda Butte Creek Drainage, Montana and Wyoming

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Abstract: Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* (YCT) are native to the Lamar River watershed and are considered a sensitive species throughout their range. YCT are also an important resource ecologically and recreationally to the Greater Yellowstone Ecosystem. YCT populations have dramatically declined with only 44% of their historic range currently occupied, and only 22% of this range supporting core conservation populations. The greatest threat to the persistence of extant YCT populations is the presence of nonnative salmonids which compete with, prey upon, and hybridize with YCT. Brook Trout *Salvelinus fontinalis* (BKT) were introduced in the Soda Butte Creek drainage as a sport fish early in the 20th century and for decades were relegated to one small tributary due to poor water quality associated with mining activities in the drainage. Mining reclamation in the early 1990s facilitated the expansion of the BKT. Electrofishing suppression of BKT in Soda Butte Creek ensued for the next two decades but the distribution of BKT continued to increase. In 2015 and 2016 Montana Fish Wildlife and Parks, Yellowstone National Park, the Wyoming Game and Fish Department, and the Shoshone and Custer-Gallatin National Forests collaborated to remove BKT from Soda Butte Creek using the chemical rotenone. This project was an effort to prevent the proliferation of BKT in the Lamar River watershed and will secure the core conservation population of YCT in Soda Butte Creek.

Designing fish barriers for reintroduction of native fish species

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Abstract: Native fishes have disappeared from many streams in the west in the last 100 years. The introduction of exotic fish species combined with dwindling in-stream flow and habitat have resulted in numerous native fish being listed as threatened, endangered or worst, going extinct. Native trout are especially at risk due to the wide spread stocking of non-native trout for the sport fishery. History has shown that native trout populations often die out when sharing habitat with non-native trout. Completion for food, introduction of predatory fish, disease and hybridization are common causes for the decline of native stock. Reclaiming reaches of headwater streams for native fish preservation is an important step toward reestablishing self-sustaining populations. WWC Engineering (WWC) and Wild Fish Engineering (WFE) are working together with federal, state and local organizations to restore and protect two headwater streams for the reintroduction of native trout. One project targets restoring and

protecting about 8.3 miles of east slope streams for Yellowstone Cutthroat Trout in northern Wyoming. The second project targets restoring and protecting about 7 miles of a headwater tributary streams to the South Platte River in central Colorado for the reintroduction of South Platte Greenback Cutthroat Trout. Both restoration projects are being conducted in phases, working from upstream to downstream by incorporating temporary barriers in the upper reaches and a permanent barrier at the terminus of the stream reach. The talk covers the steps for establishing barrier performance criteria, evaluating barrier location, selection of barrier type and the design differences between temporary and permanent fish barriers.

The combination of mechanical and chemical removal techniques to restore and enhance native cutthroat trout in a small drainage in northwestern Utah

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Abstract: Native fish restoration is at times complicated by such factors as drainage size, habitat complexity, and identifying a source of fish for post-treatment stocking, among others. We identified an opportunity to restore a small drainage in northwestern Utah to its native fish status, including Yellowstone Cutthroat Trout (YCT). The stream, Johnson Creek, contained an abundant population of brook trout that dominated the lower reaches but had not yet overtaken the YCT in the headwaters. We determined that a combination of chemical (rotenone) and mechanical (electrofishing) methods to remove brook trout from the drainage could be successful if undertaken in the proper manner. Because we had no good source of YCT for post-treatment repatriation, and because the headwaters contained more native trout than nonnative, we opted to protect the headwater YCT population by constructing a migration barrier mid-drainage. Since the barrier was intended to isolate the headwaters from the lower drainage for only a relatively brief period while removing brook trout from the two reaches, a temporary, rather than permanent, barrier was selected. Subsequent to barrier construction, we completed mechanical removal upstream of the barrier and chemical treatments below. Eleven full electrofishing passes through the upper reaches (3 stream miles total) were completed between 2011 and 2014. Hundreds of brook trout were removed in the first eight passes but none were found in passes 9-11. Rotenone treatments were completed in 2013 and 2014. Sculpin, found only in the lower mainstem, were salvaged prior to both treatments, held during chemical application, and returned to the stream afterward. The barrier was removed after an assessment of treatment success in 2015 via electrofishing downstream of the barrier, and YCT are now able to repopulate the chemically reclaimed reaches. Restoration of this stream to benefit YCT and sculpin has led to efforts to restore an additional native fish to the drainage, the Bluehead Sucker, present downstream in the broader drainage and likely present historically in Johnson Creek.

Mill Creek Bonneville Cutthroat Trout restoration project

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Abstract: Utah Division of Wildlife Resources, U.S. Forest Service, U.S. Fish and Wildlife Service, PacifiCorp, Trout Unlimited, Utah Anglers Coalition, Boy Scouts of America and others worked cooperatively to explore the opportunities for the restoration of native Bonneville cutthroat trout in the Mill Creek drainage in Salt Lake County. Over a four-year period this project successfully restored genetically pure Bonneville cutthroat trout and habitat within a portion of the historical range of the species. The project also provided the public a unique opportunity to interact with a completely native aquatic ecosystem – dominated by Utah's State Fish, the Bonneville cutthroat trout.

Restoration efforts focused on the upper nine miles of Mill Creek and the lower mile of Porter Fork in Mill Creek Canyon. Efforts included significant public interaction, the removal of all undesirable fish species, stocking of native fish species, planting riparian vegetation and removal of some man-made barriers.

It was determined that the most effective way to remove the undesirable fish in Mill Creek Canyon was with the use of rotenone. Through the public process it was determined that the fish removal would occur in three phases, for one or two days in the fall each year. This was to allow continuous fishing opportunities in part of the project area throughout the duration of the project. The rotenone was neutralized at the bottom of each of the treatment sections so that no fish or invertebrates were removed or impacted below the desired treatment section.

This presentation will present some of the successes, challenges, educational opportunities and lessons learned in trying to complete a rotenone project in the face or backyard of a million people in 2013-2016.

Efficacy, ecological consequences, and fishery performance of triploidy in Walleye *Sander vitreus* fishery management throughout the Intermountain West: a new research project

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Abstract: Induced triploidy is an increasingly common fisheries management technique used to stock sterile fishes. Stocking triploid fishes is a desirable management approach that should preclude the permanent introduction of a species, maintain genetic integrity of natural populations, and result in a population of triploid individuals that grow faster than diploid conspecifics. In theory, triploid fishes provide valuable sport fisheries without compromising natural genetics. In practice, however, triploidy is often associated with altered physiology and behavior with the potential to diminish growth, survival, and aggression relative to diploid conspecifics. Decades of application have demonstrated that the realized benefit of triploidy is uncertain and highly variable among species or even strains. Recent Walleye *Sander vitreus* invasions have resulted in discussions about and implementation of several

major triploid walleye stocking initiatives throughout the Intermountain West. The highly species-specific physiological and behavioral expressions of triploidy, however, highlight the need to thoroughly evaluate triploidy as agencies embark on a novel walleye triploidy management regime. I will discuss an upcoming research project based on a combination of cross-site, multi-year field comparisons; aquaria experiments; pond experiments; and a combination of statistical and theoretical models to evaluate the efficacy and ecological consequences of stocking triploid Walleye to manage illegally introduced walleye populations throughout the Intermountain West.

An investigation of the utility of eDNA sampling as a method to survey for Boreal Toads

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Abstract: Determining whether boreal toads occur in suitable habitats within their range is critical to assessing their status and guiding future reintroduction efforts. Various forms of visual surveys have typically been utilized to ascertain toad occurrence; however, such methods yield limited reliability in detecting toads, due to the cryptic nature of the animal. From 2014 to 2016, biologists from Colorado Parks and Wildlife (CPW) investigated the utility of sampling for boreal toad eDNA as a method to augment visual survey efforts. This investigation spanned all four administrative geographic regions of CPW, focusing on the Southwest Region in 2014, Northwest and Southeast Regions in 2015, and Northeast Region in 2016. Although sample size, replication, and timing varied from year to year, in all three years eDNA samples were collected in conjunction with visual monitoring of known breeding sites as well as with visual survey of sites of unknown occupancy. In most cases, each site was sampled on at least two occasions during the sampling season. Over the three year period we collected and analyzed 309 eDNA samples. These samples were spread across 18 sites of known boreal toad occurrence and 45 sites where occurrence was unknown. Boreal toad eDNA was reliably detected at all sites where toads were known to occur in 2014 and 2016, but at only two of six such sites in 2015. Additionally, boreal toad eDNA was detected at six out of 32 sites where their occurrence was unknown. Presence of boreal toads was ultimately visually confirmed at two of these sites. Our results suggest that eDNA sampling may be a useful tool to incorporate into survey efforts, and that reproductive material is likely the greatest source of boreal toad DNA in the environment.

Boreal toad habitat selection in relation to livestock grazing and disease prevalence

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Abstract: In recent decades, many amphibian populations have declined worldwide. Human-induced habitat disturbance has been cited as a dominant cause, which can interact with other stressors such as climate change and disease. In the majority of cases, however, mechanisms underlying declines are considered enigmatic; developing a better understanding of the individual and interactive factors threatening amphibians will therefore be critical for the prevention of further population declines and species extinctions. To investigate the possible effects of multiple stressors on amphibians, we assessed how livestock grazing individually and in conjunction with disease affect boreal toad *Anaxyrus boreas* movement and habitat selection in the Bridger-Teton National Forest in western Wyoming. During May to August, 2015 and 2016 we used radio-telemetry to quantify the movement and habitat use of 103 adult boreal toads across sites varying in grazing intensity. We swabbed the skin of each individual to test for *Batrachochytrium dendrobatidis* (i.e., amphibian chytrid fungus), a fungal pathogen causing extensive mortality in amphibians worldwide. We measured grazing intensity by comparing vegetation height before and after grazing within 1m2 cattle exclosures to randomly selected sites exposed to cattle grazing. Habitat selection was analyzed at the micro- and macro-scales by comparing sites used by radio-tracked toads with paired and randomly selected sites. Preliminary results suggest boreal toads select habitats with greater willow cover, higher soil moisture, and in closer proximity to refuge sites (e.g., burrows, logs) than what is available. Future analyses will incorporate disease and grazing metrics to determine how cattle grazing interacts with disease to influence toad habitat selection. Findings from this study will provide valuable information to several agencies working to improve management of toad populations in Wyoming. More broadly, by assessing how multiple stressors may interact to influence amphibian behavior, ecology, and habitat quality, our study design may provide a framework for future research evaluating causative factors in amphibian declines.

How do Boreal Toads move across the landscape? Implications for spread of disease

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Abstract: The probability of persistence is a touchstone in assessing extinction risk and in formulating conservation strategies. Persistence of populations of animals depends on multiple, inter-related factors including demography, genetics, and the probability of successful movements away from natal sites (e.g. colonization). Movement is recognized as a critical factor in persistence and influences gene flow, adaptation, and individual fitness. Movement can be addressed quantitatively at different spatial scales and multiple time scales, and qualitatively from many different perspectives, but despite a rich body of literature focusing on amphibian movements, there has been little attention given to a more probabilistic approach to assessing frequency of movements; specifically, the probability of movements, by adults, among breeding sites within a putative metapopulation or the probability of dispersal movements by adults completely outside of a metapopulation. We present data from Boreal Toads in Chaffee County, Colorado and relate how this information about toad movement can inform conservation concerns such as the spread of disease.

Population-level immune gene adaptations and differential tolerance to Bd fungus among Boreal Toads.

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Abstract: The chytrid fungus *Batrachochytrium dendrobatidis* (Bd) has played a significant role in the dramatic declines of many amphibian species in recent decades. Boreal Toads in particular have experienced severe population declines in response to Bd infection. In this study, our goal is to characterize immunogenetic responses of wild populations of declining Boreal Toads *Anaxyrus boreas* to fungal infection using an integrated ecological genomics approach with lab trials and field surveys. Several documented cases exist of persisting Bd-positive boreal toad populations in Utah, raising the question of how small-scale, contemporary shifts in genetic variation among populations can result in tolerance to Bd infection. We report initial data on population-level variation in the major histocompatibility complex (MHC) Class IIβ exon 2 gene. MHC Class IIβ exon 2 codes for beta chain antigen binding sites used in extracellular pathogens recognition. We conducted Illumina ultra deep sequencing of MHC Class IIβ for both Bd-tolerant (Utah) and Bd-sensitive (Colorado) toads. We also report initial findings from a Bd challenge trial comparing lab-reared Utah and Colorado Boreal Toads including their relative Bd infection load, body condition, and correlations with differences in MHC genotypes. Ongoing research into locally adapted immune responses to Bd will help determine new conservation management directions and, potentially, revisions of genetic diversity standards to more broadly include adaptive/functional genetic diversity as a metric for success.

Field trial: Manipulating the boreal toad skin microbiome to increase pathogen tolerance

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Abstract: Boreal toads *Anaxyrus boreas* are under threat from the chytrid fungal pathogen, *Batrachochytrium dendrobatidis* ('Bd' hereafter). Previous lab studies have demonstrated that boreal toads inoculated with an antifungal bacteria *Janthinobacterium lividum* (Jliv) had increased survival when challenged with Bd. In this study, we describe a field-based project to augment the naturally occurring protective bacteria that live on the skin of boreal toads for the purpose of increasing their persistence with Bd. The overarching goal is to enhance the defensive capability of the vulnerable metamorphic stage boreal toads against Bd. During late summer 2016, we applied probiotic treatments to boreal toads at two sites in Chaffee County, Colorado. One site, Brown's Creek, was a reintroduction site that was receiving tadpoles from the Native Aquatic Species Restoration Facility and the other, South Cottonwood West, had recently experienced Bd infections. We used a strain of bacteria, Jliv, that was directly isolated from boreal toads in Chaffee County during summer 2015, thus it is a native and endogenous bacteria. At each site, we captured newly metamorphosed toads, divided them into Jliv treatment and control groups, applied a bath treatment for 12 hours, and maintained the toads in captivity in the field (separated per treatment) to collect samples through time. Toads were fed and swabbed at regular intervals for up to 14 days. We also collected sterile water soak samples (pre and post treatment) to test the mucosome activity against Bd in the lab. Initial results indicate that Jliv treated toads had equal or better survival rates compared with controls over the experiment period, indicating that the Jliv treatment did not induce any increase in mortality. Advancements in probiotics can facilitate the reintroduction and conservation efforts for wildlife such as the boreal toad.

Impeding the population growth trajectory of invasive northern pike *Esox lucius* in Utah Lake, UT: a modeling approach

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Abstract: Invasive species introductions are associated with negative economic and environmental impacts, including reductions in native species populations. Successful invasive species populations often grow rapidly until prey species are decimated and a new food web equilibrium is established.

Invasive Northern Pike *Esox lucius* (hereafter pike) were detected in 2010 in Utah Lake, UT, a highly degraded ecosystem, which is home to the endemic and endangered June sucker *Chasmistes liorus*. Here we test whether pike presence and population growth could hinder the restoration efforts of June sucker. We will use a predator-prey age-structured model to assess the growth trajectory of, and identify potential mitigation options for, the Utah Lake pike population. We will simulate the growth of the pike population, increase the population size under the low, medium, and high carrying capacity scenarios, and examine how the June sucker population responds. We will then apply mitigation strategies to each scenario and assess how the population responds. We expect the most abundant and the most fecund ages to contribute the most to the pike population growth. We can better understand which age classes contribute most to the pike population growth, and thus target those groups to increase the efficiency of removal efforts. Our findings not only inform pike management efforts, but also highlight the importance of preventing the spread of aquatic invasive species.

The fate of juvenile salmonids stranded in Alaskan off-channel flood ponds

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Abstract: Fish stranding is a complex phenomenon that arises from natural and anthropogenic processes. Reported causes of fish stranding are overwhelmingly anthropogenic, resulting in limited knowledge of the causes and subsequent fate of stranded fish in natural ecosystems. Using a combination of observational data and an experimental manipulation, we investigated the fate of fish stranded in off-channel ponds created by the last spring flood, in the Kadashan River watershed on Chichagof Island, Alaska, USA. We examined the effects of pond size and cover availability on the survival of stranded juvenile salmonids and evaluated the role of predation in determining their fate. Our results indicated that juvenile Dolly Varden Char *Salvelinus malma* and Coho Salmon *Oncorhynchus kisutch* were the only two species stranded in these off-channel ponds. Smaller fish were more common in the flood ponds than larger fish. Mortality rate of small fish was mainly influenced by availability of cover, although the effect of other factors could not be determined due to small sample size. Also, larger fish tended to disappear at a higher rate than smaller fish, but species vulnerability rather than size alone may have played a role. These observations, together with data on the effectiveness of cover and detection of predator activity, suggest that predation was the main cause of mortality for stranded fish. Elucidating the causes and fate of stranded fish, especially of economically important species such as Coho Salmon and Dolly Varden Char, will benefit managers aiming to mitigate negative consequences of fish stranding. Furthermore, fish stranding could have important implications for cross ecosystem connectivity, specifically with respect to aquatic subsidies to terrestrial food webs.

Condition indices: Sensitivity and use in nonsalmonid species

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Abstract: Indices of fish condition are used by fisheries managers as a measure of relative health of fish stocks and are commonly incorporated into management and regulatory decisions. Fish condition can be affected by elevation, food availability, reproductive status, density, and environmental impacts. GEI Consultants fisheries personnel routinely gather fish lengths and weights for various populations of fish throughout the United States and use these data to calculate the Fulton Condition Factor (K) and Relative Weight (Wr) in our analyses. Evaluation of the sensitivity of these metrics to sites with known environmental impacts versus non-impacted reference sites is presented and discussed. Data collected from various projects where condition factors were calculated for Brown Trout *Salmo trutta* and Sculpin *Cottus* sp. from both reference sites and impacted sites are compared. Whether condition indices vary in the same magnitude and direction under environmental impacts and the utility of condition metrics for non-salmonid species is considered.

Mapping an invasive aquatic weed (Eurasian Watermilfoil) in Fish lake, Utah, using an unmanned aerial vehicle (sUAV).

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Abstract: The purpose of this study was for the timely acquisition of high resolution multispectral aerial imagery of Eurasian Watermilfoil *Myriophyllum spicatum*, hereafter called milfoil, a non-native invasive aquatic plant which is prevalent in Fish Lake, South-Central Utah. Milfoil effectively out-competes all native aquatic vegetation in the lake, has little nutritional value and reduces invertebrate abundance and diversity. It has eliminated shore fishing from most of the lake and is believed to have contributed to illegally introduced perch out-competing the lake trout forage fish Utah chub, affecting the recreational fishery. The imagery obtained was ortho-rectified and classified by Aggie Air. Three hundred data points were field sampled to aid classification and allow accuracy assessments. The resulting map of aquatic vegetation (both emergent and submerged) including milfoil along the western shore will be used by agencies to provide a baseline to evaluate future effects from milfoil weevil introduction, and plan resource projects. A parallel project by the Forest Service Remote Sensing Applications Center (RSAC) is using a satellite image for milfoil to allow comparison of the methodologies. This project was unique as one of the first sUAS flights from/on Forest Service lands for resource data collection, the elevation of the target area, and flight altitude. The presentation will focus on the logistics and challenges of the flight, provide samples of the data obtained, and discuss preliminary mapping results and findings.

Contaminants in the upper Colorado Basin: The forgotten stressors, mercury and selenium.

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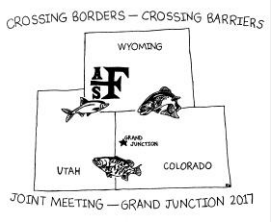
Abstract: Native fish populations, including four federally endangered fish species (Colorado Pikeminnow, Bonytail, Humpback chub, Razorback sucker), in the Upper Colorado River Basin (UCRB), have endured many threats, including altered natural flow and thermal regimes, fragmentation of habitat by dams, invasions by nonnative species, and climate change. Exposure to contaminants has been understudied in the UCRB, largely because of its remoteness and high proportion of federally managed lands. However, global transport of mercury (Hg) and deposition within the basin has become a concern. In addition, the UCRB has naturally high background concentrations of selenium (Se) in the surrounding soils and bedrock. Within the basin, mining and combustion of coal may be a local source of Hg while an expansive conversion of arid land to irrigated land has exacerbated transport of Se to the riverscape. Both Hg and Se can be toxic to wildlife, but in combination Se may abate Hg toxicity. In response to these concerns, the U.S. Geological Survey has compiled and analyzed a historical database of fish tissue Hg and Se concentrations for the UCRB. Over 2000 fish tissue samples have been collected basin-wide since 1962; however, 73% of these samples were collected in only 8 of the last 26 years, and only 12% were from federally-endangered fishes. Historically, average basin-wide Hg concentrations in two fishes of conservation concern (i.e., Roundtail Chub and Colorado Pikeminnow) were >2.4X the US EPA human health standard of 0.3 ppm; whereas only 1 native fish species, speckled dace, averaged above the 2016 US EPA tissue standards for Se. Considerable geographic variability in Hg and Se concentrations in fish was observed among the eight UCRB subbasins. The White-Yampa River and the Lower Gunnison River basins had the highest average (pooling across species) Hg and Se concentrations (respectively). There was also considerable variability in Se:Hg ratios among subbasins, however typically ratios exceeded 5. These relatively high Se:Hg ratios suggest that Hg toxicity is abated by Se, however, locally high Se concentration may pose risks to native fish. Preliminary findings suggest that some imperiled fishes of the UCRB face potential risks associated with high Hg and Se exposures. In 2016, we augmented the historical Hg and Se data by collecting more than 1000 samples, including >300 from native endangered species. These samples and those collected in the coming years will help identify if Hg and Se exposures pose risks to native fishes of the UCRB.



2017 UTAH and COLORADO/WYOMING Chapters of the American Fisheries Society Contributed Poster Abstracts

Predicting internal parasite communities from ecological traits of hosts: a test using rockfish *Sebastes* sp. from Alaskan waters

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Abstract: Parasites can have important impacts and implications for marine fish communities; however, there seem to be few ecological traits of host fishes that accurately predict diversity and abundance of parasites among host fish species. Some studies report patterns between ecological traits of host fishes and parasite diversity or abundance, but interpretations are often confounded by uneven sampling and wide spatial and temporal variation in sampling. To determine patterns of diversity and abundance of internal parasites among host fish species and relationship to ecological traits of hosts in an unconfounded way, we characterized parasite abundances by species among eight species of rockfish *Sebastes* spp. collected in the same place (near Kodiak Island, Alaska) and at the same time (May – June, 2015). When all parasites were included in the calculation of diversity and richness, few host traits were significantly correlated. When we restricted analysis to one or a few closely related species of parasite, several significant relationships were observed between parasite abundance and traits of hosts. One of the most common patterns was decreased abundance of parasites in long-lived, high trophic level species compared to those that are shorter-lived and that feed at lower trophic levels. This pattern is consistent with the hypothesis of increased allocation to somatic maintenance (possible immune function) in long-lived species compared to short-lived species.

Sculpin Qwest: cataloging the diversity of Cottus in western North America

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Abstract: Sculpins (genus *Cottus*, family Cottidae) are small, benthic, and typically freshwater fishes indigenous to the Northern Hemisphere. Their identification is problematic, to the extent that there is

no consensus on the identity and distribution of species in western North America. To resolve this issue, we undertook Sculpin Qwest, a project that combined crowd-sourced sample collection with genetic tools to characterize sculpin phylogeography throughout this region. Fellow sculpinophiles contributed over 6,000 tissue samples to the National Genomics Center for Wildlife and Fish Conservation, and we sequenced one mtDNA region from samples at every location. We applied simple species delimitation approaches to these sequences—and those in public sequence repositories—to generate hypotheses about the diversity and distribution of sculpin lineages in every western U.S. state and Canadian province. These analyses indicated that two major lineages of sculpins are present in Colorado, Utah, and Wyoming, with substantial substructure related to present and former river basin boundaries. The results argue for the restoration of *C. annae* as a taxon, and demonstrate that western *C. bairdii* lineages exhibit shallow divergence despite their geographic extent, as well as not being *C. bairdii*. A wholesale revision of the taxonomy of sculpins in inland waters of the western U.S. is warranted.

Quantifying proximate body composition in Catostomids using bioelectrical impedance analysis

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Abstract: Measurements of proximate body composition (PBC; water, lipid, and lean masses) are used as indices of fish health or condition. Proximate body composition measurements are more sensitive to changes than traditional length-weight measurements. However, standard methods for quantifying PBC are lethal. Bioelectrical impedance analysis (BIA) can be used as nonlethal method to quantify PBC. Bioelectrical impedance analysis measures the resistance and reactance of tissues, and has been used to quantify human PBC. Our goal was to develop BIA techniques for studying sensitive and endangered fishes. Our objectives were 1) compare effects of invasive needle electrodes (traditional method) versus noninvasive surface electrodes, 2) compare electrode positions using landmarks that vary with fish length versus a fixed electrode distance, 3) develop multiple regression models for predicting the PBC, and 4) develop a temperature correction factor to standardize resistance and reactance measurements taken at variable temperatures in the field to 19°C; the temperature used to develop multiple regression models. White Sucker *Catostomus commersonii* was used as a representative for native Catostomids to develop the techniques. For objectives 1 and 2, the invasive needle electrodes, variable distance surface electrodes, and fixed distance surface electrodes were comparable. For objective 3, multiple regression models which used BIA metrics improved the prediction of the three components of PBC compared to length-weight indices. Multiple regression models accounted for most of the variation in the data for both water and lean masses. Lipid mass was more variable and the best model only accounted for approximately half of the variation. Using fixed distance surface electrodes allowed for a less invasive and simpler measurement approach than the other methods compared. For objective 4, a pilot experiment was conducted to develop a temperature correction factor adjusting measured resistance

and reactance values to the standard temperature 19°C. Future work is necessary to improve lipid mass predictions and to validate models.

Movement dynamics and survival of hatchery-reared Colorado River Cutthroat Trout post-stocking

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Abstract: Colorado River cutthroat trout (CRC) have experienced significant declines in distribution and abundance throughout their native range. In Wyoming, interactions with non-native sport fish have been identified as a primary limiting factor via hybridization and resource competition. To mitigate harmful interactions with non-natives, fisheries managers in Wyoming have employed isolation/ translocation management strategies following chemical reclamation in LaBarge Creek Watershed (LCW), a tributary system to the Green River in western Wyoming. Despite successful removal of introduced salmonids and consistent stocking efforts since 2007, establishment and reproduction of hatchery reared CRC remains limited to date. We hypothesized that rearing history, timing of stocking events, and size of fish at release are driving large scale, post-stocking emigration and or mortality events. To test this hypothesis, approximately 6,952 of 36,000 CRC were PIT-tagged (Passive Integrated Transponder) and stocked into LCW from August 2015-October 2016. PIT-tagged individuals are representative of 1/7 unique stocking/rearing treatments employed during this study. Fish movement to and from stocked tributaries, as well as permanent emigration from the system (i.e. migration over the fish barrier), was monitored from June 2016-November 2016 using multi-directional, fixed PIT-tag antennas throughout LCW. Survival of individuals exhibiting site fidelity was monitored via mobile PIT-tag surveys during the same period. At the conclusion of our first field season, a single individual was observed emigrating from the system. Tag return of both dead/ live individuals within the system was considerably higher, suggesting preliminarily, that limited establishment is mortality driven.

Apple Valley- A collaborative approach to stream restoration

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Abstract: Severe flooding due to sustained, heavy rainfall occurred in portions of the Colorado Front Range during September 2013. Like many stream reaches in the area, Apple Valley, along North St. Vrain Creek upstream of Lyons, CO, was severely impacted. Floodwaters damaged homes and caused widespread changes to in-stream and riparian habitat. In response, a collaborative approach was utilized to identify limiting factors within the reach and to set stream restoration project goals. Stakeholders include Apple Valley landowners, the St. Vrain Creek Coalition, engineering groups S2O and Michael

Baker International, and stream ecologists from GEI Consultants. Multiple meetings were held during the restoration process, allowing landowner input and collaboration among groups. Aquatic habitat surveys identified a lack of instream cover, an over-widened and shallow stream channel, long, monotonous pools and runs, and widespread bank erosion and loss of riparian vegetation. Planned restoration measures include increasing pool habitat, benching of the stream bank at appropriate heights to provide flood resilience and floodplain connectivity, narrowing and deepening of the stream channel, and adding boulders and large woody debris to increase habitat heterogeneity. Planned restoration measures also include the addition of both seasonal and perennial side channels as rearing habitat for young trout and native fish species found in transition zone streams. A Before-After, Control-Impact study design will be implemented to evaluate project effectiveness in improving aquatic habitat. We present this use of a collaborative framework as a means of addressing concerns of multiple stakeholder groups, and as a method for evaluating restoration goals through qualitative and quantitative habitat surveys and quantification of fish populations.

How does a stream restoration after a flood event and barrier removal affect fish abundance, condition and movement?

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Abstract: The North Fork of the Big Thompson River, CO incurred a 500-year flood event September 2013. An instream, riparian restoration and barrier removal project was completed in 2015 for a 2.5-mile reach of the North Fork of the Big Thompson River upstream of Drake, Co. The restoration was planned and completed by Big Thompson River Restoration Coalition, Wildlands Restoration Volunteers, FlyWater Inc. and Eco-Hydro Consulting. The objective was to create a more resilient, healthy, and functioning river corridor to restore and enhance geomorphic and ecosystem function in this reach of the North Fork by: 1) Improving river function, 2) Rehabilitate ecological function, 3) Fish habitat improvement, and 4) Fish migration improvement. The design of this project will rely on Leopold's riffle-pool-run sequence within 5 to 7 stream widths concept (Ayres Associates 2015 and McNally 2014). The primary objective of my research project was to evaluate and analyze brown trout abundance, condition and movement in response to the stream restoration and removal of in-stream barrier of the North Fork of the Big Thompson River. A secondary objective was to monitor how stocked rainbow trout disperse from a single stocking point and how their abundance and condition respond to the restoration reach. Five experimental sites were established within the 2.5-mile restoration reach. Each site was surveyed in October 2014 and 2016 using 2 pass electrofishing depletion method one year before and after the stream restoration and barrier removal. August 2015 and 2016, fish were tagged within and around the 5 sites before and after the stream restoration and barrier removal. The stream restoration and barrier removal was completed in December 2015. Brown trout abundance increased in 2 of the five sites. Average Condition (K) of Brown trout decreased in 3 of 5 sites, and the other 2 site average only differed by one-one hundredth. Movement of tagged fish was extremely minimal and almost all movement detected was down stream movement and only one upstream. This stream restoration and barrier removal shows promise for fish abundance, condition and movement. However, future sampling should

occur to monitor abundance, condition, and possible movement as the stream matures years after the restoration.

An alternative to the "build it, monitor it, does it work?" approach to designing fish passage structures: design, construction, and operation of a full-scale indoor research fishway

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Abstract: Fish passage structures are expensive to construct and the designs of proposed structures are commonly based on knowledge gained from existing structures, assuming that structures which allow passage of the species of interest exist. Developing an apparatus that allows rigorous testing of fish passage structure designs prior to the construction of structures in the field could reduce the reliance on a "build it, monitor it, does it work?" approach, thus saving limited resources. Such an apparatus would also allow testing of the response of target fish species to design parameters (e.g., slope, roughness elements, water depth, etc.). To meet this need, we designed and constructed a full-scale indoor research flume at the Colorado State University Foothills Fisheries Laboratory and installed an experimental rock-ramp fishway within the flume. The slope of the flume can be adjusted (0 – 10%) and integrates a set of four full duplex/half duplex dual mode PIT tag antennas to track the individual progress of fish as they ascend the flume. Flows up to 0.10 m3/s (3 cfs) are recirculated through the flume with a 15-hp pump and temperature is controlled by a heater and chiller. Lessons learned during the design, construction, and operation of the flume are presented here.

Double-crested Cormorant foraging responds to fish stocking in suburban ponds in northern Utah

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Abstract: Double-crested Cormorant *Phalacrocorax auritus* foraging on fish populations has increasingly become a problem in North America. The Cormorant is a piscivorous bird which populates a wide variety of aquatic habitats. Our project quantified the level of Cormorant foraging in local stocked fishing ponds in relation to water temperature, turbidity, and fish-stocking date. We hypothesized lower water temperatures would lead to greater foraging success. By contrast we expected greater turbidity to decrease foraging success for these visual predators. Finally, we expected foraging to increase just after stock dates and decrease thereafter. Foraging was observed at two ponds: Farmington Pond in Farmington, Utah, and Meadow Creek Pond in Roy, Utah. Farmington Pond is in the foothills of the Wasatch Mountains and is fed by fresh snow-melt runoff. Meadow Creek Pond is farther from the mountain front and is fed by groundwater and suburban runoff. For 31 days, we surveyed both ponds concurrently, from 6:00am to 2:00pm, taking a census of the number of Cormorants present, the surface water temperature, and turbidity using a Secchi-tube, at half-hour intervals. We attempted to document all instances of foraging Cormorants surfacing with and swallowing fish, noting the time of catch. Fish species could not be systematically determined. Cormorant foraging success was estimated by how many fish were caught per hour. We used Pearson Correlations to determine relations of fish per hour versus: 1) mean daily water temperature and turbidity, 2) number of days post fish stocking, and 3) mean number of Cormorants fishing per hour. Cormorants caught a total of 669 fish, but neither water temperature nor turbidity were correlated with fish caught per hour. We found a positive correlation between the number of Cormorants at a given pond and the number of fish caught per hour, and a negative correlation between the number of days since the ponds were stocked and the number of fish caught. Our findings indicate that Cormorant foraging success at stocked suburban ponds in northern Utah is driven primarily by the number of fish stocked and the stocking dates. Environmental conditions have minimal impact.

Road Beaver Creek (Gunnison County, Colorado) watershed management and monitoring for possible cutthroat trout reintroduction.

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Abstract: Road Beaver Creek, a small perennial stream located in Powderhorn, CO, was home to one of the few historical remaining populations, thought to potentially be green lineage, of Colorado River Cutthroat Trout *Oncorhynchus clarkii pleuriticus*. Habitat degradation, water quality issues, along with Brook Trout *Salvelinus fontinalis* expansion have extirpated the population within the last decade. Over the past several years, watershed habitat improvement projects have been implemented which include stream crossings, water gaps for grazing, and travel management. These management actions have been monitored for changes to the Road Beaver Creek macroinvertebrate community, substrate size class distribution and physical water quality parameters. A relatively recent extirpation of the Colorado River Cutthroat Trout population, fisheries survey data coupled with stream geomorphology and

monitoring data indicates that Road Beaver Creek could support a reintroduced population. Reclamation of the stream for Colorado River Cutthroat Trout is the final step in restoring this area. This would include maintaining current watershed habitat improvement projects, construction of a barrier and treatment of the stream for the removal of Brook Trout.

Bioaccumulation of selenium and mercury in fish tissues of an urban watershed and reservoir, Denver Colorado

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Abstract: Along the Rocky Mountain Front Range, the natural geology contains deposits of selenium rich sub-surface material (e.g. marine shales). The natural weathering of these marine shales often result in elevated selenium concentrations in a number of aquatic ecosystems. A portion of the Cherry Creek Watershed is composed of marine shales and tributaries to Cherry Creek Reservoir contain elevated selenium water and fish tissue concentrations. Cherry Creek Watershed also lies in a heavily populated urban area, which contributes to the mercury concentrations in the tributary streams. Elevated selenium concentrations raises concern for aquatic life use in the Reservoir, while the mercury concentrations raises concern for fish consumption. We present the results from a multi-year selenium and mercury study.

In Cottonwood Creek, a tributary to the Reservoir, geomean whole-body fish tissue samples ranged from 6.3 to 24.6 mg/kg dry weight (dw) depending on species and location. While whole-body fish tissue concentrations in tributary streams exceed the EPA draft criterion of 8.0 mg/kg dw, fish tissues from Walleye *Sander vitreus* (top predator) collected from the Reservoir were considerably less than the EPA draft criterion for tissues (11.3 mg/kg dw). Muscle plugs from female Walleye ranged from 3.39 to 6.0 mg/kg dw and male whole-body samples ranged from 2.65 to 3.8 mg/kg dw.

In Cherry Creek, mercury fish tissues ranged from 0.0383 mg/kg wet weight (ww) to 0.162 mg/kg ww for Creek Chub *Semotilus atromaculatus* and White Sucker *Catostomus commersonii*. In the Reservoir, mercury fish tissue concentrations ranged from 0.0193 to 0.0686 mg/kg ww for Walleye skinless filets. All mercury fish tissue concentrations were well below the EPA tissue criterion of 0.3 mg/kg ww which is considered safe for human consumption.

At the forefront: evidence of the applicability of using environmental DNA to quantify the abundance of fish populations in natural lentic waters with additional sampling considerations

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Abstract: Environmental DNA (eDNA) sampling has proven to be a valuable tool for detecting species in aquatic ecosystems. Within this rapidly evolving field, a pressing and promising application of these eDNA techniques would allow for quantitative (albeit relative) estimates of species abundance in lieu of obtaining these estimates from traditionally arduous, expensive, and potentially intrusive methods. We investigated the relationship between concentrations of eDNA in a series of five natural lakes with known species diversity and abundance, and we examined aspects of lentic eDNA sampling strategies at different temporal (e.g., stratified vs. mixed) and spatial (e.g., site, depth) scales. Concentrations of eDNA were highly correlated with fish abundance (R2 = 0.80) and density (R2 = 0.84). Across lakes, eDNA concentrations were greater and more homogeneous in the water column during autumn, when the lakes were recently mixed and isothermal; however, when the lakes were stratified, eDNA concentration were greater in the hypolimnion. Overall, our findings demonstrate that eDNA techniques can produce effective estimates of relative fish abundance in natural lakes. These findings can guide future studies to improve upon and expand upon eDNA sampling regimes in effort to guide research and management with an innovative technique that is rapid, relatively inexpensive, and non-intrusive.

PIT tag retention in a small-bodied native catfish *Noturus flavus*

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Abstract: Members of the freshwater catfish family Ictaluridae possess the capability for trans-intestinal expulsion of foreign bodies through three steps: adhesion, migration and passage. Studies have shown that tags used for marking catfish that are implanted internally can be shed through this expulsion process. We are currently implanting PIT tags to examine movement and survival in wild stonecat populations *Noturus flavus*. Since stonecats are Ictalurids, we were concerned that trans-intestinal expulsion and subsequent tag loss would bias movement and survival estimates. We evaluated retention rates in a laboratory setting to assess overall tag loss. We surgically implanted PIT tags in May 2015 and have been continuously measuring expulsion rates. Tag retention was approximately 85% at ten months. We also used ultrasound images to inform our analysis and help understand expulsion mechanisms and allow visualization of tag movement in the body cavity.

Comparing ontogenetic dietary shifts of Bear Lake Sculpin *Cottus extensus* and a nearby congener species

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Abstract: Bear Lake sculpin *Cottus extensus* are endemic to Bear Lake, UT-ID, and are vital forage fish for game fishes of the lake, such as Bonneville cutthroat trout and lake trout. In order for the Bear Lake sculpin to be an energy-rich food source, reaching their maximum growth potential is paramount. A dietary shift to piscivory is necessary for fishes to reach their maximum growth potential. Our overall goals are to test whether these fish experience an ontogenetic shift to piscivory, and if the ontogenetic shift is occurring at a similar size as a congener species in the nearby Logan River. We analyzed gut contents of 40 Bear Lake sculpin collected in July 2016 and found they consumed primarily two species of invertebrates. Mottled sculpin *Cottus bairdii* in nearby Logan River, UT, exhibited an ontogenetic shift to piscivory at 111mm and consumed fish at lengths of 19.9% to 47.0% of their total length. However, Bear Lake sculpin never exhibited an ontogenetic shift to piscivory even though larval fish were present at the time of sampling. Our findings suggest that Bear Lake sculpin may not be reaching their maximum growth potential with implications on fecundity and population growth rates. A decrease in population growth rates and smaller individual sizes of sculpin may limit the food base for the predatory fishes of Bear Lake.

Investigating morphometric differences across and among Arctic Char populations in lakes on the North Slope, Alaska

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Abstract: Niche specialization can reduce intraspecific competition through resource polymorphism, especially in ecosystems with relatively low interspecific competition. Notably, Arctic Char *Salvelinus alpinus*, often found in oligotrophic, depauperate lakes, exhibit a high degree of phenotypic plasticity including multiple morphs living in sympatry. Their survival in these challenging environments is a direct

result of adaptive resource and habitat use, growth patterns, life-history expressions, and morphology. On the North Slope, Alaska, Arctic Char occupy lakes that are either "closed" or "open" to immigration and emigration by Arctic Char and other species (e.g., Lake Trout and Arctic Grayling). Our goal was to determine what niche individual char may occupy to achieve optimal growth and survival. Similarly, we aimed to determine the influence other species may have on Arctic Char morphology. In 2016, we collected and photographed Arctic Char from a series of open and closed lakes (to immigration/emigration). From these photographs, we measured more than nine morphological traits (e.g., snout length, eye width, head depth, head length) and compared measurements within and across populations. Arctic Char were larger in open lakes relative to closed lakes (451 ± 20 vs. 294 ± 22; mean TL (mm) ± 2 SE), and we noted further morphological differences across and within these systems. For example, we observed greater eye widths for char in closed lakes relative to open lakes (11.4 vs. 10.6 mm; P= 0.02), and principal component analyses recognized at least two different morphs within open lake systems. Next, we will use these morphometric measurements in conjunction with diet and genetic analysis to better understand the differentiation and persistence of Arctic Char populations across the North Slope.

The evolutionary history of Lake Tanganyika's nile perch species

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Abstract: Lake Tanganyika is volumetrically the second largest lake in the world, and at 9-12 million years in age, it hosts a long history of evolution that has produced remarkable animal communities consisting largely of endemic species. Among these endemics are six fish species that comprise the lake's pelagic (i.e. open water) fish community. Four of these six species are endemic species of the genus Lates ("Nile Perch"), and two of the four species have undergone serious population declines in recent years, rendering them listed as "threatened" by the IUCN. All four species are dominantly piscivorous (i.e. fish-eating), and as key predatory species they exhibit strong ecological influences on the lake ecosystem. Remarkably, all four of these species have evolved within this single lake. Previous studies have examined the morphology, habitat, feeding behaviors, growth, and reproductive strategies amongst Nile perch in Lake Tanganyika. The purpose of this project is to explore the evolutionary history of the four endemic Lates species. Here, we present preliminary results using mitochondrial DNA sequences to study the order of species divergence and their relative divergence times using phylogenetic methods. This project is significant because very little research has previously examined the genetics of Lake Tanganyika Lates species to infer their evolutionary history. The results will provide an important foundation for future work in conservation genetics of these species.

Growth of bluehead sucker under different temperature and flow regimes

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Abstract: Over-allocated water due to diversions and dams alters the natural flow and temperature regime in river systems which in turn affects fish reproduction, growth, and survival often lead to fish

population declines. Bluehead sucker *Catostomus discobolus*, native to the Weber River, Utah, currently face an apparent "recruitment bottleneck" likely due to changes in the contemporary hydrologic regime. Our goal was to compare growth of bluehead sucker from three different reaches of the Weber River with distinct thermal and hydrologic regimes. We aged a minimum of 12 bluehead sucker pectoral fin rays from each reach and measured the distance between annuli to determine annual growth of each fish. The warmer reach had both a higher average temperature and mean discharge over the 13 years of observation versus the two cooler reaches. We observed that fish from the warmest reach (average July temperature: 20.0 °C) generally grew faster than fish from two cooler reaches (average July temperature: 17.4°C; influenced by discharge from dams). Mature age-6 fish from the warmer section averaged 440 mm whereas fish from the two cooler reaches averaged 412 mm. Our findings can contribute to the conservation of this bluehead sucker subpopulation by providing a better understanding of their optimal thermal and hydrologic habitat requirements, to help guide habitat restoration efforts.

Physiological responses of fishes to stressors associated with oil and natural gas development

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Abstract: With the human population growth rising, one challenge facing managers is to develop a balance between resource use/extraction and wildlife conservation efforts. Stressors associated with oil and natural gas (ONG) development have been linked to increased sedimentation, nutrients, temperature, salinity, and metals, and decreased riparian cover; however, the ecological consequences of these activities are still not fully understood. Stressors, like increased conductivity and temperature, threaten the homeostasis of individuals and may cause changes from the cellular up to the population level. Very little is known on the stress physiology of non-game fishes that dominate most North American freshwater assemblages. The objective of this study is to measure changes in physiological responses of Mottled Sculpin and Mountain Sucker to stressors associated with ONG development. Specifically, we are measuring hormonal responses across a gradient of ONG stressors (e.g., temperature and salts) to examine how fishes experiencing increased stress respond physiologically using metrics such as: 1) baseline glucose, 2) baseline cortisol, 3) stress reactivity, and 4) immunocompetence. Data collected from our study streams in the Wyoming Range indicate conductivity and temperature are greater and more variable in drainages with higher levels of ONG development. Preliminary results from our 2015 blood sampling, suggest a significantly negative correlation between average baseline cortisol and in-situ specific conductivity for Mottled Sculpin, but no significant relationship was observed for Mountain Sucker. Our results imply stressors associated with ONG development differentially affect the physiological responses of fishes. Under more stressful conditions, Mottled Sculpin appear to down regulate their hypothalamus pituitary-adrenal axis, resulting

in the release of fewer stress hormones and apparent acclimation to the related stressors. Understanding how fishes respond physiologically to chronic stressors associated with anthropogenic activities will help improve conservation and best management practices, and allow us to better understand species' adaptability in changing environments.

Compensatory response of Common Carp *Cyprinus carpio* fecundity following removal efforts in Utah Lake, UT

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Abstract: Common Carp *Cyprinus carpio* (hereafter carp) are a destructive invasive species that reduce the abundance of aquatic macrophytes, increase water turbidity, and ultimately contribute to the decline of native aquatic species. Introduced into Utah Lake, UT during 1883, carp quickly degraded the lake ecosystem and dominated the fish community, as their population comprised over 90% of the lake's total fish biomass. To alleviate the detrimental effects of carp on the ecosystem and native biota, managers initiated an ambitious invasive species removal effort during 2009, which involved the removal of approximately 3 million pounds of adult carp annually through 2016 with the goal of reducing population abundance by 75%. However, during large-scale removal efforts such as this, reduced intraspecific competition has the potential to result in increased body size, which may lead to improved fecundity of remaining females. We compared pre- and post-removal carp population egg production by combining Utah Lake carp body size-fecundity relationship data with carp body size distribution data derived from pre- and post-removal netting efforts. Our preliminary results suggest, due to substantial improvement in adult female body condition, population-level egg production increased following removal efforts. Such an enhancement in egg production could lead to increased recruitment rates of young carp into the adult population currently being targeted for removal. Thus, our results showed a compensatory response to Utah Lake carp removal efforts that could hinder ongoing management strategies. This study emphasizes the importance of continuous monitoring of demographic characteristics during invasive species removal efforts, and carries important implications for Utah Lake carp management recommendations, including consideration of size-selective removal of large fecund individuals.