# Proceedings of the Colorado-Wyoming Chapter of the American Fisheries Society


2015 Annual Meeting

February 24-27, 2015
Ft. Collins, Colorado

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# General Information

**Registration**

Registration will be located at the Marble Registration area. Registration will be open: Tuesday 5 pm – 7 pm, Wednesday 7 am – 5 pm, and Thursday 7 am – 5 pm.

**Presentation Download & Audio-Visual Preview**

Audio-visual room is the Timnath Room. Presentations will be downloaded during the following times: Tuesday 5 pm – 7 pm, Wednesday 7 am – 6 pm, and Thursday 7 am-2 pm. All presentations must be downloaded by 7:30 am the morning of the scheduled presentation. Please be considerate to the audio-visual volunteers and avoid last minute submissions.

**Poster Session**

Contributed posters will be displayed in Foyer A-C throughout the meeting. Posters will be assembled Tuesday between 6pm and 8pm and dismantled following the banquet.

**Continuing Education Workshop**

**Title**: "Fish Nutrition Basics: What Fish Culturists Need to Know About Feeds and Feeding"

**Date/ Location**: February 27th, 8am – 5pm at the Mariott Inn in Salon D

**Instructors:** Dr. Jesse Trushenski, Center for Fisheries, Aquaculture, and Aquatic Sciences, Southern Illinois University Carbondale

Lunches will NOT be provided. Lunch break will be from 12-1 pm. Mid-morning and mid-afternoon beverage/snack break will be provided.

**Auction and Raffle Display**

Make sure to check out the great auction and raffle items on display in Salon H. Raffle tickets will be on sale throughout the meeting.

**Business Luncheon**

Business meeting luncheon will be held in Salon A-D from 12 to 1:30 pm on Thursday. All Chapter members are encouraged to attend. Lunch is only available for those that pre-registered for this meeting.

# Socials

## Welcome Social

A Welcome Social will be held Tuesday evening from 6 to 10 pm in Salon E-H. Free beer and a light meal will be provided. Cash bar is also available.

## Banquet Social

The Banquet Social on Thursday will be held from 6 to 10 pm in Salon E-H. Free beer and a cash bar will be available. Everyone is invited to the social, auction, and raffle. A banquet ticket is required for the banquet buffet. Dinner will be served at 6:30 pm.

## Student Events

Hosted by the Colorado State University Student Subunit

**Student Job Fair**

When: Wednesday, 5 to 6PM

Where: The Gazebo at the Marriott Hotel

Students and professionals meet and greet before the social. Students come prepared with resumes and questions. Professionals come prepared with any job vacancy announcements or information to students for future job opportunities.

Employers accepting applications (or those who would like to meet students and offer some mentoring) send me (Adam.Herdrich@gmail.com) or CSU-AFS (afscsu@gmail.com) an email so we can print signs to post at their table with their names and affiliations so student can find them.

For those who are accepting resumes for specific jobs, we would like them to post job announcements on a job board early in the meeting so students can find out who and where is hiring and be able to locate them during the job fair/mentoring social.

**Student Social**

**When:** Wednesday, 6 to 10 PM

**Where:** The Gazebo at the Marriott Hotel

**Featuring a Fajita Bar and beer courtesy of High Hops Brewery**

Open Mic Night for anyone musically inclined!

# Tuesday, February 24th

| | |
|---|---|
| 5:00 PM-7:00 PM | Registration and Presentation Download/Practice |
| 6:00 PM-10:00 PM | Welcome Social- Salon E-H (see page 5 for details) |
| 6:00 PM -8:00 PM | Poster/Raffle Setup |

# Wednesday, February 25th

| | |
|---|---|
| 7:00 AM-5:00 PM | Registration |
| 7:00 AM-5:00 PM | Presentation Download/ Audio Visual Preview |
| 8:20 -8:30 AM | Opening Remarks and Presidential Message by Dan Brauch |

## Session 1: Fisheries Habitat

Moderator: Nate Jean, Stantec Consulting

| | |
|---|---|
| 8:30-9:00 AM | **Christopher Carroll** (professional) "Jeeps in creeks: The Jenny Creek OHV-trail and stream restoration" |
| 9:00 -9:20 AM | **Dan Kowalski** (professional) "Evaluation of an electric fish guidance system in the south canal- of the Gunnison River, Colorado" |
| 9:20-9:40 AM | **Adam Herdrich** (student) "Effects of large wood and log jams on eastern slope Rocky Mountain Trout Populations" |
| 9:40-10:00 AM | **Erin Pettigrew** (student) "Effects of in-stream large wood on fish diets" |
| 10:00-10:20 AM | **Nate Jean** (professional) "The Green River, changing the path" |
| 10:20-10:40 AM | **Break** |

## *Session 2: Fisheries Habitat*

Moderator: Anna Senecal, Wyoming Game and Fish Department

10:40-11:00 AM **Jillian Cole** (professional)"An ecological approach to water diversions in natural stream channels"

11:00-11:20 AM **TC Dinkins** (professional) "Stream restoration and private rangeland management: A harmonious relationship"

11:20-11:40 AM **Matt Kondratieff** (professional) "Influence of stream habitat enhancement on trout and giant stonefly abundance on the Wason Ranch, Rio Grande River, CO"

11:40AM-12:00 PM **Eric Richer** (professional) "The effects of post-flood recovery on fisheries in the Colorado Front Range"

12:00-1:30 PM **Lunch on Your Own**

| | **SESSION 3A: Native Fish Conservation**<br>**Moderator:** Ann Widmer, SWCA Environmental Consultants<br>**Abstracts:** Pages 17 to 20 | **SESSION 3B: Temperature and Disease Effects on Fish**<br>**Moderator:** Dan Kowalski, Colorado Parks and Wildlife<br>**Abstracts:** Pages 20 to 22 |
|---|---|---|
| 1:30-1:50 | **Laura Burckhardt** (professional) "Effects of seismic surveys on pallid sturgeon and paddlefish in Lake Sakakawea, North Dakota" | **Kevin Rogers** (professional) "WaTSS: software for interpreting water temperature data" |
| 1:50-2:10 | **Nick Hogberg** (professional) "Population dynamics of channel catfish in the Red River of the North, Manitoba: Investigating a high catch – low harvest catfish population" | **Andrew Todd** (professional) "Robust, low-cost data loggers for stream temperature, flow intermittency, and relative conductivity monitoring" |
| 2:10-2:30 | **David Stewart** (professional) "Conservation of native Wyoming fishes through identification and implementation of native fish management areas" | **Chris Craft** (professional) "Deadwood Creek: A case study illustrating possible impacts of climate change on fragmented streams" |
| 2:30-2:50 | **Lori Martin** (professional) "East Fork of Parachute Creek (Colorado River drainage): Beavers, brook trout, and chemical reclamation, Oh My!" | **R. Barry Nehring** (professional) "Breaking the life cycle of the whirling disease parasite: The Placer Creek story" |
| 2:50-3:10 | **Kyle Battige** (professional) "Seasonal and temperature-related distribution shifts of Colorado River Cutthroat Trout in Milk Creek" | **Eric Fetherman** (professional) "Formalin sensitivity of whirling disease-resistant rainbow trout" |

3:10-3:30 PM **Break**

| | SESSION 4A: Native Aquatic Organisms<br><br>**Moderator:** Jason Kline, SWCA Environmental Consultants<br>**Abstracts:** Pages 23 to 25 | SESSION 4B: Native Warmwater Fishes<br>**Moderator:** Mandi Brandt, Colorado Parks and Wildlife<br>**Abstracts:** Pages 25 to27 |
|---|---|---|
| 3:30-3:50 | **Wendy Lanier** (student) "Investigating the direct and indirect effects of greenback cutthroat trout on boreal toad recruitment" | **Nate Cathcart** (professional) "Habitat Use and Movement Behavior of Fishes at a Desert Stream Confluence Zone" |
| 3:450-4:10 | **Brittany Mosher** (student) "Evaluating factors that influence amphibian chytrid fungus detection via filtration?" | **Mark Haver** (professional) "Native aquatic species restoration facility" |
| 4:10-4:30 | **Larissa Bailey** (professional) "Boreal Toad reintroductions: interim results and an innovative assessment of survival" | **Jessica Dugan** (student) "Warmwater fish community response to habitat availability in improved and unimproved sites in the Laramie River" |
| 4:30-4:50 | **Lusha Tronstad** (professional) "The status and distribution of an endemic aquatic beetle petitioned for endangered species act listing in Wyoming" | **Elizabeth Mandeville** (student) "Variable hybridization outcomes and population genetic structure in *Catostomus* species in Wyoming and Colorado" |

5:00-6:00 PM **Job Fair** – Marriott Hotel Gazebo (see page 5 for details)

6:00-10:00 PM **Student Social** – Marriott Hotel Gazebo (see page 5 for details)

# Thursday, February 26th

7:00 AM-5:00 PM Registration

7:00 AM-2:00 PM Presentation Download/ Audio Visual Preview

## *Session 5: Sport Fish Management*

Moderator: Eric Gardunio, Colorado Parks and Wildlife

8:00-8:20 AM **Michael Quist** (professional) "Population dynamics of channel catfish in northern Idaho Lakes: Implications for management"

8:20-8:40 AM **Nikki Schlitter** (professional) "Optimizing oxygen usage at Colorado's largest trout production facility"

8:40-9:00 AM **Ben Felt** (professional) "Effects of habitat improvement, harvest regulations, and stocking of whirling disease resistant rainbow trout on the fishery in the Rio Grande River at Coller State Wildlife Area"

9:00-9:20 AM **Jeff Lee & Sunny Bradford** (professional) "Safety in Colorado state hatcheries"

9:20-9:40 AM **Alexander Townsend** (professional) "Reduced thermal tolerance in Colorado salmonid species after exposure to sublethal concentrations of copper"

9:40-10:00 AM **Break**

## *Session 6: Sport Fish Management*

Moderator: Leland McDonald, Wyoming Game and Fish Department

10:00-10:20 AM **Lars Alsager** (professional) "Hatchery design concepts and construction utilizing state of the art technologies"

10:20-10:40 AM **Brain Avila** (student) "Evaluation of resistant rainbow trout fry stocking in Colorado"

10:40-11:00 AM **Adam Leiferman** (professional) "What is a statewide response specialist?"

11:00-11:20 AM **Jason Kline** (professional) "Fisheries of Department Of Defense lands"

11:20-11:40 AM **Tyler Firkus** (student) "The effects of increased winter temperatures on native fish reproduction in the South Platte River"

12:00 AM to 1:00 PM **Business Lunch** - Salon A-D (see page 4 for details)

## *Session 7: Burbot & Bass Research*

Moderator: Paul Dey, Wyoming Game and Fish Department

| | |
|---|---|
| 1:20-1:40 PM | **Zack Klein** (student) "Habitat use of non-native burbot in a western non-wadeable River" |
| 1:40-2:00 PM | **Zack Klein** (student) "Population dynamics of burbot in the Green River of Wyoming" |
| 2:00-2:20 PM | **Zack Underwood** (student) "The effects of water development on the genetic structure of burbot in the upper Wind River Basin, Wyoming" |
| 2:20-2:40 PM | **Andre Breton** (professional) "Population trends of smallmouth bass in the upper Colorado River basin with an evaluation of removal effects" |
| 2:40-3:00 PM | **Kevin Bestgen** (professional) "Population dynamics modeling of introduced smallmouth bass in the Upper Colorado River Basin" |
| 3:00-3:20 PM | **Break** |

## *Session 8: Public Outreach*

Moderator: Matt Kondratieff, Colorado Parks and Wildlife

| | |
|---|---|
| 3:20-3:40 PM | **Beth Bear** (professional) "Wyoming aquatic invasive species program update" |
| 3:40-4:00 PM | **Steve Gale** (professional) "CO/WY AFS chapter mentoring program overview and update" |
| 4:00-4:20 PM | **E. Dale Broder** (student) "An authentic science approach maximizes outreach impact while minimizing time investment" |
| 4:20-4:40 PM | **Nick Walrath** (professional) "Upper Bear River Adopt-A-Trout" |
| 4:40-5:00 PM | **Kurt Fausch** (professional) "For the love of rivers: The power of engaging the public in our freshwater futures" |
| 6:00-10:00 PM | **Banquet** - Salon E-H (see page 5 for details) |

## Contributed Posters (see Abstracts on Pages 37-45)

**Zach Klein** (student). "Precision of hard structures for estimating the age of burbot"

**Jared Smith** (professional). "Trip the hybrid dip"

**Alyssa Graziano** (student). "Why did the cutthroat jump? Effects of fish density on greenback cutthroat trout jumping attempts"

**Darrel Snyder** (professional). "Fishes of the Upper Colorado River Basin— Distribution and abundance by HUC subbasins, 2004-14"

**Christopher Kopack** (professional). "Chemical cues of predation induce antipredator behavior in highly domesticated, predator-naïve rainbow trout"

**Caitlin Peterson** (student). "An evaluation of thermal criteria in Wyoming surface water quality standards"

**Zak Maurer-Erickson** (professional). "National rivers and streams assessment"

**Nick Eglseder** (professional). "Raising sauger (*Sander canadensis*) spawned from the Little Wind River in Wyoming to enhance numbers and maintain genetic integrity of the population"

**Matt Starr** (professional). "Aquaculture Technology: A glance at Wyoming Game and Fish Department's Dubois Fish Hatchery"

**John Walrath** (professional). "Habitat diversity influences fish diversity and assemblage structure"

**Estevan Vigil** (student). "Distribution and life history traits of gill lice *Salmincola californiensis* in Colorado."

**Jacob Powell** (student). "Preliminary assessment of underwater video to locate fish associated with heavy surface, anchor and frazil ice in the Gunnison River, Colorado, USA."

**Katie Rohwer** (student). "The effects of land use, large in-stream wood and invertebrate populations on *Salvelinus fontinalis* density, growth and diet"

**Shai Kamin** (professional). "Effects of extreme high flows on the fish community on Lower Sand Creek, Colorado"

**Matthew Fairchild** (professional). "Jeeps in Creeks: Effects of off-highway vehicle roads on headwater streams in Colorado"

**Taylor Barnes** (professional). "Incorporating GPS and radio-frequency identification (RFID) to evaluate fish movement and habitat utilization"

## Jeeps in Creeks: The Jenny Creek OHV-Trail and Stream Restoration

**Christopher Carroll**, USFS, 970-295-6637, christophercarroll@fs.fed.us

Off-highway vehicle (OHV) use has grown in recent decades along the Front Range Mountains of Colorado. Yet, funding to manage roads and recreation on public lands has declined. Jenny Creek is a high montane stream in Gilpin County, CO where a historic wagon road had become a popular OHV recreation area. The OHV use and annual run-off had created several avulsions to the channel where the road overtook the stream channel and had simplified long distances of aquatic habitat. Following a pilot study conducted in 2012 that identified specific elements of habitat degradation and significant reductions in aquatic life, the Arapaho and Roosevelt National Forest developed a restoration project to re-route the road and rehabilitate damaged reaches of Jenny Creek.

The primary factor driving the reduction in trout density was pool frequency and the related absence of large wood. Identifying the needs of the stream prior to implementation allowed for planning proper restoration for the affected stream reaches.

The road re-route and restoration was implemented in 2014 with a combination of USFS, CPW, TU, and State OHV grant program dollars. The project constructed an upland reroute to continue to provide a recreational opportunity, restored approximately 1 mile of stream, and decommissioned the road adjacent to the stream. Specific restoration treatments include avulsion repair, streambank reconstruction, pool reconstruction, large wood placement, and revegetation. The project was completed in 2.5 weeks at a cost of $220,000 using several pieces of heavy equipment. Post-treatment monitoring will be used to determine the effectiveness of the restoration. The methods of the pilot study in identifying the limiting factors of the affected reaches underscore the need to involve the scientific method in proposing and implementing stream restoration.

## Evaluation of an electric fish guidance system in the south canal- of the Gunnison River, Colorado

**Dan Kowalski**, Colorado Parks and Wildlife, 2300 South Townsend Ave, Montrose, CO 81401, 970-252-6008, dan.kowalski@state.co.us

Eric Gardunio, Colorado Parks and Wildlife, 2300 South Townsend Ave, Montrose, CO 81401, 970-252-6017, eric.gardunio@state.co.us

The South Canal is an irrigation ditch in southwest Colorado that diverts an average of 857 cfs April-October from the Gunnison River, a Gold Medal trout fishery. An electric fish guidance system (EFGS) was installed at the diversion structure in 2012 to reduce fish entrainment when two hydropower plants were installed on the canal. The objective of this study was to monitor entrainment of fish in the canal over time and evaluate the effectiveness of the EFGS. The study reach was 0.72 miles of the canal below the first power plant that is the first available good fish habitat below the diversion tunnel. Fish must pass through the electric guidance system, avoid entrainment in a small lateral ditch and survive the first turbine to end up in the study reach. Three groups of fish were tagged and released upstream of the EFGS; previously entrained fish from the canal (n= 125), wild fish from the Gunnison River above the EFGS (n=3,106) and hatchery reared

fingerling trout (n=19,800). Fish sampling was done with mark recapture boat electrofishing and population estimates were made with the Huggins Closed Capture model in Program Mark using fish length to model capture probabilities. Fish were also captured prior to irrigation season with backpack electrofishers and seines and removed from the study reach to reduce numbers. The study reach contained an estimated 2,994±1,043 fish (>150 mm) in Oct-2011, 1,764 ±279 in Oct-2013, 1,224 ±239 in Jul-2014 and 1,900 ±379 in Oct-2014. Fish population estimates are lower after the guidance system was built, but not significantly (95% level) while the number of fish >350 mm in the study reach has increased, but not significantly. A total of 288 tagged fish <300mm and four fish >300 were recovered below the EFGS, 1.3% of all tagged fish. The EFGS (and turbine mortality) likely excludes larger from the study reach but that effect is offset by the growth and survival of smaller entrained fish, resulting in no significant differences in the fish population of the study reach before and after the EFGS.

## Effects of large wood and log jams on eastern slope Rocky Mountain trout populations

**Adam Herdrich**, Colorado State University, 1484 Campus Delivery Fort Collins, CO 80521, 970-290-2446, Adam.Herdrich@gmail.com

Dana Winkelman, Colorado Cooperative Fish and Wildlife Research Unit, 1484 Campus Delivery Fort Collins, CO 80521, 9704901414, dana.winkelman@colostate.edu

David Walters, United States Geological Survey 2150 Centre Ave Fort Collins, CO 80526 970-226-9484 waltersd@usgs.gov

The effects of clearing high elevation streams of large wood (LW) are still being felt 100 years after the end of intensive logging in the Southern Rocky Mountains and LW recruitment into streams has been greatly reduced. As part of a larger project examining ecosystem level effects caused by the loss of LW, our project focuses on examining how trout populations in high elevation streams are affected by the loss of LW. We accomplished this by comparing streams with high and low amounts of in-stream LW. We compared individual growth rates, lipid content, length-weight relationships, and diets, as well as population density and biomass. LW appears to have an effect on brook trout density. Further, first year growth rates across a gradient of increasing wood load do not show a clear pattern, however, do correlate with population densities. Our goals are to understand how LW influences trout biology and ultimately fish population density. Our results will be beneficial for managers in evaluating specific endpoints for stream restoration projects in high-elevation streams.

## Effects of in-stream large wood on fish diets

**Erin Pettigrew,** Colorado State University, Colorado Cooperative Fish and Wildlife Research Unit, Department of Fish, Wildlife and Conservation Biology 1484 Campus Delivery, Fort Collins, CO 80523-1484

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Adam Herdich, Colorado State University, Colorado Cooperative Fish and Wildlife Research Unit, Department of Fish, Wildlife and Conservation Biology 1484 Campus Delivery, Fort Collins, CO 80523-1484

As part of a larger project on ecosystem function, we have been evaluating how fish ecology is affected by anthropogenic and natural disturbances to large wood in streams. Specifically, we are interested in how insect production influences fish biomass, individual growth and energy storage. To understand mechanisms influencing fish production, we quantified brook trout *Salvelinus fontinalis* diets in two streams with high and low levels of large wood. We hypothesized that large wood input in streams would increase insect production because it creates lentic habitats that provide food resources and attachment sites for insects. Increased insect production should result in higher fish biomass, growth rates, and energy storage. Streams were sampled in August and October 2014 for both fish and insects. Brook trout stomach contents were removed, identified and analyzed for total biomass. We found that fish diets differed between sites with low and high in-stream wood. In August insect biomass in fish diets was higher at the high in-stream wood site. The insect orders Diptera and Plecoptera accounted for the differences in average biomass. Insect diversity was also higher in trout diets from the high wood site. In October insect biomass in fish diets was similar between the low and high in-stream wood sites. Analyses of insect biomass and production are ongoing; however, it appears that differences in diet can at least partially be explained by differences in insect community between the sites. It appears that fish consumption may help explain differences in fish biomass and individual growth observed between the sites and will aid in understanding how large wood influences ecosystem function.

## The Green River, changing the path

Greg Taillacq, Stantec Consulting, 2950 E. Harmony Rd. Suite 290, Fort Collins CO 80528, 970-449-8647, greg.taillacq@stantec.com

**Nathan Jean**, Stantec Consulting, 2950 E. Harmony Rd. Suite 290, Fort Collins CO 80528, 970-449-8615, nathan.jean@stantec.com

Originating in the Wind River Range in remote west central Wyoming, the Green River flows from Wyoming to Utah, briefly entering Colorado before returning to Utah, it then meanders across the Utah desert where it joins the Colorado River at an impressive confluence in a remote and majestic section of Canyonlands National Park in Southeastern Utah. The Green River is one of the legendary rivers of the west. Not far into its journey, approximately 120 miles from its headwaters, the Green River is in a state of instability. It is eroding its banks, forming mid-channel bars, and braiding in response to an increased sediment load. The channel migration associated with such instability is causing the loss of private land and prompting the need for management intervention.

In 2014, Trout Unlimited (TU) and the Natural Resource Conservation Service (NRCS) contracted with Stantec Consulting to perform a geomorphic assessment and survey on the Green River in the area of the Flying W Ranch near Big Piney, Wyoming. Upon completing the assessment and survey, Stantec was tasked with describing conceptual design options for restoring the reach to a more stable form. The principle objectives of these concept designs are to show plausible methods to slow/or stop the migration of the bank and to change the dimensions of the channel cross-section to improve sediment transport processes through the project reach. This presentation will explore and describe the work completed to-date, including the assessment and survey, and present the conceptual level designs that were delivered to TU and the NRCS.

### An ecological approach to water diversions in natural stream channels

**Jillian Cole**, Stantec Consulting, 2950 E Harmony Rd, 970-449-8644, jillian.cole@stantec.com

Diverting water from a natural stream channel for beneficial uses is a common practice in the Western United States. While water diversions are necessary to meet our water needs, they commonly create ecological barriers. Structures used to divert water change the hydraulics and sediment transport of a river system and can impact native stream fauna. They also often require extensive annual maintenance which is disruptive to the river and can be costly.

Wyoming Game and Fish Department (WGFD) maintains a water diversion on the East Fork Wind River near Dubois, Wyoming. Annual maintenance practices, including dredging of the river to create a "push-up dam", have caused the river to exhibit instability immediately upstream of the diversion. The push-up dam cannot withstand high flows and requires annual replacement and disturbance within the river channel. This repeated practice has caused significant instream aggradation and bank erosion behind the dam, ultimately increasing the channel width and flattening the slope. These changes in channel morphology are further promoting sediment deposition and exacerbating instability in the reach. In addition, the push-up dam inhibits fish passage on the East Fork Wind River which is home to a variety of native fish species, including the Yellowstone cutthroat trout.

WGFD teamed with Stantec to address these issues with ecological solutions. Stantec performed a geomorphic assessment to evaluate the physical processes and features present along the East Fork Wind River. Using these data, conceptual design options were developed to meet WGFD's goals of creating a stable point of diversion, reducing annual maintenance, increasing channel stability, and improving fish passage and aquatic habitat. This presentation will discuss the methods used to minimize ecological impacts and maintenance issues associated with the WGFD diversion. These methods can be applied to other water diversions located in natural stream channels.

### Stream restoration and private rangeland management: a harmonious relationship

**TC Dinkins**, Stantec Consulting Services, 2950 E Harmony Road Suite 290, 865-755-8361, tdinkins@stantec.com

Traditional land management practices, including long grazing rotations and intensive agricultural production, have largely been implemented without considering the watersheds in which they are found. Many of these long-standing methods accelerate erosional processes in streams and rivers, and my lead to bank failures and land loss, water quality impairment, groundwater table depressions, and a resulting increase in irrigation demand. Conventional short term fixes, such as armoring failing banks with riprap and debris, inevitably require long term maintenance and associated costs. Without thorough investigation of the source of the problem, a long term solution is unlikely.

Natural systems tend toward stability by equalizing various inputs and outputs. Reach-scale geomorphic assessments of impaired streams provide insight into the broader watershed and serve as baseline references from which permanent solutions can be derived. Survey and analysis of naturally functioning and stable "reference reaches" serve as a blueprint for determining stream restoration design criteria. Proper channel dimensions and floodplain reconnection can provide significant increase in biological function, not just within the riparian corridor, but for the broader landscape. Elevation the local water table will help reduce the demand for irrigation by providing plant roots with accessible groundwater. Allowing flood flows access to the floodplain reduces erosive forces, land loss, and sediment loading in the stream. Although these restoration practices

require implementation costs, the long term stability, reduction of lost land, and minimal maintenance yield long term benefits.

However successful stream restoration techniques may be, without active and informed land management practices, the system could degrade into a state of instability. One of the most important elements in attaining long term stability is understanding how to maintain a healthy riparian corridor. This requires operational planning, management, and monitoring. By limiting grazing access during vulnerable periods (wet, soft and muddy or growing season), short-rotation grazing, and construction of alternative watering locations, a harmonious relationship can exist between the agricultural land and the supporting water body.

This presentation will discuss a recent stream restoration project on a private ranch that incorporated many of the principles stated above. A brief background of the factors that led to the stream degradation will be presented, and a discussion of the proposed solutions will follow.

## Influence of stream habitat enhancement on trout and giant stonefly abundance on the Wason Ranch, Rio Grande River, CO

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A large-scale habitat enhancement project was conducted on a 3.8-mile privately-owned reach of the Rio Grande River flowing through the Wason Ranch in Creede, CO. Landowners believed that poor habitat conditions were responsible for declining trout quality and quantity over time. Project goals included: 1) improve fish quality (increase trout> 35cm), 2) improve fish quantity (increase trout density and biomass), 3) reduce bank erosion, 4) reduce width/depth ratio (i.e. increase river depths), 5) establish bedform features at correct spacing, 6) improve adult fish holding and overwinter habitat (i.e. develop deep pools) and 7) re-vegetate banks. After project completion, CPW monitored trout and giant stonefly Pteronarcys californica response to habitat enhancements. The giant stonefly serves as an important food source for resident trout. Research goals were: 1) to determine how the habitat project influenced trout population biomass (kg/ha), density (trout ≥ 15 cm/ha), and numbers of quality–sized trout (trout ≥ 35 cm/ha) and 2) to determine if river enhancement activities increased giant stonefly abundance on a reach-wide scale. Three reaches were identified for monitoring trout and invertebrate response to varying intensities of habitat treatments. All three reaches experienced the same historic land uses (over-grazing, water quality issues from mining, and logging impacts). The Upper Wason (3.1 km; heavy-treated) contains the most instream structures with frequent large, deeply-excavated pools. The Lower Wason (2.9 km; light-treated) consists mainly of randomly distributed boulders with fewer instream structures and deeply-excavated pools. The La Garita (3.8 km; natural) contains no instream structures and serves as a downstream control. Fish sampling was conducted by electrofishing with two rafts equipped with throw electrodes. Data collected included fish population estimates based on mark/recapture techniques, fish size by relative abundance, age and growth (scales), and fish species composition data. Removal methods were used to estimate stonefly abundance in study reaches. Exuviae were collected and counted in 15 different 100-foot stations above (controls), within (treatment sections), and below (controls) the Wason Ranch study area. This study has unique value because it was conducted on a large river system, while most published habitat enhancement evaluations are conducted on smaller streams.

## The effects of post-flood recovery on fisheries in the Colorado Front Range

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Severe flooding impacted rivers and streams in the Colorado Front Range during September 2013. The flooding had devastating effects on communities and infrastructure, but had many beneficial effects on river ecosystems and stream functions. Flooding is a natural component of river systems that is vital for many ecological and physical processes. 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 armored channels. Initial monitoring following the flood showed variable impacts to fish populations, with changes in trout abundance ranging from -58% to +69% at sites that were severely impacted by the flood 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%. This presentation will build upon results from initial monitoring efforts by incorporating additional post-flood fisheries data collected during the summer and fall of 2014. Floods may provide an opportunity to improve a variety of stream functions related to channel stability, flood conveyance, geomorphology, water quality, and habitat connectivity. However, programmatic constraints at both the state and federal level limit opportunities to improve rivers beyond their pre-flood condition. Addressing permitting and funding constraints 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.

## Effects of seismic surveys on pallid sturgeon and paddlefish in Lake Sakakawea, North Dakota

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Water-based seismic surveys can use airguns to produce the energy source for mapping subsurface geologic features. Airguns produce impulsive sound exposure levels (SELs) with high peak levels and short rise times, which can adversely affect fish. This study was conducted to determine the

effects of sound pressure produced by airguns on pallid sturgeon (*Scaphirhynchus albus*) and paddlefish (*Polyodon spathula*). During this study the fish were placed in cages in Lake Sakakawea, exposed to sound generated by the airgun array, removed from the cages, and monitored for morality in captivity for 7 days. Fish were then sacrificed on day 7 following exposure and necropsied to determine whether potentially mortal internal injuries were present. Exposure to a single impulse SEL produced by the airgun array (224 dBPeak [peak decibel level]; 205 dBSEL) did not cause immediate or delayed mortality in either species within 7 days of exposure. These results indicate that no mortality should occur to pallid sturgeon or paddlefish exposed to the seismic airgun array proposed for use in Lake Sakakawea. These species may exhibit a temporary shift in habitat use based on National Oceanic and Atmospheric Administration thresholds for behavioral responses in fish (150 dBRMS [root mean squared noise level]).

## Population dynamics of channel catfish in the Red River of the North, Manitoba: investigating a high catch – low harvest catfish population

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Channel catfish *Ictaluris punctatus* is a popular sport and game fish to anglers in North America. In many areas where catfish occur, anglers tend to have a harvest-oriented mentality toward channel catfish. Angler preferences and prohibitive catfish harvest regulations on the Red River of the North are believed to have led to reduced harvest of channel catfish. The result has been that trophy channel catfish angling in the Red River of the North has gained popularity among recreational sport anglers as a catch-and-release trophy fishery. Little information exists on the basic population dynamics of this population. Therefore, we used baited hoop nets and angling to collect channel catfish during May and June, 2012. Pectoral spines and sagittal otoliths were collected from individuals to collect age and growth data. The information collected from this unexploited population could serve as an important component in predicting the effects of alternative harvest regulations in exploited populations.

## Conservation of native Wyoming fishes through identification and implementation of native fish management areas

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Freshwater fish species and habitats are among the most threatened in the world. Priority management areas are one approach to minimizing habitat loss and human disturbance. Here, we used Zonation conservation planning software as a strategy for determining priority native fish management areas. Prioritization analysis was based on known and predicted distributions of 33 native fish species and 15 nonnative fish species. To determine predicted distributions, we evaluated the relative importance of landscape-scale factors on fish occupancy using multi-species hierarchical Bayesian mixture modeling that explicitly accounted for imperfect detection. We used additional assessments using Zonation to generate conservation priority rankings that considered native species distributions only or in combination with information on habitat disturbance and nonnative species. Modeling results suggested that the fish assemblage in eastern Wyoming was primarily influenced by stream size and position, urban land cover, and elevation. Interestingly, the areas proposed for conservation were similar among the three Zonation approaches. Our study demonstrates the utility of strategic conservation planning for broad, multi-species landscapes that is intended to aid managers in effective allocation of resources to manage native fishes in Wyoming.

## East Fork of Parachute Creek (Colorado River drainage): beavers, brook trout, and chemical reclamation, oh my!

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The East Fork of Parachute Creek (EFPC) is located northwest of Rifle, Colorado, on lands managed by the U.S. Bureau of Land Management (BLM) within the area known as the Roan Plateau. This drainage was once home to native Colorado River Cutthroat Trout (CRCT) *Oncorhynchus clarkii pleuriticus*, but the population is now considered extirpated due to competition with non-native Brook Trout Salvelinus fontinalis. Colorado Parks and Wildlife (CPW) and the BLM initiated planning for chemical reclamation of the EFPC drainage in 2007. From 2011-2013, the agencies collaborated with Colorado Trout Unlimited and contractors to construct a fish barrier in the upper portion of the drainage, as the first step in preparing to eliminate Brook Trout from the watershed. In July 2014, 23 beaver ponds were converted into stream habitat and three beaver were live-trapped and removed from the treatment reach, upstream of the fish barrier. Time of travel studies, using dye to simulate the fish toxicant, were conducted after beaver trapping and dam breaching. One week later, CPW used liquid rotenone, a fish toxicant certified for fish control by the U.S. Environmental Protection Agency, to eradicate Brook Trout from 6.4 kilometers (km) of the EFPC drainage upstream of the fish barrier. The treatment reach was reclaimed twice on successive days during base flow conditions in mid-August 2014. Drip stations and backpack sprayers were utilized to apply 5% CFT Legumine (liquid rotenone). Potassium permanganate was dispensed using a constant head delivery device to detoxify rotenone downstream of the fish barrier. Adjustments to drip station locations and concentrations of rotenone and detoxicant were made between the first and second day of treatment due to unanticipated changes in environmental conditions. All sentinel fish in live cages upstream of the primary detoxification station were dead by the end of the second day of chemical treatment. Crews from CPW and the BLM electrofished the entire treatment area post-

reclamation, and no live fish were observed or collected. The treatment reach will be re-evaluated again in 2015 prior to the re-introduction of CRCT into the headwaters of the EFPC drainage.

## Seasonal and temperature-related distribution shifts of Colorado River Cutthroat Trout in Milk Creek

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Milk Creek, a tributary to the Yampa River, contains a relatively low elevation population of Colorado River Cutthroat Trout (CRCT) Oncorhynchus clarkii pleuriticus where elevated summer stream temperatures are a limiting factor influencing downstream extent of the population. However, despite locations where summer stream temperatures exceed 26°C in July CRCT have been documented in October sampling efforts. This study examined how CRCT in Milk Creek respond to, and persist in the face of elevated summer stream temperature. Fixed temperature data loggers were used to monitor stream temperature over 10 kilometers of Milk Creek from May through October and location of CRCT was monitored during similar time periods using radio telemetry. Thirty-six CRCT were captured toward the downstream extent of the population's range and implanted with radio transmitters. During the study CRCT used all 10km of the study reach including several tributary streams, with overall fish movements of greater than 9.5km observed. As stream temperature increased throughout the summer maximum upstream distance, extent of downstream distribution, and mean location of transmitter bearing CRCT shifted further upstream. Our findings suggest Milk Creek CRCT responded to elevated summer stream temperatures in varying ways. Some CRCT moved early in the season to spawn and stayed in these cooler upstream locations, other CRCT made later migrations as stream temperatures increased, while certain individuals remained lower in the drainage even with increasing summer stream temperatures. Our data indicated that despite elevated summer stream temperatures in portions of Milk Creek these areas are, at least seasonally, still important to the CRCT population.

## WaTSS: software for interpreting water temperature data

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As perhaps the single most important environmental influence on fish, water temperature drives survival, behavior, growth, distribution, and other physiological processes. Recent concerns over changing climactic conditions and its implications for persistence of threatened or endangered fish species has led to a proliferation of water temperature monitoring efforts. The combination of heightened interest coupled with the availability of relatively inexpensive and durable temperature loggers has precipitated an explosion in the use of these devices that has spread to applied fish management as well, beyond just monitoring water quality. From detecting timing of fry emergence that inform water management practices to predicting optimum timing to implement successful wild spawn operations, use of these devices is becoming routine. While inexpensive remote temperature loggers have been available for several decades, interpreting the resulting data has been hampered by the lack of user-friendly software. The hope is that this program can serve as a developing

platform to make common analyses of temperature data readily available to managers and researchers alike.

## Robust, low-cost data loggers for stream temperature, flow intermittency, and relative conductivity monitoring

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Water temperature and streamflow intermittency are critical parameters influencing aquatic ecosystem health. Low-cost temperature loggers have made continuous water temperature monitoring relatively simple but determining streamflow timing and intermittency using temperature data alone requires significant and subjective data interpretation. Electrical resistance (ER) sensors have recently been developed to overcome the major limitations of temperature-based methods for the assessment of streamflow intermittency. This presentation will describe the development of the STIC (Stream Temperature, Intermittency, and Conductivity logger); a robust, low-cost, simple to build instrument that provides long-duration, high-resolution monitoring of both relative conductivity (RC) and temperature. Simultaneously collected temperature and RC data provide unambiguous water temperature and streamflow intermittency information that is crucial for monitoring aquatic ecosystem health and assessing regulatory compliance. With proper calibration, the STIC relative conductivity data can be used to monitor specific conductivity. This presentation will highlight the use of STICs in the collection of water temperature and streamflow intermittency data within conservation populations of the Rio Grande cutthroat trout for consideration of their vulnerability to climate change.

## Deadwood Creek: A case study illustrating possible impacts of climate change on fragmented streams

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Culverts are one common method of conveying small streams underneath roads. However, these culverts are not always constructed with fish passage in mind, and may be permanently or seasonally impassible to fish, depending upon their size and swimming ability. Extreme floods can also affect fish distributions within streams, often reducing the abundance of fish in impacted areas immediately after flooding. The combined impacts of severe floods and barriers to fish migration can have lasting impacts on fish communities where both occur. On August 3, 2010, a severe storm and subsequent flood occurred on Deadwood Creek near the towns of Lead and Deadwood, South Dakota. This flood severely reduced fish abundance in Deadwood Creek immediately after flooding. In subsequent years, Brook Trout abundance increased to high levels, while Brown Trout have not been collected at any sampling sites on Deadwood Creek since 2010. Culverts on Deadwood Creek appear to be preventing Brown Trout inhabiting downstream reaches from recolonizing the study sites. Climate change during coming years is predicted to increase the regularity of spates in parts of North America. On streams fragmented by culverts and other barriers to fish migration, these

floods could have lasting impacts on fish populations. Deadwood Creek serves as a case study illustrating these possible impacts. The effects of the flood on the Deadwood Creek fish populations highlight the need to identify barriers and remove or modify them to allow fish passage when plausible.

### Breaking the life cycle of the whirling disease parasite: The Placer Creek story

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Placer Creek, a small stream in the San Luis Valley of Colorado, supported a core conservation population of Rio Grande native (RGN) cutthroat trout during much of the 20th century. After failure of gabion barriers in the late 1990s, brook trout infected with *Myxobolus cerebralis* (Mc) invaded from Sangre de Cristo Creek. By 2005, the ravages of whirling disease (WD) and competition from brook trout reduced the RGNs to less than 10% of the trout population. After the Malo Vega fire burned through much of the Placer Creek basin in June 2006, new barriers were constructed and the stream was treated with rotenone in 2007 and again in 2009 to eliminate nonnative brook trout, prior to reintroduction of RGN cutthroat trout. WD research studies in Montana, California and Colorado suggested that management interventions might make it possible to break the life cycle of the Mc parasite. These interventions included 1) keeping the stream fishless for approximately 2-3 years, 2) introduction of lineage V and VI Tubifex tubifex (Tt) worms that are not susceptible to infection by the Mc parasite, and 3) elimination of a small off-channel pond that provided optimal habitat for lineage III Tt oligochaetes, the susceptible host for the Mc parasite. Electrofishing during the fall of 2009 and spring of 2010 indicated the drainage was devoid to fish. Fry, juvenile and adult RGN cutthroat trout were stocked in the late summer and fall of 2010 and 2011. Approximately 975,000 lineage V and VI Tt worms were introduced into Placer Creek between 2010 and 2012. The off-channel pond was filled in and the surface reseeded in April 2012. Among more than 270 RGN trout sacrificed for disease screening between July 2012 and November 2014, no evidence of Mc infection has been detected, indicating the Mc parasite has been eradicated from the Placer Creek basin upstream of the barriers.

### Formalin sensitivity of whirling disease-resistant rainbow trout

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The culture and use of a wide variety of whirling disease-resistant rainbow trout crosses is increasing in Colorado. In 2014, over 6,000,000 Hofer-cross rainbow trout were stocked by

Colorado Parks and Wildlife (CPW) hatcheries. Culturing these crosses requires an understanding of fish performance under culture conditions, including hatch and survival rates, growth, rearing densities, susceptibility to disease, and sensitivity to chemicals used to treat disease outbreaks. For example, CPW hatchery managers have reported increased mortality rates when treating Hofer and Hofer-crosses with formalin. We conducted three experiments to determine the sensitivity, defined as an increase in mortality, of four rainbow trout strains/crosses (pure Hofer and Harrison Lake strains, and 50:50 and 75:25 crosses of the two) to formalin treatments. In the first experiment, eggs were exposed to various concentrations of formalin for treating fungal infections. The second experiment examined if fish exposed to higher concentrations of formalin as eggs exhibited an increase in sensitivity to formalin when exposed as fingerlings. The effects of various hatchery conditions on formalin sensitivity, including size at exposure, crowding away from the inlet, feeding the day of treatment, and various combinations of density and flow, were examined in the third experiment. Results suggest that the 50:50 and 75:25 crosses show an increased sensitivity to formalin as eggs. Although previous exposure to formalin does not appear to affect sensitivity in fingerlings, formalin concentration and duration of exposure does affect fingerling sensitivity, and sensitivity varies among strains and crosses. Concentration has the largest effect on formalin sensitivity, and interactions with size at exposure, feeding the day of treatment, and flow increase mortality. Baseline mortality rates from these experiments can be used to inform hatchery managers of expected minimum losses of rainbow trout during formalin treatments.

## Investigating the direct and indirect effects of greenback cutthroat trout on boreal toad recruitment

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Amphibian populations are in great decline worldwide. The boreal toad, Anaxyrus boreas boreas, is no exception. Much of the decline in its populations can be attributed to the chytrid fungus, *Batrachochytrium dendrobatidis*. However, there are some declining populations with little to no evidence of chytrid. One such population breeds at Spruce Lake, a historically fishless lake in Rocky Mountain National Park, Colorado, where greenback cutthroat trout, *Oncorhynchus clarkii stomias*, were introduced from 1990-1992. Salmonids have been shown to alter ecosystems where they have been introduced yet toads are not typically among species that show declines associated with these introductions. Despite being unpalatable to many predators, boreal toads might be negatively impacted by trout in other ways, thus explaining these enigmatic declines. Here we present the results from a laboratory experiment in which we repeatedly exposed boreal toad tadpoles to greenback cutthroat trout. The tadpoles came from two sources: eggs bred in the wild and eggs bred in a hatchery. We observed the effects of the trout on tadpole survival, growth, and development. Our results indicate that trout exposure can markedly reduce boreal toad tadpole survival, even though few individuals were actually consumed by the trout. Given the current unprecedented declines in amphibian populations and the continued introduction of salmonids for recreation as well as conservation, better understanding of the interactions of salmonids and amphibians will help inform management decisions of both these taxa.

## Evaluating factors that influence amphibian chytrid fungus detection via filtration

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*Batrachochytrium dendrobatidis* (Bd) is a fungal pathogen that causes the disease chytridiomycosis in amphibians. Bd has been detected on every continent where amphibians exist, and has been implicated in the declines, local extirpations, and extinctions of many amphibian species around the globe. Currently, the main method of testing for the presence of Bd at amphibian breeding sites is by swabbing encountered amphibians and testing the swab for the presence of Bd using molecular techniques like PCR. Unfortunately, this methodology implies that once amphibians become rare or extinct at a site, the detection of Bd often becomes costly or impossible. Because reintroductions, translocations, and repatriations are common amphibian management techniques, it is important to have an alternative method that can be used to detect Bd in the absence of amphibians.

We conducted a laboratory experiment in order to assess how our ability to detect Bd in water varies with Bd concentration and water type. We used 0.22 micron Sterivex filters to sample 300 tanks, each randomly assigned to treatment groups consisting of a water type (distilled or natural) and Bd concentration (4 levels). Though we detected Bd at all concentrations, the probability of detecting Bd was less than one even for the highest Bd concentration treatment. We show that water filtration is a viable means for detecting Bd, and suggest that, by collecting multiple filters per site, researchers can drastically reduce the probability of false negatives. This method has great potential to maximize agency resources to detect Bd when amphibians are scarce or when reintroductions are being considered.

## Boreal toad reintroductions: interim results and an innovative assessment of survival

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Erin Muths, USGS Fort Collins Science Center,

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Over the last several decades, various methods have been employed to preserve amphibian species. The family of tools termed relocation, repatriation, translocation, and reintroduction represent an approach to managing populations and species of concern that focus on moving individuals or groups of individuals from established populations (wild or captive) to historical or new habitats. Despite ongoing use of this management tool, success is infrequent. Moreover, success can be defined on a continuum from survival of released individuals (low success) to the establishment of a breeding population of adults and the presence of multiple age classes (high success; Griffiths and Pavajeau 2008) and because negative results are less likely to be published, the proportion of successful reintroductions is likely inflated. Quantitative evaluations of reintroductions are infrequent and assessments of milestones reached before a project is completed, or abandoned due to lack of funding, are rare. However, such assessments, which are promoted in adaptive management frameworks, are critical.

We use a novel application of a multistate, robust design capture–recapture model to estimate survival of reintroduced Boreal toad tadpoles (*Anaxyrus [Bufo] boreas*) through metamorphosis (i.e., the number of individuals emerging from the pond) and thereby provide a quantitative measure of effort and success for an "in progress" reintroduction. Our data also suggest that tadpoles released at later developmental stages have an increased probability of survival and that eggs laid in the wild hatched at higher rates than eggs laid by captive toads. We illustrate how an interim assessment can identify problems, highlight successes, and provide information for use in adjusting the reintroduction effort or management strategy.

## The status and distribution of an endemic aquatic beetle petitioned for endangered species act listing in Wyoming

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*Hygrotus diversipes* is an endemic predaceous diving beetle that is known from 12 locations in east-central Wyoming. *H. diversipes* was a category 2 Candidate species under the Endangered Species Act between 1989 and 1996, and the beetle was petitioned for listing in 2007, 2008, and 2013. H. diversipes distribution was predicted using Maximum Entropy (Maxent) and Random Forest in Wyoming. Modeling predicted that H. diversipes was more likely to occur in intermittent streams with a gentle gradient, in areas of Wyoming with a shallow water table, highly variable precipitation pattern, high soil electrical conductivity and warm temperatures. We conducted surveys for *H. diversipes* at sites where the beetle was known to occur and in areas where models predicted the species to occur to evaluate whether *H. diversipes* might be more widely distributed than is currently known. We sampled beetles using dip nets and assessed water quality at each site. We collected *H. diversipes* at 2 sites where the beetle has previously been collected and discovered a new site. *H. diversipes* was collected in small, alkaline intermittent streams with disconnected pools. Suitable habitat for *H. diversipes* is likely dynamic and may depend on annual precipitation patterns. Maintaining the hydrology of these prairie streams is likely vital to conserving the beetle.

## Habitat use and movement behavior of fishes at a desert stream confluence zone

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River confluence zones connect disparate habitats and support increased species diversity and life history strategies. The local "edge" effects of confluence zones have potentially more spatially expansive consequences for entire river network processes because they might inhibit or facilitate movement through the system. We used seasonal sampling and passive integrated transponder (PIT) technology to study the junction of two small streams in the San Juan River basin from 2012-2014. The objective was to characterize habitat use and movement behavior of fishes with respect to the

confluence zone. The fish community in this area was comprised of > 90% native fishes. The reach downstream of the confluence had consistently higher abundances, diversity, and more frequent detections of PIT-tagged fish relative to upstream reaches. The confluence habitat on average contained the highest abundance and richness of all habitats sampled. Movement among habitats was significantly different among species and size classes. Small flannelmouth sucker (*Catostomus latipinnis*; < 300 mm) and roundtail chub (*Gila robusta*) were commonly detected in Yellow Jacket Creek whereas large flannelmouth sucker (> 300 mm), bluehead sucker (*C. discobolus*), and channel catfish (*Ictalurus punctatus*) primarily used McElmo Creek habitats. Movements differed according to McElmo Creek discharge where channel catfish appeared after the monsoon season began while other large-bodied fishes (flannelmouth sucker and bluehead sucker) were displaced. Monsoon events also triggered movements of roundtail chub, small flannelmouth sucker, and black bullhead (*Ameiurus melas*) between McElmo and Yellow Jacket creeks. These results suggest confluence zones maintain local diversity through increased habitat heterogeneity and regional diversity by providing movement corridors for different species and size classes of native fishes.

## Native aquatic species restoration facility

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I will be talking about the production and goals of the Native Aquatic Species Facility. We have 12 species of endangered and/or threatened fish and one state endangered toad. Some of these fish have never been raised in captivity so we are pretty much "writing the book" on these species.

## Warmwater fish community response to habitat availability in improved and unimproved sites in the Laramie River

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Instream habitat can be rare in Wyoming Rivers, making it extremely important to native fishes that rely on it for shelter and food. Urbanization, among other land use practices degrades rivers and fish habitat. A common technique to augment fish habitat is to add habitat improvement structures during stream restoration projects. Coldwater game fishes, like brown trout (Salmo *trutta*), tend to respond positively to habitat improvement. Less is known about the response of entire fish communities to habitat improvement efforts. The Laramie River, a high plains river, is located in the South Platte River Basin in southeast Wyoming. Within the study area, warmwater nongame fishes dominate the fish community, and the only abundant coldwater game fish is brown trout. Agriculture and urban development dominate the area. Two unrelated stream restoration projects have occurred at sites along the Laramie River. Both projects used wood and rock to improve instream fish habitat at each site. We analyzed species preference for specific habitat types and examined the relationships between habitat variables and species abundance. We compared results between improved and unimproved sites.

## Variable hybridization outcomes and population genetic structure in Catostomus species in Wyoming and Colorado

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Hybridization between native and introduced Catostomus species (suckers) in the Upper Colorado River basin has been a conservation and management concern for some time, and is also interesting from an evolutionary perspective. In some instances, hybridization between native and introduced species has the potential to erode genetic boundaries between species, potentially leading to a local or more widespread loss of species diversity. Historically, management has treated hybridization between two species as a single, homogenous process. However, evolutionary and genetic evidence suggest that diverse outcomes can occur across repeated instances of contact between a pair of species. To better understand Catostomus hybridization and population genetic structure, we have generated genomic data for approximately 3,000 fish from Wyoming and Colorado, spanning six different Catostomus species (bluehead, flannelmouth, white, Utah, longnose, and mountain suckers). Our results indicate extreme variation in outcomes of hybridization in different rivers. Across >20 rivers where hybridization occurs, 11 different types of hybrids are produced. Both the identity of species involved and the extent of hybridization vary widely, and therefore the potential for hybridization to threaten native species varies as well. Our genetic study has also led to insights about population genetic structure within the individual species, including new information about the origins of white sucker invasion, and clarification of population structure in bluehead and mountain suckers among drainages. The results of this study provide new insights both for management and for evolutionary research on the maintenance of species boundaries in natural populations with broad geographic ranges.

## Population dynamics of channel catfish in northern idaho lakes: Implications for management

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Channel catfish, *Ictalurus punctatus* (Rafinesque), populations in six lakes in northern Idaho were sampled to describe their population characteristics. During the summers of 2011 and 2012, 4,819 channel catfish were sampled. Channel catfish populations had low to moderate catch rates and length structure was dominated by fish under 400 mm. Channel catfish were in good to excellent body condition. When compared to other channel catfish populations in North America, growth was fast for the first two years and then declined rapidly thereafter. Fish were stocked at age 2 suggesting that once stocked, cold water temperatures and (or) prey resources limited growth. Total annual mortality of age-2 and older channel catfish was generally less than 40%. Tag returns indicated that angler exploitation was low, varying from 0 to 42.5% among lakes. This research

provides insight on factors regulating channel catfish population dynamics and highlights important considerations associated with their management.

## Optimizing oxygen usage at Colorado's largest trout production facility

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Optimizing Oxygen Usage at Colorado's Largest Trout Production Facility

The hatchery sits at an elevation of 6,900 ft. Rifle Falls Fish Hatchery is a spring fed cold-water unit. The spring temperature is 58 degrees Fahrenheit year round. Rifle Falls raises approximately five million trout per year with maximum densities occurring in May and minimum densities in December. Untreated spring water is 48% oxygen and 130% nitrogen. Spring water enters aeration columns packed with Koch rings while liquid oxygen is added. Before this study, liquid oxygen for six aeration towers were set at 70 SCFH (square cubic feet/hour) per column to total 420 SCFH. In February of 2014, liquid oxygen was lowered from 420 SCFH down to 335 SCFH to obtain a constant oxygen percentage per column. Oxygen readings were taken monthly at the aeration columns to watch for oxygen fluctuations. In the lowest density part of the year, liquid oxygen is dropped from 335 SCFH to 245 SCFH. When turning down the oxygen settings for four months during the lowest density part of the year, Rifle Falls has saved approximately $7,500 in liquid oxygen within one year.

## Effects of habitat improvement, harvest regulations, and stocking of whirling disease resistant rainbow trout on the fishery in the Rio Grande River at Coller State Wildlife Area

**Ben Felt**, Colorado Parks and Wildlife, 719-849-9457, benjamin.felt@state.co.us

In 2014, the Rio Grande River trout fishery at Coller State Wildlife Area exceeded Gold Medal minimum requirements for both biomass and density for the first time since 2005. Previous management actions at this site include a habitat improvement project, implementation of harvest regulations to protect large brown trout, and the stocking of whirling disease resistant Hofer-variety rainbow trout. A historical analysis of the correlation between the timing of these management actions and the response of trout density and biomass revealed that all of these management actions were likely contributing factors to the improvement of the fishery. The objectives of the habitat improvement project completed in 2007 were to increase instream cover and pool habitat through the installation of J-Hooks and boulder clusters. There was a substantial increase in the number of large brown trout observed at the site immediately following the habitat improvement project; this increased abundance of large brown trout continued to be present in all following sampling events. There was also a strong correlation between the timing of the harvest regulation change in 2000 (switched from a harvest regulation of two brown trout ≥ 16" to the current regulation of two brown trout ≤ 12") and the increase in density of brown trout ≥ 16". Lastly, the stocking of Hofer-variety rainbow trout was implemented in 2010 and is strongly correlated with recent increases in rainbow trout density. This historical examination of fishery trends in response to management actions has limitations because it is based solely upon correlation rather than causation, and secondly, many variables other than these specific management actions affect

the fishery. However, this historical analysis can provide insight into the effects of habitat improvement, harvest regulations, and fish stocking on the Rio Grande River trout fishery.

## Safety in Colorado state hatcheries

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Colorado's State Fish Hatchery System has fairly recently implemented an innovative and unique safety program. A safety manual, safety team, and ongoing attention to details potentially affecting the well-being of employees has created a culture of awareness and produced measurable results.

## Reduced thermal tolerance in Colorado salmonid species after exposure to sublethal concentrations of copper.

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Anthropogenic climate change, diversion of water and urbanization are expected to increase surface water temperatures in Colorado. Salmonid populations are especially sensitive to changes in temperature patterns. Heavy metals, such as copper (Cu) have negative impacts on larval and juvenile salmonid fitness. State water quality standards are based largely on laboratory toxicity trials that prescribe only one stressor and examine mortality as the only response variable. But, in the wild organisms are exposed to numerous stressors simultaneously, including multiple toxicants, insufficient dissolved oxygen and high temperatures. We examined the interaction of thermal stress and sublethal exposure to resident Colorado salmonids. Acute Cu exposure, below lethal concentrations, routinely reduced the critical thermal maxima (CTM) of Brook Trout Salvelinus fontinalis, Rainbow Trout *Oncorhynchus mykiss* and Cutthroat Trout *Oncorhynchus clarkii* at 30 days post swim-up development. To determine if this trend was conserved throughout all Colorado trout species and to determine if this trend differs in older age classes, we conducted acute Cu toxicity trials at subleathal levels on pre swim-up, post swim-up and young of year Mountain Whitefish *Prosopium williamsoni*. Immediately after exposures, CTM trials and critical dissolved oxygen minimum trials were conducted. Cu tolerance of Mountain Whitefish differed across age classes. However, across age classes sublethal concentrations of Cu consistently reduced thermal tolerance of Mountain Whitefish. In the face of global warming these results imply that toxicity experiments examining only mortality overestimate protective concentrations of Cu for salmonid species.

## Hatchery design concepts and construction utilizing state of the art technologies

**Lars Alsager**, Hatchery Superintendent Wyoming Game and Fish Department, 8200 Speas Road, 208-827-6505, lars.alsager@wyo.gov

Over the past decade, many Game and Fish Departments across the nation have begun renovating old and even building new facilities. In 2007, Dan Speas Fish Hatchery (WGFD) underwent complete renovation. Wyoming Game and Fish took a unique approach in designing the facility's renovation and as a result created an efficient and state of the art fish production facility. This presentation discusses the mentality, planning, construction, challenges, and future of Dan Speas Fish Hatchery, one of the most advanced facilities in the nation. 30-45 min.

## Evaluation of resistant rainbow trout fry stocking in Colorado

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Following the establishment of whirling disease in Colorado in the late 1980s, Colorado Parks and Wildlife developed a resistant Rainbow Trout for stocking known as the HxC. The HxC is created by crossing the Colorado River Rainbow (CRR) with the German Rainbow (GR). It was hoped that the HxC would exhibit the survival and reproduction of the CRR, overcome potential disadvantages associated with the domesticity of the GR, and maintain genetic resistance to whirling disease. One potential disadvantage of stocking HxC is the potential for backcrossing that could result in decreased whirling disease resistance. Stocking pure GR was not considered a viable option because it was felt that they would not perform well in a natural environment. However, in a laboratory study HxC and GR showed few significant physiological differences, indicating that the GR may be a reasonable candidate for stocking in whirling disease endemic streams. We undertook a laboratory and field experiment to compare fry survival between two resistant strains (HxC and GR). The field experiment was conducted in three drainages (Poudre River, South Fork of the South Platte River, and Colorado River) and 3 streams were selected in each drainage. One-mile reaches of each stream were stocked in August 2014 with 5,000 HxC, identified with coded wire tags, and 5,000 untagged GR. In October 2014, population estimates were conducted in all 9 streams, providing short-term apparent survival for each strain. The laboratory experiment was conducted in September 2014. Fifteen HxC and 15 GR were stocked into large mesocosms with one wild brown trout predator to determine if there was a difference in survival based on brown trout feeding preference. Data collected for the field experiment revealed that there is no short-term apparent survival difference between the HxC and GR. Similarly, laboratory data revealed that there was no difference in survival between the strains when confronted with brown trout predation. Short-term results indicate that the GR strain may be a viable alternative for stocking in whirling disease endemic streams. However, longer-term monitoring is necessary before stocking recommendations can be made.

## What is a statewide response specialits?

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The duties of the Statewide Response Specialist primarily involve the transport of fish throughout Wyoming. In this short video, I will inform the viewer with history, modern day techniques, the species and places we haul fish, public interaction and an idea of what it takes to transport fish for the Wyoming Game and Fish Department.

## Fisheries of Department Of Defense Lands

**Jason Kline**, SWCA Environmental Consultants, 295 Interlocken Blvd, Suite 300, Broomfield, CO 80021, 520-269-9424, jkline@swca.com

In 2014, SWCA Environmental completed fisheries surveys in conjunction with the USFWS (U.S. Fish and Wildlife Service) on three DOD (Department of Defense) bases (Warren AFB, Cheyenne, WY; U.S. Air Force Academy (USAFA), Colorado Springs, CO; and Pueblo Chemical Depot (PCD), Pueblo, CO). Surveys were completed via backpack electrofishing and minnow traps to assess the populations and provide a baseline for future surveys. SWCA found that the fish assemblage has shifted on Crow Creek at Warren AFB, is more diverse where beaver activity occurs at USAFA, and that a high predator population at the AWS pond in PCD may be keeping the refuge for the state listed southern redbelly dace from reaching their full potential.

## The Effects of increased winter temperatures on native fish reproduction in the South Platte River

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Frank Rahel, University of Wyoming,

Harold Bergman, University of Wyoming

During winter, effluent discharge from wastewater treatment facilities can warm stream temperatures above ambient levels, but the effects of warmer temperatures on native fish reproduction are largely unknown. We examined the spawning success of two fish species resident in the South Platte River downstream of an effluent discharge north of downtown Denver Colorado. In laboratory experiments, we exposed johnny darters (*Etheostoma nigrum*) and fathead minnows (*Pimephales promelas*) to three temperature regimes for four months to bracket both elevated temperatures typical of the South Platte River below the effluent discharge (16° and 20°C) and the temperature standard set by the state of Colorado (12°C) over the winter months. Johnny darters spawned at all three temperatures during the winter, and did not spawn again in the spring. Fathead minnows spawned under the 16° and 20°C temperature regimes but not the 12°C temperature regime during the winter. Fathead minnows that had not spawned in the winter at 12°C did spawn during the simulated spring warm-up period. Fathead minnows that had spawned during the winter at 16° and 20 °C spawned again in the spring, but had reduced fecundity. Real time PCR analysis for vitellogenin mRNA production supported the spawning data. These results suggest that

warm water temperatures resulting from effluent discharge in the South Platte River could promote spawning by some native fishes during the winter.

### Habitat use of non-native burbot in a western non-wadeable river

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Darren Rhea, Wyoming Game and Fish Department

Anna Senecal, Wyoming Game and Fish Department

Burbot *Lota lota* were illegally introduced into the Green River drainage, Wyoming in the 1990s. Burbot have the potential to alter the food web in the Green River, thereby negatively influencing socially, economically, and ecologically important fish species. Therefore, fisheries managers of the Green River are interested in implementing a removal program for Burbot. Unfortunately, relatively little is known about the habitat use of non-native Burbot in lotic systems, severely limiting the effectiveness of any removal effort. The objective of our study was to identify habitat features related to the presence and relative abundance of Burbot using hurdle models. A total of 260 Burbot was collected during 207 sampling events in the summer and autumn of 2013. Regardless of the season, large substrate (e.g., cobble, boulder) best predicted the presence and relative abundance of Burbot. In addition, our models indicated that the occurrence of Burbot was inversely related to mean current velocity. The efficient and effective removal of Burbot from the Green River largely relies on an improved understanding of the influence of habitat on their distribution and relative abundance.

### Population dynamics of burbot in the Green River of Wyoming

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Darren Rhea, Wyoming Game and Fish Department

Anna Senecal, Wyoming Game and Fish Department

Burbot *Lota lota* is a picivorous fish species that was illegally introduced to the Green River of Wyoming in the 1990s. Burbot have the potential to alter fish assemblage structure of the Green River through competition and predation. Because of the potentially deleterious effects of Burbot, managers of the Green River are interested in monitoring and eventually suppressing the Burbot population. Unfortunately, little information is available regarding population demographics for Burbot in the Green River. Without baseline information, the efficacy of future management of Burbot in the Green River will be difficult to evaluate. Therefore, our objectives were to describe age structure, growth rates, and age-specific mortality of Burbot in the Green River. Demographic information was used to predict the response of the Burbot population to varying levels of

suppression. Mean back-calculated lengths at age of Burbot were estimated using a Fraser-Lee method and age structure was estimated using an age- length key. Growth was described using a von Bertalanffy model and total annual mortality was estimated using a weighted catch curve. The effects of suppression on the Burbot population were predicted using a female-based Leslie matrix. Results from this study will provide baseline information for management of Burbot in the Green River.

## The effects of water development on the genetic structure of burbot in the upper Wind River Basin, Wyoming

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Joe Deromedi, Wyoming Game and Fish Department

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Burbot (*Lota lota*), a member of the cod family, are a unique freshwater fish species of ecological, recreational, and cultural importance throughout their Holarctic distribution. In the state of Wyoming, USA, burbot are native to the Wind/Bighorn River drainage where they are a popular sport fish and an apex native predator in the region. Regional declines in abundance and demographic shifts have been observed, spurring increased research and conservation efforts. One main factor attributed to these declines is water development for agricultural purposes. We examined the genetic structure of burbot populations within natural and human-made water bodies throughout the watershed using next-generation DNA sequencing and a Bayesian modeling approach. Genetically divergent groups were observed within both the natural and human-made waters, and gene flow between populations was minimal in a downstream direction only. Our results indicate that burbot populations in all waters are largely isolated, and that human-made waters are not acting as sink populations to the degree expected. Our findings will aid fisheries managers in the conservation of burbot within this region, and within other regions affected by water development.

## Population trends of smallmouth bass in the upper Colorado River basin with an evaluation of removal effects.

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Smallmouth bass *Micropterus dolomieu* were rare in the upper Colorado River basin until the early 1990's when their abundance dramatically increased in the Yampa River sub-basin. Smallmouth bass

established a self-sustaining population and eventually colonized the downstream Green River sub-basin. The rapid increase of smallmouth bass in the upper Colorado River basin overlapped with significant reductions in native fish populations in some locations. Thus, an integrated and widespread bass removal program was instituted to reduce those negative effects. Our data and analyses indicate 4 major trends influencing smallmouth bass population dynamics in the upper Colorado River basin. First, smallmouth bass densities were substantially reduced in most years by electrofishing removal efforts. Second, environmental effects including high flows and associated cooler water temperatures were also responsible for declines in smallmouth bass densities in some reaches but only in some years. Third, immigration and recruitment was responsible for post-removal population recovery in some reaches. Finally, abundant year classes of young smallmouth bass produced in low flow and warm years, such as 2006 and 2007, have potential to overwhelm removal efforts. Despite the potential for post-removal population recovery recent electrofishing removal efforts have resulted in declining smallmouth bass population trends. Therefore, we recommend that removal efforts continue, especially in river reaches that are perceived to be production areas for smallmouth bass. We also suggest that other management options to reduce smallmouth bass populations be considered. For instance, it is clear that flow and temperature influence the spawning success of smallmouth bass and manipulation of these factors could be used in some areas to influence smallmouth bass reproductive success. It is also imperative that escapement of resident smallmouth bass and other fishes from reservoirs and other sources be prevented.

## Population Dynamics modeling of introduced smallmouth bass in the Upper Colorado River Basin

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We combined life history and ecological information for smallmouth bass Micropterus dolomieu with estimates of density and exploitation from the upper Colorado River basin into a custom-built population projection model. We then ran model simulations aimed at predicting bass abundance under a variety of management scenarios. We focused on simulations of smallmouth bass numbers in Little Yampa Canyon, a 24-mile reach on the Yampa River where extensive removal and estimation occurred. Based on our analyses, the smallmouth bass population in Little Yampa Canyon, and just upstream, appears to be the epicenter of the Yampa River smallmouth bass population. Sensitivity analysis of demographic parameter estimates implemented into our projections suggested results were robust to parameter uncertainty. Model projection results suggest that, (1) early season nest disturbance was most effective because most age-0 smallmouth bass that survive the winter are from the early hatching cohorts and conversely, few from middle and late season hatching cohorts survive; (2) early spawning season removal of adults (aka, "the surge") is a cost effective way to further reduce smallmouth bass numbers, especially when many are reproducing (adult) fish; (3) spring electrofishing exploitation is preventing the smallmouth bass population from increasing exponentially; (4) immigration is preventing the smallmouth bass population from going extinct in some reaches given present levels of electrofishing effort; and (5), low frequency of detrimental

environmental conditions had little impact on smallmouth bass abundance. In addition to management recommendations integrated into our smallmouth bass assessment, we recommend that the Recovery Program integrate the surge as a core component of the spring-summer exploitation effort and that this strategy be applied to areas of smallmouth bass reproduction responsible for significant smallmouth bass recruitment.

## Wyoming aquatic invasive species program update

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An overview of the Wyoming Aquatic Invasive species (AIS) program and an update on the current status of AIS populations in Wyoming and in neighboring states will be given. The AIS program began in 2010 and has changed significantly over the last five years. The main components of the program are education and outreach, watercraft inspections, and water sampling. Awareness of AIS among boaters using Wyoming waters is high, and compliance with AIS regulations seems to be increasing. Watercraft inspections account for the majority of resources by the program and have considerably decreased the risk of watercraft transporting AIS into Wyoming. Sampling continues to increase to new waters each season and several new populations of curly pondweed and New Zealand mudsnail have been discovered in Wyoming in recent years. To date, no evidence of zebra or quagga mussels has been found in Wyoming, and new populations in neighboring states reaffirms the importance of stopping the movement of AIS on watercraft entering the state.

### *CO/WY AFS chapter mentoring program overview and update*

**Steve Gale**, Wyoming Game & Fish Department, 528 South Adams Street, 307-399-8722, Steve.Gale@wyo.gov

The principal goal of the Colorado/Wyoming AFS Mentoring Program is to assist college students and young fisheries professionals in expanding their fisheries expertise and skills and continuing their personal and professional growth. Application to the program is open to students enrolled in biology or ecology related programs at any Colorado or Wyoming university or college or to individuals who have obtained a degree in biological or ecological sciences and are currently residing in the states of Colorado or Wyoming. Successful applicants should expect to receive a positive mentoring experience that supplements previous school or work experiences in the fisheries field. Potential focus areas will include, but are not limited to, fish management, culture, and research, sampling techniques, data summary and analysis, report writing, personal development, and professional development. Mentors will work with applicants to improve communication and time management skills and will provide guidance on the intricacies of applying for future job or educational opportunities. Come hear about how the first year of the program went and the great opportunities available for students in 2015.

## An authentic science approach maximizes outreach impact while minimizing time investment

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Lisa M Angeloni, CSU,

Science education in the United States lags behind other countries. For example, Colorado fifth-graders have a less than 50% passing rate in the statewide scientific aptitude test, and report, "rarely doing or thinking about science." Fish biologists are in a unique position to provide positive science experiences since we work with charismatic animals that have easily observable behavior. But it is important that we use our outreach time efficiently. Authentic science is a pedagogic technique that effectively engages students and ultimately increases scientific literacy. Using an authentic science approach, we can maximize our impact while minimizing time investment. Here I present an authentic science program that I developed and implemented for three consecutive years as a proof of concept. Each year, I helped 12-30 low-income, Hispanic middle school students design and conduct month-long experiments that they presented at local scientific conferences. My time investment ranged from just 2-10 hours each year, yet assessments indicate that the program impacted the students' scientific self-efficacy. Applying authentic science techniques to existing outreach programs has the potential to significantly increase scientific literacy in the United States.

## Upper Bear River adopt-a-trout

**Nick Walrath**, Trout Unlimited, 520 Wilkes Dr. Suite 4B, 307-532-0753, nwalrath@tu.org

Jim DeRito, Trout Unlimited, jderito@tu.org

The Upper Bear River Adopt-A-Trout (AAT) program was a three-year telemetry study of Bonneville cutthroat trout (BCT) movement in the Bear River around Evanston, WY. From 2011 to 2014, Trout Unlimited tagged, tracked, and documented locations of 47 adult BCT with an average length of 39.4cm and weight of 675.5g in the Bear River from Woodruff Narrows reservoir to the headwaters of the Bear River in the Uinta Mountains. Fish were tagged during the fall of the 2011, 2012, and 2013 and documentation of fish locations were attempted once a month for one year including their spring migrations to spawning areas. Throughout the project, a local 8th grade science class was included in the study to "adopt" the fish. This process brought more funding partners, gave TU a foot in the door with private land owners along the river, and provided an avenue for the kids to take ownership and learn about their local resource. BCT in this reach of the Bear River are still fluvial in nature and tagged fish have migrated up to 71 km during the spring. The study identified 2 tributaries that are primarily used for spawning, a mainstem migration barrier, and 17% of the fish tagged were entrained in 5 irrigation ditches. This unique project used diverse funding sources to generate awareness of BCT and identify restoration projects within the upper Bear River watershed.

## For the love of rivers: The power of story in engaging the public in our freshwater futures

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Freshwater ecologists strive to provide information so that river managers can balance human needs for water with conserving ecosystems. However, most of this is unknown to the public that shapes river management. If we want real rivers in our future, then we must help the public understand what is at stake, what humans value, and what it will take to conserve these ecosystems.

Here I describe using narrative non-fiction writing to draw readers into a story, educate them about how streams work, and ask what is essential about rivers that would compel humans to conserve them. Beyond simply water to drink and fish to eat, humans are hard-wired to seek rivers, and science shows that they can reduce stress and increase happiness, thereby improving creativity and offering solace in times of great loss. The power of story is to help humans understand and achieve a deep love of rivers, and in that find a reason to conserve them.

## Precision of hard structures for estimating the age of burbot

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Burbot *Lota lota* are the only freshwater member of the family Gadidae and have suffered population declines throughout much of their native distribution. Management agencies tasked with monitoring Burbot populations often rely on age and growth data gleaned from calcified structures (e.g., otoliths, fin rays). Although otoliths have been identified as reliable ageing structures for Burbot, they require that fish be sacrificed. Due to the conservation status of many Burbot populations, identifying effective non-lethal ageing structures is warranted. Brachiostegal rays, pectoral fin rays, and dorsal fin rays were compared to sagittal otoliths to evaluate the precision and readability of non-lethal structures for estimating the age of Burbot. All structures were sectioned and independently read by two readers. Between-reader precision, the relationship between readability and precision of age estimates (i.e., confidence ratings), and differences in age estimates among hard structures were evaluated. By identifying the best non-lethal ageing structure, conservation efforts for Burbot will gain insight into understanding the age distribution and dynamic rate functions without the need to sacrifice fish.

## Trip the hybrid dip

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Various management strategies may require sterile species of fish. One method to create sterile fish is to shock eggs (pressure or thermal) shortly after fertilization, resulting in sterile, triploid (3N) progeny. Generally, triploid fish performance is compromised in the incubator and hatchery, as compared with unsterilized (diploid 2N) fish. The Story Fish Hatchery produces eggs from five brood stocks: Brook, Brown, Golden, Rainbow, and Lake trout. In addition to these brood stocks, hybrids are also produced. One such hybrid produced, is the tiger trout (♀ brown X ♂brook) In opposition to the higher incubator and hatchery performance of normal diploids (2N), tiger trout hybrids, require the triploid (3N) inducing shock, to greatly enhance incubation and hatchery performance. Also, the reciprocal tiger trout cross, (♀ brook X ♂brown), was investigated, to see if eggs from the inverse cross would create a viable alternative.

## Why did the cutthroat jump? Effects of fish density on greenback cutthroat trout jumping attempts

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Colorado is home to three subspecies of Cutthroat Trout (*Oncorhynchus clarkii*). Competition from non-native introduced trout species such as Brook Trout (*Salvelinus fontinalis*) can lead to extirpation of local Cutthroat Trout populations. Native trout habitat and populations can be protected using vertical waterfall barriers, which are often designed using laboratory-derived fish jumping data. Early fish jumping studies used arbitrarily-chosen numbers of fish per jumping trial, without an understanding of the factors that might motivate fish to jump. One possible motivational factor is density (number of fish per trial), wherein higher densities of fish downstream of a waterfall might stimulate more fish to jump than lower densities. This study aimed to explore the effects of fish density on the motivation of juvenile Cutthroat Trout to jump under laboratory conditions when presented with a passable waterfall. Juvenile Greenback Cutthroat Trout (*O. c. stomias*; mean TL: 112.5 mm) were tested in Kondratieff-type artificial waterfalls at densities of 1, 4, 6, and 10 fish/trial (n = 9 – 11) set to a jump height of average fish length (10 cm) and a plunge pool volume of 24977.4 cm3 and given 8 hours to attempt to negotiate the waterfall. Digital videos were recorded and reviewed to count the number of jumping attempts and successes of each trial. The starting fish density was compared to number of jumping attempts per trial and number of jumping attempts per individual fish. There was a significant density effect on the number of jumping attempts per trial (ANOVA, $P < 0.01$). However, the effect of starting fish density on the number of attempts per individual was not significant (ANOVA, $P > 0.05$), suggesting that fish density does not affect the rate at which individual trout jump in artificial waterfalls. Nevertheless, the finding that higher starting densities result in more passage attempts per trial is an important one, because it suggests that using higher densities in jumping studies would increase the researchers' confidence that fish are indeed trying to negotiate the apparatus.

## Fishes of the Upper Colorado River Basin— Distribution and abundance by HUC subbasins, 2004-14

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I am compiling a comprehensive list of fishes currently in the Upper Colorado River Basin (UCRB) for the introduction to my forthcoming guide for cyprinid larvae and juveniles of the basin. The results to date are presented in this poster for review, correction, and supplementation.

Species presence and general abundance since 2003 in lotic and lentic habitats were assessed for the three major subbasins and eight USGS hydrologic sub-regions therein (4-digit HUCs 1401-1408). Based on these assessments, the UCRB is currently inhabited by 68 species of fish, 7 subspecies (1 cyprinid and 6 cutthroat trout), and 24 hybrids (4 cyprinid, 14 catostomid, 4 salmonid, 1 esocid, and 1 centrarchid). Eight of the species are listed in this poster herein only for lotic habitats and four only for lentic habitats. Among the eight subbasins, the current number of species varies from 42 (possibly 44) for HUCs 1403 (Upper Colorado-Delores) and 1407 (Upper Colorado-Dirty Devil) to 49 (possibly 50) for HUC 1401 (Colorado Headwaters). Of the thirteen

species native to the basin (9 cypriniforms), eight are currently present in all subbasins, four in five to seven subbasins, and one in just two subbasins.

The current list of 68 species (55 non-natives) represents a net increase of 13 non-native species since 1982 (16 new species less 3 previously reported species not in the current list—O. kisutch, F. sciadicus, H. placitus). Of the current 55 non-natives, 45 have been reported in the Colorado portion of the UCRB during the past decade and represent a net increase of 12 (13 new less 1 no longer listed) over the 33 non-natives I reported therein in 1981.

## Chemical cues of predation induce antipredator behavior in highly domesticated, predator-naïve rainbow trout

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Many fisheries management agencies allocate significant poportions of available resources to rear fish for stocking in lakes, rivers, and reservoirs. However, domesticated fish reared in a hatchery environment may fail to exhibit appropriate antipredator behavior and can have relatively low survival when released into natural habitats. Exposing hatchery fish to natural predator cues can provide information about their capacity to exhibit behavioral responses and has the potential to enhance antipredator behavior and subsequent survival in the wild. We investigated behavioral shifts in captive, hatchery-reared rainbow trout Oncorhynchus mykiss in response to chemical cues associated with predation. We used a frequently stocked and economically important strain of rainbow trout, the German Rainbow (GR), which is resistant to whirling disease but particularly susceptible to predation. We exposed individual rainbow trout to alarm cues from conspecifics, kairomones from brown trout Salmo trutta predators, and a combination of the two cues. Fish exposed to these cues exhibited changes in behavior expected to reduce predation risk, including a reduction in time spent actively swimming and exploring, and an increase in time spent frozen. Thus, these highly domesticated, hatchery-reared fish have the capacity to exhibit appropriate responses to the threat of predation. Future research should investigate whether exposure to predator cues in a hatchery setting translates to long-term enhancement of antipredator behavior and increased survival rates, as this would provide a rapid, simple and low cost way to increase the efficiency of stocking programs for recreational purposes as well as native fish restoration and conservation.

## An evaluation of thermal criteria in Wyoming surface water quality standards

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Temperature is a significant determinant of fish distribution due to its impact on fish metabolism, reproduction, and behavior. Because surface water thermal regimes are highly vulnerable to anthropogenic influence, states must establish management standards in order to maintain thermal conditions suitable for aquatic life. The objective of this study is to evaluate the Wyoming surface water temperature standards and propose revisions where needed. We will present our approach for developing temperature standards to adequately protect Wyoming aquatic life, focusing on our division of fish species into multiple management guilds based upon their thermal requirements. We will also discuss our development of the instantaneous and weekly allowable thermal maxima used to define each guild. An improved understanding of Wyoming fish species' thermal requirements will allow for better management of Wyoming surface waters.

## National rivers and streams assessment

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PG Environmental, LLC (PG) was tasked with performing field assessment support for the United States Environmental Protection Agency's (EPA) National Rivers and Streams Assessment (NRSA) in 2013 and 2014. The NRSA is a study of all rivers and streams of the U.S., from the largest "great rivers" to the smallest headwater streams.

The NRSA field sampling schedule for 2013-2014 was a continuation of the 2008/2009 NRSA field sampling effort conducted across the lower 48 states, including Colorado and Wyoming. PG sampled a total of 687 sites across 30 states during 2013 and 2014, 120 of which were in Colorado and Wyoming.

The continuation of the NRSA field sampling, including the fish collection, allows for statistical assessment of the condition of the Nation's rivers and streams, evaluation of changes in condition from the 2008/2009 NRSA, and identifies key stressors to these systems. The goals of the NRSA are to determine the extent to which rivers and streams support a healthy biological condition and the extent of major stressors that affect them. In addition, the survey supports a longer-term goal: to determine whether or rivers and streams are getting cleaner and how we might best invest in protecting and restoring them.

## Raising sauger (*Sander canadensis*) spawned from the Little Wind River in Wyoming to enhance numbers and maintain genetic integrity of the population

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Raising Sauger (*Sander canadensis*) Spawned From the Little Wind River in Wyoming to Enhance Numbers and Maintain Genetic Integrity of the Population

In 2012 the Wyoming Game and Fish Department began a joint 5 year project with the United States Fish and Wildlife Service, Shoshone and Arapahoe tribes, to enhance the population size and maintain the genetic integrity of sauger in the Little Wind river in Wyoming.

For each of the last two years, sauger were collected and spawned at these river sites. After fertilization the eggs are transported to the Dan Speas Fish Hatchery in Casper, Wyoming for incubation. The eggs are measured into hatching jars and incubated for about seven days until hatch. After hatching, most of the fry were shipped to the Garrison Dam National Fish Hatchery to be raised in earthen ponds until they reached a 2" and 4" fingerling size. Multiple trips were taken to pick up and stock the first batch of fingerling fish and then the advanced fingerling fish back into the Little Wind River.

Last spring while collecting the brood fish which were to be spawned from the river, there was an increased presence of 9" sauger which points to the success of our 2013 plants. The project will continue until 2017 when the success of the project can be measured through data analysis.

## Aquaculture technology: A glance at Wyoming Game and Fish Department's Dubois Fish Hatchery

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The Wyoming Game and Fish Department's Dubois Fish Hatchery utilizes some of the most innovative techniques and equipment in the aquaculture industry to maximize fish production in a challenging environment. Discovery of whirling disease in production water in 2000 led to an extensive renovation, turning an aging hatchery into a state of the art facility utilizing a partial reuse recirculation system to make the most of a limited pathogen free water supply. From water conditioning techniques and conveyance, to maximizing rearing space and production, the Dubois facility's innovative approach produces fish for sportsman to enjoy throughout the state.

## Habitat diversity influences fish diversity and assemblage structure

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Healthy riparian corridors are the foundation for preserving the biological integrity of stream ecosystems. They provide a number of benefits to fishes including cover, streambank stabilization, stable water temperatures, and allochthonous food input. The goals of this study were to determine how four dimensions of habitat diversity (i.e., cover, substrate, velocity, depth) influence fish diversity, how indicators of grazing (i.e., woody riparian vegetation, stream channel dimensions, streambank condition) influence habitat diversity, and how instream habitat diversity and other habitat features influence fish assemblage structure. We conducted fish and habitat surveys at 37 sites in Goose Creek (Idaho-Nevada-Utah boarder) from June to October in 2013 and 2014. Fish were present at 32 of 37 sites. A principal components analysis (PCA) including only habitat data showed a stream-size gradient, contrasting sites that were high gradient and cold with more bank

sloughing and slumping and more small wood versus lower gradient sites with deeper residual pools, warmer temperatures, and more variation in water depths and velocities. Fish species diversity was positively associated ($P < 0.15$) with all four dimensions of habitat diversity as revealed by multiple linear regression. The overall model fit the data well ($F_{4,27}=12.78$; $P<0.001$) and explained 62% of the variance in fish species diversity (adj-$R^2=0.62$). Variation in each of the four dimensions of habitat diversity was explained, to varying degrees, by grazing indicators after accounting for a strong and persistent stream-size effect whereby habitat diversity was higher in larger streams. A canonical correspondence analysis (CCA) was conducted to determine which habitat variables significantly affect fish assemblage structure. Significant habitat variables were temperature ($P<0.001$), percent slope ($P=0.019$), SD of velocity ($P=0.005$), percent woody vegetation ($P=0.003$), percent stream bank sloughing and slumping ($P=0.100$), and percent fine substrates (clay/silt/sand; $P=0.109$). The results of this study provide insight into how land management influences the diversity of instream habitat that structures fish species diversity and assemblage structure.

## Distribution and life history traits of gill lice *Salmincola californiensis* in Colorado.

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Gill Lice are parasitic copepods that attach externally to fish, limiting oxygen exchange through the gill filaments on which they are attached. Gill lice negatively affect fish behavior, immune system function, growth, warm water tolerance, sexual maturation, fecundity, and survival. To date only one species of gill lice, Salmincola californiensis has been confirmed in Colorado. We inspected multiple fish species and populations throughout Colorado and have created a map that shows the distribution of gill lice in Colorado. S. californiensis infections have been observed on multiple salmonid species of the genus *Oncorhynchus* throughout the state. These species include Rainbow Trout (*O. mykiss*) Cutthroat Trout hybridized with Rainbow Trout (*O. clarkii x O. mykiss*) and Kokanee Salmon (*O. nerka*). Other salmonid species such as Brown Trout *Salmo trutta*, Brook Trout *Salvelinus fontenallus* and Native Mountain Whitefish *Prosopium williamsoni* are not susceptible to *S. californiensis* infection and no gill lice have been observed and confirmed on these fish species in Colorado. Relatively little information is known about gill lice, and a better understanding of their distribution and life history traits will help managers determine which fish populations may be most at risk of experiencing detrimental effects due to gill lice infestation, as well as mitigate the negative consequences due to these infections.

## Preliminary assessment of underwater video to locate fish associated with heavy surface, anchor and frazil ice in the Gunnison River, Colorado, USA.

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Overwintering of salmonids and other freshwater stream fish in river conditions with heavy surface, anchor and frazil ice coverage is an important management bottleneck that is often not investigated due to lack of access. This lack of access is due to the challenge of sampling under large sheets of ice, as well as dangerous instream conditions. This study is using underwater video from a GoPro Hero 3+ attached to an extendable pole to observe the location of salmonids and catastomids in the Gunnison River during periods of heavy surface, anchor and frazil ice coverage. Preliminary results indicate that the camera is effective at locating and determining trout and sucker presence in areas where other sampling techniques could not be used. Three study areas have been chosen and are being observed repeatedly during exceptionally cold mornings as well as warm evenings in order to assess the location of salmonids and catastomids. Preliminary data indicates that salmonids and catastomids are both associated with shelf ice but not anchor or frazil ice. In addition to catastomid and salmonid presence, we are investigating the effects of surface, anchor and frazil ice on periphyton and macroinvertebrates.

## The effects of land use, large in-stream wood and invertebrate populations on *Salvelinus fontinalis* Density, growth and diet

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Adam Herdrich,

Dana Winkelman,

As part of a larger project on ecosystem function, we have been evaluating how fish ecology is affected by land use and large in-stream wood. We are particularly interested in how insect production may influence fish density, growth, diet, and energy storage. Energy acquisition and storage are critical for an organism's reproduction and survival. Fish with increased energy stores grow faster, have more reproductive success, and higher survival rates. One of the best measures of energy storage is lipid level, which is a key indicator of condition. The amount of energy available to fishes in a stream may be influenced by fish density and available cover. Our poster summarizes lipid levels in brook trout (*Salvelinus fontinalis*) from two sites that were sampled from July to August of 2013 and 2014. We also summarize three additional sites sampled in 2014. Sites were picked based on forest management history and wood loading amounts. Brook trout were collected in multiple passes with a backpack electro shocker, then measured, and sacrificed. Brook trout from each site were processed with the Folch method to find percent whole body crude fat. Percent crude fat decreased from 4.36% of the body mass in 2013 to 3.68% in 2014. This is most evident in North Saint Vrain and Glacier Creek (Rocky Mountain National Park), both percent averages decreased by 2.06%. The sites with a large amount of in-stream wood showed higher lipid percents than the low in-stream wood areas. The three additional sites all contained low in-stream wood and resulted in an average of 4.89% whole-body crude fat. We found that the sampled streams with more in-stream wood provided increased cover and boasted amplified invertebrate populations. Higher levels of lipids in 2013 would have lead to more fish surviving winter thus increasing the density. The increased fish density places greater pressure on the invertebrate populations, leading to a decrease in invertebrate density. The data we have establishes that in-stream wood affects the percent of lipids stored; however we would like to collect data from additional streams to establish a definite pattern.

## Effects of extreme high flows on the fish community on Lower Sand Creek, Colorado

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Extreme flood events in urban landscapes are believed to be particularly catastrophic to fish communities, as channelization and reinforced bank habitat often constrain the floodplain where fish can seek refuge from high flows. Severe flooding (>100-year recurrence interval) occurred between September 13 and 20, 2013, in the Denver, CO metropolitan area due to prolonged precipitation. Fish sampling and habitat evaluation on three reaches of Sand Creek were conducted in July and November 2013 and August and November 2014. Substantial changes to instream habitat were not observed in the study reaches. Even with substantial 2013 flooding, species composition, density, and biomass showed similar patterns between 2013 and 2014. Despite likely relocation of fish by high flows as well as isolation of populations by instream drop structures, no substantial changes were observed between the two years.

## Jeeps in creeks: Effects of off-highway vehicle roads on headwater streams in Colorado

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Off-highway vehicle (OHV) use is a primary threat to aquatic ecosystems in the western United States. This controlled study quantifies the impacts OHV roads have on montane streams and provides recommendations for effective restoration of such sites. To date, few studies have empirically quantified the effects of OHV activities on habitats and on aquatic biota. I examined the impacts of rugged, high-clearance vehicle roads on the aquatic biota and physical habitat of two Rocky Mountain streams using a control-impact comparison of stream reaches with and without OHV road encroachment in the stream. Aquatic communities (invertebrates and fish), physical stream attributes, and riparian widths were measured and compared. In OHV-affected stream reaches, density, biomass, and structure of the aquatic communities were reduced, altered, or nearly eliminated when compared to unimpacted reaches along the same stream. Physical habitat structure was simplified in OHV-affected reaches compared to controls, which correlated well with biological shifts (e.g., loss of trout with absence of pools) and appeared to attenuate with functional riparian vegetation. Results provide insights that may aid in the effective restoration of such sites.

## Incorporating GPS and radio-frequency identification (RFID) to evaluate fish movement and habitat utilization

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Incorporating mobility and GPS technology into radio-frequency identification (RFID) systems can link the spatial distribution of fish to individual characteristics, such as species, length, and weight. Coupling spatial and biological fisheries data has a range of implications, including evaluating fish migration patterns and habitat utilization, as well as estimating the abundance of tagged fish. The

mobile RFID-GPS system developed for this study consists of an Oregon RFID single HDX reader interfaced with a CR1000 Datalogger. The CR1000 Datalogger can accommodate a range of sensors, including GPS and water temperature. To enhance maneuverability in small to mid-sized rivers, the system was mounted to a pontoon raft. To analyze detection probability and GPS accuracy, a controlled test using passive integrated transponder (PIT)-tagged rocks was conducted in the stream inlet to Parvin Lake, Colorado. Four operators each completed three down-stream detection passes, taking a different path through the stream on each pass. An additional down-and-back pass was conducted mid-channel. GPS accuracy was evaluated by comparing the "true" position, established with a high-accuracy (± 0.026 ft) Trimble GNSS survey system, to the "detected" position from the RFID-GPS system. Detection probability averaged 0.45 (± 0.02) for the downstream passes, whereas detection probability for the down-and-back pass was 0.58. Overall, 92 of the 98 PIT-tagged rocks (94%) were detected. Absolute error in GPS position averaged 14.6 ft, ranging from 1.0-40.8 ft. To evaluate utility of the RFID-GPS system for estimating PIT-tagged fish abundance and habitat utilization, a pilot field test was conducted on the Middle Fork South Platte River (MFSP), Colorado. During 2013-2014, 1,371 fish were PIT-tagged and released over approximately 20 river miles in the MFSP, resulting in 69 tagged fish/mile. Using a two-pass mark-recapture estimate, PIT-tagged fish abundance was estimated at 50-65 tagged fish/mile. Habitat units were classified and surveyed to evaluate habitat utilization. Detection locations will be summarized by habitat unit and presented in detail on the poster. Future research efforts will focus on further development of the RFID-GPS system to evaluate fish migration patterns and seasonal habitat utilization in the MFSP.