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

2014 Annual Meeting

March 4-6, 2014
Laramie, Wyoming

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General Information

Registration

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

Presentations will be downloaded during the following times: Tuesday 5 pm – 7 pm, Wednesday 7 am – 5 pm, and Thursday 7 am-3 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 Grand Ballroom Lobby throughout the meeting. Posters will be assembled Tuesday between 6pm and 8pm and dismantled following the banquet.

Continuing Education Workshop

Title: "Genetics Workshop"

Date/ Location: March 4th, 10am – 5pm at the Hilton Garden Inn in Salon B

Instructors: Dr. Chis Funk and PhD candidate Sarah Fitzpatrick, Department of Biology, Colorado State University

Lunches will NOT be provided. Lunch break will be from 12-1 pm and a beverage/snack break approximately at 2:30pm.

Auction and Raffle Display

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

Business Luncheon

Business meeting luncheon will be held in Salon A from 12 to 1:30 pm on Wednesday. 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 AB. Free beer and hors d'oeuvres will be provided. Cash bar is also available.

Banquet Social

The Banquet Social on Thursday will be held from 6 to 10 pm. 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 SOCIAL

Hosted by the University of Wyoming Student Subunit

When: Wednesday, March 5th, 6:30 to 10 PM

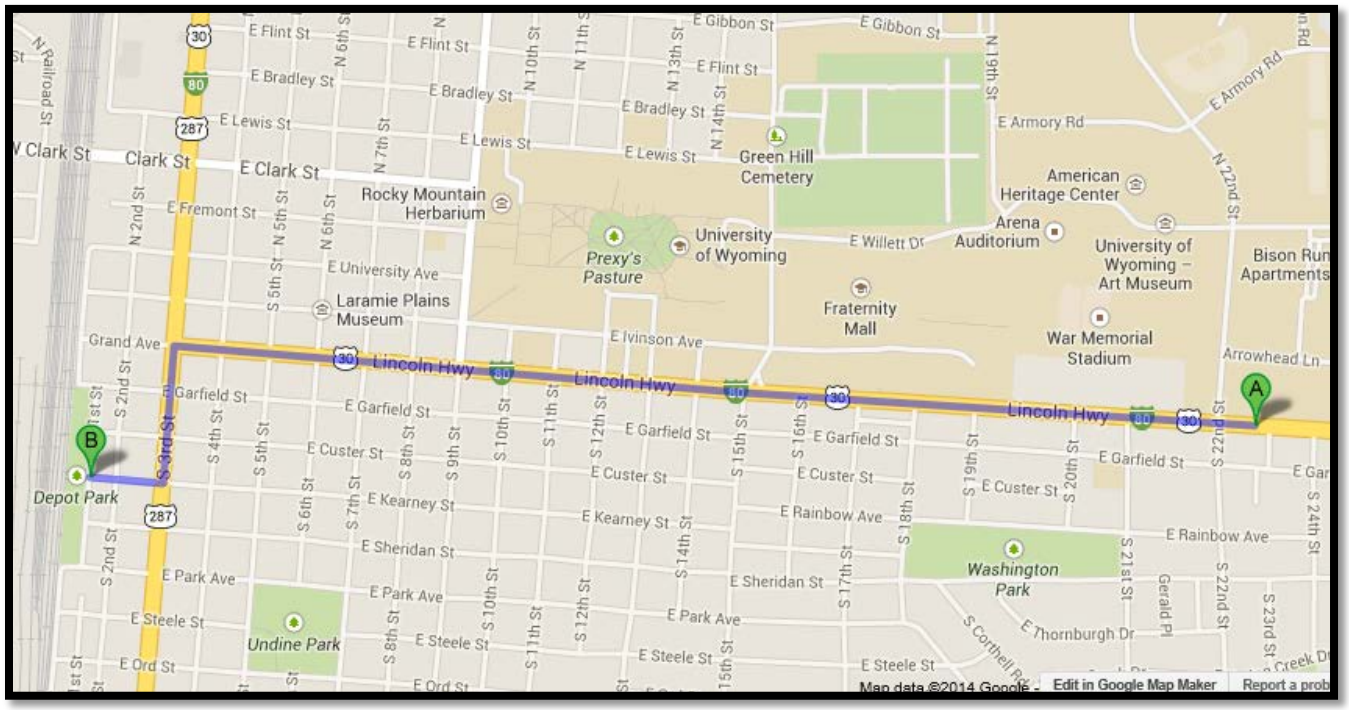
Where: Laramie Historic Railroad Depot (1st St. and E. Kearney St., Laramie, WY 82070). All are welcome! Shuttles will be provided for transportation to and from the Hilton Garden Inn.

Featuring food from Grand Avenue Pizza and beer courtesy of High Hops Brewery

Open Mic Night for anyone musically inclined!

Directions from Hilton Garden Inn to Railroad Depot (1.8 miles):

From the Hilton Garden Inn head west on Grand Avenue for 1.5 miles. Turn left onto South 3rd Street (0.2 miles), then right onto East Kearney Street (0.1 mile).



Tuesday, March 4th

10:00 AM-5:00 PM	Continuing education workshop (see page 4 for details)
5:00 PM-7:00 PM	Registration and Presentation Download/Practice
6:00 PM-10:00 PM	Welcome Social (see page 5 for details)
6:00 PM -8:00 PM	Poster/Raffle Setup

Wednesday, March 5th

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 Paul Gerrity

Session 1: Culture and Management

Moderator: Rick Henderson, U.S. Forest Service

8:30-9:00 AM	**Jesse Trushenski** (Keynote) "AFS - The Big Tent of Fisheries Science"
9:00 -9:20 AM	**Al Conder** (professional) "Evolving Trout and Walleye Management in the Upper North Platte Reservoirs"
9:20-9:40 AM	**Lars Alsager** (professional) "Integration of Fisheries Management and Fish Culture to Meet Management Objectives of the Upper North Platte River Reservoirs
9:40-10:00 AM	**Dan Brauch** (professional) "The value of kokanee salmon: maximizing reservoir angling opportunities in Colorado by maintaining Blue Mesa Reservoir's kokanee salmon (*Oncorhynchus nerka*) population"
10:00-10:20 AM	**Seth Firestone** (professional) "Making every egg count: improvements to the Roaring Judy Hatchery kokanee salmon (*Oncorhynchus nerka*) production program"
10:20-10:40 AM	**Break**

Session 2: General Session 1

Moderator: Bret Barngrover, Wyoming Game and Fish Department

10:40-11:00 AM	**Adam Leiferman** (professional)" A year in the life of a WGFD Fish Culturist"
11:00-11:20 AM	**Frank Rahel** (professional) "Fishing regulations and changing philosophies of fisheries management"
11:20-11:40 AM	**Gordon Edwards** (professional) "Wyoming's Whistlers – A Statewide Mountain Whitefish Assessment"
11:40AM-12:00 PM	**Annika Walters** (professional) "What insight can the Wyoming Basin Rapid Ecoregional Assessment provide for fisheries and aquatic habitat management in Wyoming?"
12:00-1:30 PM	**Business Lunch**

SESSION 3A: ***Wyoming Wonders I*** **Moderator:** Mike Mazur, USFWS **Abstracts:** Pages 22 to 25		**SESSION 3B: Restoration** **Moderator:** Kurt Davies, CPW **Abstracts:** Pages 25 to 27
1:30-1:50	**Jason Burckhardt** (professional) "Prioritizing Conservation of Yellowstone Cutthroat Trout Across Their Range"	**Nathan Jean** (professional) "North Platte River Restoration"
1:50-2:10	**Zachary Klien** (student) "Sampling techniques for Burbot *Lota lota* in the Green River of Wyoming"	**Adam Herdrich** (student) "Effects of Large Woody Debris and Log Jams on Eastern Slope Rocky Mountain Trout Populations"
2:10-2:30	**Bill Bradshaw** (professional) "Restoring Fish to Clear Creek through the Kendrick Dam Bypass Channel"	**Todd Goodsell** (professional) "Fish Habitat Compensation – Eagle Gold Project, Yukon"
2:30-2:50	**Lusha Tronstad** (professional) "What trace elements bioaccumulate in the Muddy Creek food web: from food sources to fish and birds"	**Colin Tierney** (professional) "Using Sheet Piling Structures for Riparian Bank Building along a Shifting Sand Bottom Stream in Central Wyoming"
2:50-3:10	**Wendy Estes** (professional) "Monitoring Amphibians in the Rocky Mountain Region: A multi-agency occupancy-based approach"	**Michael Geenan** (professional) "Grand Valley Diversion Ditch – Stream Restoration Project"

3:10-3:30 PM Break

SESSION 4A: *General Session 2* **Moderator: Adam Leiferman, WGFD** **Abstracts:** Pages 28 to 31		SESSION 4B: **General Session 3** **Moderator:** Dan Kowalski, CPW **Abstracts:** Pages 31 to 32
3:30-3:50	**Dana Winkelman** (professional) "Waste water effluent, estrogenic exposure, and the future of eastern plains native fishes"	**Chris Crowder** (professional) "Creation of the Monte Vista Isolation Facility"
3:450-4:10	**William Pate** (professional) "Counting calories in your fish: why and how?"	**Matt Hahn** (professional) "From a ditch to a destination: flushing flows and the evolution of the Gray Reef tailwater fishery"
4:10-4:30	**David Stewart** (professional) "Spatial structuring within a reservoir fish population by an unintended protected area: implications for management"	**Dean Follett** (professional) "Performance characteristics of Fall Rainbow Trout produced from three, four, and five year old brood fish through rearing cycle"
4:30-4:50	**James Roberts** (professional) "Ecological consequences of climate change for mountain lake-stream populations of cutthroat in the Southern Rocky Mountains"	**Paul Mavrakis** (professional) "History and Status of Leasing Water in Lake DeSmet"
4:50-5:10	**Kyle Christianson** (professional) "Evaluating and Enhancing Colorado's Trophy Largemouth Bass Opportunities"	**Kellie Carim** (professional) "Battle of the invaders: Can a nonnative parasite alter hybridization between native and invasive trout?"

6:30-10:00 PM **Student Social** – Laramie Historic Railroad Depot (see page 5)

7:00 AM-5:00 PM Registration

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

Session 5: Techniques

Moderator: Bill Janowsky, U.S. Forest Service

8:00-8:20 AM **Brian Hodge** (professional) "Tracking movement of Colorado River Cutthroat Trout in a small stream using mobile PIT tag interrogators"

8:20-8:40 AM **Brian Avila** (student) "Raft and Floating RFID Antenna Systems for Detecting PIT-tagged Fish in Rivers"

8:40-9:00 AM **Jon Wardell** (student) "Dissolved Oxygen and Formalin Tolerance of Whirling Disease-Resistant Strains of Rainbow Trout"

9:00-9:20 AM **Clark Johnson** (student) "Use of Summer Profundal Index Netting to Estimate Lake Trout Abundance in Wyoming and Colorado Waters"

9:20-9:40 AM **Travis Neebling** (professional) "Hydroacoustic Repeatability in High Savery Reservoir"

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

Session 6: Wyoming Wonders II

Moderator: Darren Rhea, Wyoming Game and Fish Department

10:00-10:20 AM **Carlin Girard** (student) "The Dry Piney Study: Energy development effects to native fish communities along the Wyoming Range"

10:20-10:40 AM **Eben Johnson** (student) "Endocrine Disrupting Compounds in Wyoming Surface Waters: Assessment of the Presence, Suspected Sources, and Impacts to Exposed Fishes"

10:40-11:00 AM **Sean Lewandoski** (student) "Exploitation and Population Dynamics of Burbot in the Upper Wind River Drainage"

11:00-11:20 AM **Jessica Dugan** (student) "Investigating fish community composition and brown trout diet and condition in a high plains river"

11:20-11:40 AM **Bill Yaracz** (professional) "Using partial and full recirculating reuse to increase productivity at the Dubois Fish Hatchery"

11:40 AM to 1:20 PM **Lunch on Your Own**

Session 7: Colorado's Creatures

Moderator: Ryan Fitzpatrick, Colorado Parks and Wildlife

1:20-1:40 PM	**Matt Haworth** (student) "Reproduction and recruitment dynamics of flathead chub relative to flow regime in Fountain Creek, Colorado.
1:40-2:00 PM	**Estevan Vigil** (professional) "Gill Lice in Colorado"
2:00-2:20 PM	**Daniel Gibson-Reinemer** (student) "Range shifts from climate change across three Colorado rivers"
2:20-2:40 PM	**Greg Fraser** (student) "Use of Coal Creek, White River drainage, CO, by flannelmouth and bluehead sucker"
2:40-3:00 PM	**Koreen Zelasko** (professional) "Population abundance and dynamics of introduced Northern Pike, Yampa River, Colorado, 2004 – 2010"
3:00-3:20 PM	**Break**

Session 8: Native Trout

Moderator: Boyd Wright, Colorado Parks and Wildlife

3:20-3:40 PM	**Kevin Bestgen** (professional) "Phenotype predicts genotype for lineages of native cutthroat trout in the southern Rocky Mountains"
3:40-4:00 PM	**Jason Burckhardt** (professional) "The effects of anthropogenic barriers on movement patterns of Yellowstone cutthroat trout in the Greybull River drainage"
4:00-4:20 PM	**Cory Toye** (professional) "Reconnecting Yellowstone cutthroat habitat on the Greybull River"
4:20-4:40 PM	**Diana Miller** (professional) "The Hoback River: A tale of fisheries management"
4:40-5:00 PM	**Kevin Bestgen** (professional) "Contributions of Robert J. Behnke to salmonid biology and conservation
6:30-10:00 PM	**Banquet Social**

Bret Barngrover (professional). "The initial challenge of raising Tiger Muskie at the Wyoming Game and Fish Department's Speas Fish Hatchery"

Bill Bradshaw (professional). "Restoring Native Fish to Clear Creek: Kendrick Dam Fish Bypass Channel"

Nathan Cook (professional). "Evaluating Wyoming's 1st walleye length limit"

Zachary B. Klein (student). "Standardized Removal and Sectioning Locations for Common Carp Dorsal Spines"

Christopher Kopack (student). "Chemical cues of predation induce anti-predator behavior in naïve rainbow trout: implications for training hatchery-reared fish"

Philip Mathias (professional). "Wild Trout and Native Freshwater Mussels: Their Relationship, Focusing on *Margaritifera falcata* (Western Pearlshell)"

Kristen Pearson (student). "Spawning probability of humpback chub, Gila cypha, in the Little Colorado River, Arizona"

Miles Peterson (student). "An Investigation of Suitable Spawning Habitat for Brown Trout (*Salmo trutta*) in the Gunnison Basin, Colorado"

Will Radigan (student). "Fish aging and its application in the management of non-native western Colorado fish species"

Darrel Snyder (professional). "Illustrations Depicting Larval and Juvenile Development of Suckermouth Minnow"

Pete Starr (professional). " Performance of Rainbow Trout (*Oncorhynchus mykiss*) and Snake River Cutthroat Trout (*Oncorhynchus clarki*) Fed Two Starter Feed Types"

Zack Underwood (Presenter). "Burbot movement and entrainment pathways in the upper Wind River drainage"

Estevan Vigil (professional). "Temperature Effects on Hatching and Survival of Juvenile Gill Lice"

Kerrie Vivian (professional). From Ponds to Circular; One Wyoming Rearing Station's Transformation in Response to Whirling Disease"

The initial challenge of raising Tiger Muskie at the Wyoming Game and Fish Department's Speas Fish Hatchery.

Bret Barngrover (Presenter), **Lars Alsager**, and **Adam Leiferman**. Wyoming Game and Fish Department, bret.barngrover@wyo.gov

The Wyoming Game and Fish Department has been importing and stocking Tiger Muskie into Wyoming waters since 1983. Typically The Game and Fish Department would stock the Tiger Muskie directly into the receiving waters upon arrival from other states. In May of 2013 Wyoming's Speas Fish Hatchery received 50,500 Tiger Muskie at 1,207 fpp. These Tiger's were reared on the station for six months and stocked out in October of 2013. The poster will describe the rearing process from rearing unit design, growth rates, and additional rearing information prior to the stocking of Wyoming waters.

Restoring Native Fish to Clear Creek: Nedrick Dam fish Bypass Channel

Travis Cundy and **Bill Bradshaw** (Presenter), Wyoming Game and Fish Department, Bill.Bradshaw@wyo.gov

Clear Creek is a tributary to the Powder River in Northeast Wyoming. Kendrick Dam was constructed by the former Kendrick Ranch miles above the mouth of Clear Creek in 1911 and prevented upstream fish movement for the next 100 years. The current ranch owner agreed to allow the Wyoming Game and Fish Department to construct a fish bypass channel (bypass) around the dam with the caveat that water rights of 22 cfs would be satisfied before operating the bypass. A bypass designed after other successful Bureau of Reclamation projects around the west was constructed and became operational in 2010. The bypass provides fish access to 36 miles of Clear Creek where another diversion dam blocks movement. Nineteen, mostly native species, have used the channel since it became operational. This poster focuses on design, operation, and maintenance of the channel.

Evaluating Wyoming's 1st walleye length limit

Nathan Cook, Wyoming Game and Fish Department, Nathan.Cook@wyo.gov

Fishing regulations such as creel and length limits are the most commonly used tool for managing recreational fish harvest. Implementation of water specific fishing regulations is often strongly supported by anglers. However, the effects these regulations actually have on the fishery are difficult to detect given inherent variability in population dynamics and angler success. I discuss the efforts of the Wyoming Game and Fish Department to evaluate the effects of the state's first minimum length limit (MLL) on walleye. Based on population modeling and angler desires, a 15 inch MLL was implemented for Glendo Reservoir walleye in 2010. Population models predicted increases in population size structure and angler yields in response to a 15 inch minimum. Data from annual netting and spot creel surveys before and after the MLL are being used to evaluate these and other potential changes in the fishery. Preliminary results suggest that walleye population size structure may be increasing as predicted following implementation of the MLL. Variability in size structure and recruitment was similar before and after the MLL. Contrary to model predictions, yield has gone down after the MLL, but has been increasing since 2010. Little change in overall population

total annual mortality (AM) has been detected following the MLL. However, AM for age classes protected by the MLL has gone down, while AM for older age classes has gone up, a result consistent with a shift in harvest from smaller to larger fish. Although there is some evidence that the MLL is affecting the Glendo Reservoir fishery, reference walleye populations that did not undergo minimum length limits also show changes in population length structure and total mortality. Thus, preliminary evaluation of the effects of the 15 inch MLL highlight the need for long term monitoring and reference lakes before definitive conclusions about the efficacy of special regulations can be made.

Standardized Removal and Sectioning Locations for Common Carp Dorsal Spines

Zachary B. Klein (Presenter) and **Carson J. Watkins,** Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, klei7686@vandals.uidaho.edu
Marc M. Terrazas, Department of Fish and Wildlife Sciences, University of Idaho
Michael C. Quist, U.S. Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, Department of Fish and Wildlife Sciences, University of Idaho,

Common Carp *Cyprinus carpio* is known to cause deleterious effects on water quality and fish assemblage structure outside of their native distribution. In systems where Common Carp have reached high abundances, effort has focused on improving altered habitat condition and oftentimes suppressing populations to low levels. As such, Common Carp have garnered considerable management attention focused on understanding dynamic rate functions of populations of concern. Gaining information on dynamic rate functions and age structure; however, requires the use of calcified hard structures that provide high quality information. Dorsal spines have been shown to provide precise estimates of Common Carp age and are commonly used by management agencies to gain information on Common Carp populations. However, no previous studies have evaluated the techniques for removing and sectioning Common Carp dorsal spines. Standardization of fish sampling and processing is critical for producing and maintaining data that are both meaningful and comparable. However, inconsistencies may exist among agency personnel regarding dorsal spine removal and sectioning that may result in age and growth data that are not useful for making comparisons across populations and among individuals. The purpose of our study was to evaluate the precision and distribution of age estimates obtained from various sectioning locations along Common Carp dorsal spines. Additionally, we evaluated the readability of dorsal spine sectioning locations and its relationship with precision in age estimates. We examined dorsal spines from 192 Common Carp sampled from Crane Creek Reservoir and Lake Lowell in southwestern Idaho. Dorsal spines were sectioned at the base (i.e., near the curve in the dorsal spine where it forms the articulating process), immediately distal to the basal section (i.e., where a section would be taken if the dorsal spine was removal near the tissue of the fish), and at 25, 50, and 75% of the total length of the dorsal spine. Exact agreement (PA-0) and with-1 year agreement (PA-1) between readers was highest and the coefficient of variation lowest for section 2. Assuming section 1 represented the true age, age distributions for sections 2 and 3 were not significantly different. Mean confidence rating was highest for section 2 and confidence ratings were not significantly different among sections 1, 2, and 3. In general, age distributions from sections 2 and 3 were similar to section 1 and sections 2 and 3 also displayed the highest concordance in age estimates with section 1.

Chemical cues of predation induce anti-predator behavior in naïve rainbow trout: implications for training hatchery-reared fish

Christopher Kopack (Presenter), Colorado State University undergraduate, cjkopack@rams.colostate.edu
E Dale Broder, Colorado State University Department of Biology E437
Dr. Jesse M Lepak and **Dr. Eric R Fetherman**, Colorado Parks and Wildlife
Dr. Lisa M Angeloni, Colorado State University Department of Biology E441

State agencies spend millions of dollars annually to rear fish for stocking in lakes, rivers, and reservoirs, yet hatchery-reared fish tend to have relatively low survival when released into natural habitats. Manipulation of the rearing environment in hatcheries can potentially enhance fitness-related traits, like anti-predator behavior, and thus fish survival. We investigated behavioral shifts in response to chemical cues associated with predation in a strain of rainbow trout that is resistant to whirling disease but particularly susceptible to predation. We exposed individual rainbow trout to alarm cues from conspecifics, kairomones from brown trout 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 an increase in time spent frozen, with the greatest response in those exposed to conspecific alarm cues. These findings suggest that a one-time exposure to chemical cues may have significant effects on anti-predator behavior and thus survival in the wild. Implementation of this rapid and simple treatment during rearing could increase survival of hatchery-reared rainbow trout, consequently reducing costs of stocking programs.

Wild Trout and Native Freshwater Mussels: Their Relationship, Focusing on *Margaritifera falcata* (Western Pearlshell)

Philip Mathias, Wyoming Game and Fish Department, philip.mathias@wyo.gov

Trout and native freshwater mussels have co-evolved, even crossing the continental divide together, literally. Native mussels have a unique life history. Native mussel reproduction includes a parasitic larval state, in which larval mussels, glochidia, attach themselves to a host fish's gills and fins. These mussel-bearing fish can travel extensively within rivers and among watersheds. This almost guarantees that larval mussels will be deposited in new locations. In the case of the western pearlshell (*Margaritifera falcata*, WPM), it can use a multitude of hosts, almost all of which are salmonids: cutthroat trout, rainbow trout, brown trout, brook trout, sockeye salmon, Coho salmon, Chinook salmon, speckled dace, Tahoe sucker, and Lahontan redside. WPM can live upwards of 80-100 years, but without trout present, a key step in its life history is missing, securing its peril. North America hosts the world's highest diversity of freshwater mussels (over 300 species) and more than 70% have an imperiled conservation status. Native mussels continue to decline, including the WPM in the western U.S., which is found in Alaska, California, Idaho, Montana, Nevada, Oregon, Washington, Wyoming, British Columbia, and is presumed extirpated in Utah. The headwater nature of Wyoming drainages increases the risk of native mussel extirpation due to limited habitat for them in the state. Recent efforts have focused surveying on the western drainages in Wyoming: Bear and Snake Rivers, home to the WPM. In 2011 and 2012, the Wyoming Game and Fish Department performed systematic surveys for WPM at 23 sites. Their range in Wyoming extends from Grand Teton National Park to the southern Wyoming-Utah border. At almost all the sites with WPM, they were found in large numbers ranging from 500~1,200 individuals. Habitat associations were measured, but significant predictors of mussel presence-absence was not detected using binary logistic regressions. A species status ranking was suggested for WPM as a result of survey efforts and its distribution throughout the Snake River and Bear River drainages.

Spawning probability of humpback chub, *Gila cypha*, in the Little Colorado River, Arizona

Kristen Pearson (Presenter), Colorado State University, Department of Fish, Wildlife and Conservation Biology, kristennpearson@gmail.com
William Kendall and **Dana Winkelman** USGS Colorado Cooperative Fish and Wildlife Research Unit
William Persons, USGS Grand Canyon Monitoring and Research Center

Accurate estimation of demographic parameters, such as survival and breeding probability, is crucial to the appropriate management of fish and wildlife populations. When estimating vital rates for migratory species monitored on their breeding grounds, it may be necessary to evaluate temporary emigration from the study site to avoid generating biased estimates of survival and breeding probability. Evaluating temporary emigration is especially important when non-annual breeding is anticipated as skipped breeders may be unavailable for detection. Population monitoring for the endangered humpback chub, *Gila cypha,* within the Lower Colorado River Basin (LCRB) has focused on sampling within their primary breeding grounds, the Little Colorado River (LCR). Therefore, to generate unbiased estimates of survival and breeding probability, we evaluated temporary emigration, which we equate to skipped spawning probability, using robust design mark-recapture methodologies.

We found considerable evidence for skipped spawning among both males and females. On average, the probability of a current spawner failing to breed in the subsequent year is 0.45 (95% CI from random effect: 0.10, 0.80), and the probability of a current skipped spawner failing to breed in the subsequent year is 0.60 (95% CI from random effect: 0.26, 0.83). In long-lived species, such as humpback chub, skipped breeding may be an adaptive trait to accumulate sufficient resources prior to spawning, thereby increasing survival and future spawning success. Understanding the spawning strategy of humpback chub in the LCRB is essential to accurately estimate demographic parameters because, as our research indicates, humpback chub are not annually present in the LCR.

An Investigation of Suitable Spawning Habitat for Brown Trout (*Salmo trutta*) in the Gunnison Basin, Colorado.

Miles Peterson (Presenter) and **Kevin Alexander**, Department of Natural and Environmental Sciences, Western State Colorado University, Gunnison, Colorado 81231, miles.peterson@western.edu.

We conducted snorkel surveys on the Brown Trout (*Salmo trutta*) population of Tomichi Creek (Gunnison County, CO) and found very low population numbers and conducted a redd survey in which we found no redd formation. One factor that we hypothesized may be limiting to the population is the lack of suitable spawning habitat and the goal of our study was to determine what constitutes suitable spawning habitat for brown trout in the region and what physical stream characteristic are utilized. We then switched our focus to the East River near Crested Butte, CO which has a reproducing Brown Trout population and conducted a redd survey to determine spawn site characteristics. Brown Trout on the East River showed significant selection of small side channels when selecting redd sites (1-sample proportions test with continuity correction, p=0.0011, n=34), along with a selection of gravel substrate (Chi-squared test with simulated p-value, p=0.022, n= 34). These small side channels provide the Brown Trout with lower flows, shallower water depth, gravel size substrate and greater riparian cover. The conservation and management of side channels in Gunnison Basin streams may be necessary to maintain suitable spawning habitat for Brown Trout populations. This knowledge concerning the importance of side channels may be important to

managers as they continue to look at fisheries management on Tomichi Creek, and possible restoration efforts.

Fish aging and its application in the management of non-native western Colorado fish species.

Will Radigan, Colorado State University. wradigan@rams.colostate.edu

Various methods for aging fish exist, including the use of cleithra, otoliths, scales, and other structures. Each method for aging fish has its own costs and benefits, and application of a method is dependent on what management plan is necessary. In order to manage non-native species (smallmouth bass and northern pike) in western Colorado, aging using scales and otoliths is used to determine population age structure. Age structures of non-native species are used to guide the management of these species.

Illustrations of Larval and Juvenile Development of the Suckermouth Minnow.

Darrel E. Snyder (Presenter), **Kevin R. Bestgen**, and **C. Lynn Bjork**; Larval Fish Laboratory, Colorado State University, darrel.snyder@colostate.edu

The suckermouth minnow Phenacobius mirabilis (Cyprinidae) is a widespread midwestern and central plains fish native to the Mississippi River Basin, including the Ohio and Missouri River Basins, with isolated populations in western Lake Erie drainages and Gulf Coast rivers in Texas. The western extent of it native range includes the eastern plains of Colorado, Wyoming, and New Mexico, where populations have declined considerably and are now respectively considered state endangered, imperiled, and threatened.

It is moderately slender, terete, and seldom more than 100 mm TL (120 mm max). As its common name suggests, it has a subterminal to inferior mouth with prominent lower-lip lobes and a protractile upper jaw. The snout is long and blunt, eyes are positioned high, and gut is short and S-shaped with a silvery, speckled peritoneum. The dorsal fin begins forward of the pelvic fins and typically has eight principal fin-rays; the anal fin typically has seven. The lateral line is complete with 40-51 scales.

Primarily a benthic insectivore, the suckermouth minnow typically inhabits riffles and faster runs over sand and gravel in small streams to large rivers of low to moderate gradient. Spawning occurs over a protracted season from April through August at 14-25°C. In the laboratory, spawning was observed in flowing water over gravel and cobble, but not sand, with fish vibrating side-by-side, pushing their anal fins against the substrate, and releasing one to a few eggs at a time. Fertilized eggs were spherical, 1.5-1.7 mm in diameter, demersal, and adhesive. At 17-23°C, eggs hatched in 3-4.5 days, yielding 4-5 mm TL larvae.

Knowledge of the morphological ontogeny of a fish is often critical to identification of its larvae and understanding its early life physiology, ecology, and behavior. To that end, we've begun to document the early morphological development of suckermouth minnow with eight detailed, three-view illustrations from a recently hatched 4.7 mm TL protolarva to a 40.2 mm TL young-of-the-year juvenile. Notable features, besides the subterminal to ventral mouth and lower-lip lobes, include unusually deltoid-shaped eyes and prominent patterns of sensory papillae on the lower lateral and ventral surfaces of the head.

Burbot movement and entrainment pathways in the upper Wind River drainage

Zack Underwood (Presenter), and **Annika Walters,** Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, zunderwo@uwyo.edu

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 Wyoming, burbot are native to the Wind/Bighorn River drainage where they are popular sport fish and the top native predator in many of the waters they occupy. However, declines in abundance and demographic shifts have been observed in many waters in recent decades, spurring increased research and conservation efforts.

One hypothesized threat to burbot in the upper Wind River drainage is that burbot are becoming entrained in irrigation networks and are permanently lost to the system. High densities of burbot have been observed in the Pilot Butte Canal below Pilot Butte Reservoir, and it was assumed that these fish were entrained through outmigration events from upstream populations.

We captured outmigrating burbot below one dammed lake with a highly regulated flow regime and below one natural lake with a natural flow regime. We found that outmigration was minimal for both systems. Based on the low migration observed, we now postulate that the entrained burbot are primarily coming from reproduction within the Pilot Butte Canal, outmigration from Pilot Butte Reservoir, outmigration from an unidentified population within the Wind River, or a combination of the preceding. We are now working to determine which scenario is actually occurring using retargeted sampling efforts, otolith microchemistry, and genetic analyses.

Temperature Effects on Hatching and Survival of Juvenile Gill Lice.

Estevan Vigil (Presenter), Colorado State University, estevan.vigil@state.co.us
Jesse Lepak and **Kyle Christianson**, Colorado Parks and Wildlife

Gill Lice are parasitic copepods that attach externally to fish primarily on the gills and are found on multiple salmonid species in Colorado. Gill lice limit oxygen exchange through gill filaments on which they are attached and negatively impact 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 the state. We used this species of gill lice to examine how temperature affects hatching and survival of juvenile gill lice. Hatching of gill lice eggs and survival of the free swimming stage are directly related to temperature. Given current global climate change trends, understanding how temperature affects these critical stages of gill lice development will become increasingly important for predicting their future distribution and movement. Ultimately, better understanding of gill lice and their life history 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.

From Ponds to Circulars…One Wyoming Rearing Station's Transformation in Response to Whirling Disease.

Kerrie Vivian, Wyoming Game and Fish Department, Kerrie.Vivian@wyo.gov

Whirling disease, caused by the internal myxosporean *Myxobolus cerebralis*, was first discovered stateside in Pennsylvania circa 1958. Since then the causative agent has been confirmed in 23 states, including Wyoming. Spores of the whirling disease parasite were first detected in Wyoming circa 1988 in the Laramie River and North Platte River drainages. Since then the parasite has been found in every major drainage in Wyoming.

The hatchery systems in Wyoming have not been spared from the effects of this parasite, and to date 7 of 10 facilities have been affected either through direct exposure or proximity to infected waters. Wyoming has taken a very proactive stance in combating the parasite within its hatchery system. To date major renovations have taken place at 6 of 10 department owned facilities. Each of the facilities renovated had a unique situation and response to the threat.

The Wigwam Rearing Station, featured in this poster, had its first known exposure to whirling disease spores in January of 2002. A 2004-2006 renovation of the facility completely changed the look and operation of the Wigwam Rearing Station by addition of fiberglass circular tanks, oxygenation equipment, and the removal of dirt ponds and degrading concrete raceways. In 2008, shortly after this full scale renovation, the causative agent of whirling disease was again discovered during an annual fish health inspection. After several sentinel fish studies at Wigwam it was determined that an incoming water source was compromised, and renovation of old pipelines was completed in 2009. Another positive test for whirling disease spores in 2010 indicated outside influences to the incoming water, and construction of Rotary Filter Ultraviolet light water treatment systems (RFUV) for both incoming water sources was completed in the fall of 2012.

This poster gives an overview of the transformation of the Wigwam Rearing Station located in north central Wyoming and provides an interesting contrast between past facilities and equipment used at Wigwam and modernized fish culture equipment currently in use.

Evolving Trout and Walleye Management in the Upper North Platte Reservoirs

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Prior to the salmonid introductions, the only sport fish species in the North Platte River by today's definition, were native sauger, channel catfish and perhaps shovelnose sturgeon. The dam building period on the upper North Platte River (1909 to 1961) transformed approximately 93 miles of river into five reservoirs (Seminoe, Kortes, Pathfinder, Alcova and Gray Reef reservoirs) with 44,965 surfaces acres of cold water reservoir habitat. Completion of Dan Speas Rearing Station in 1958 provided the needed increased hatchery production for the Upper North Platte Reservoirs. From 1958 to 1981, between 2.2 and 4.4 million fingerling trout, most of which were raised at Speas, were stocked annually into Upper North Platte Reservoirs. The first documented catch (1961) of a walleye in Seminoe Reservoir marked the start of the second evolution of sport fish management in the Upper North Platte Reservoirs. Biologists and culturists worked together to develop management plans using fewer but larger stocked trout to reduce walleye predation on stocked trout. Fall stocking of nine- inch rainbows became the management prescription following a comprehensive evaluation in 1995. Today we are entering perhaps the third evolution by attempting to manage walleye and trout by increasing walleye mortality by angler harvest while continuing to manage trout to reduce predation.

Integration of Fisheries Management and Fish Culture to Meet Management Objectives of the Upper North Platte River Reservoirs

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Over the years the Upper North Platte River reservoirs (Seminoe, Pathfinder, and Alcova) have been stocked utilizing a variety of different sized fish, from fingerlings to catchable size trout. A comprehensive evaluation in 1995, determined that a nine inch catchable rainbow trout stocked in the fall performs well and meets or exceeds management objectives for these reservoirs. Dan Speas Fish Hatchery works closely with fisheries management to produce the number and size of rainbow required for fall stocking under the present management objective. Fish production planning at the station has been adjusted to meet the annual request of 100,000 pounds of rainbow trout stocked in late October. This presentation provides insight on how producing larger fish at a fish production facility impacts the day to day operations, hatchery production potential, and costs associated in meeting these management objectives.

The value of kokanee salmon: maximizing reservoir angling opportunities in Colorado by maintaining Blue Mesa Reservoir's kokanee salmon (*Oncorhynchus nerka*) population.

Dan Brauch, Colorado Parks and Wildlife, dan.brauch@state.co.us

Kokanee *(Oncorhynchus nerka)* are well suited for deep pelagic habitats that were rare in Colorado prior to the construction of major impoundments. After the construction of large reservoirs in the early to mid 20th century, kokanee quickly became a preferred species to provide expanded angling opportunity. After kokanee were established at Blue Mesa Reservoir, Colorado, they quickly became a popular target for anglers, providing the largest share of fish captured during the busy summer fishery. Establishment of a reliable kokanee egg source for restocking Blue Mesa Reservoir and other Colorado lakes and reservoirs was an early management objective, but hampered by angler harvest of kokanee during the fall migration. Over time, angling harvest of mature migrating kokanee has been nearly eliminated once kokanee leave the reservoir, allowing the Blue Mesa kokanee run to become a primary source of eggs for Colorado's kokanee program. More recently, the reservoir's kokanee population has been impacted by an expanding population of lake trout (*Salvelinus namaycush*). Increases in annual kokanee stocking resulted in a brief recovery followed by continued reduction in population coincident with continued lake trout population expansion. Reducing lake trout populations and predation on kokanee has been a controversial strategy due to the popularity of fishing for trophy lake trout at Blue Mesa. Stocked kokanee are an important component in management of up to 26 waters in Colorado, providing opportunities for anglers to catch kokanee or providing a forage base for other fish species. Availability of kokanee for these waters is greatly dependent on maintenance of the Blue Mesa Reservoir kokanee egg source.

Making every egg count: improvements to the Roaring Judy Hatchery kokanee salmon (*Oncorhynchus nerka*) production program

Seth Firestone (Presenter), and **Dan Brauch**, Colorado Parks and Wildlife, p), seth.firestone@state.co.us

The Roaring Judy State Fish Hatchery, located on the East River is home to the largest kokanee salmon (*Oncorhynchus nerka*) run in Colorado. Eggs collected during the spawn ensure that 3.5 million kokanee can be restocked into Blue Mesa Reservoir, providing for recreational fishing and future spawning runs. East River kokanee eggs are also utilized by other state fish hatcheries to restock additional Colorado reservoirs. Two challenges for maintaining Colorado's kokanee salmon fisheries are reaching the statewide egg requests and ensuring eyed eggs are available within the proper timeframe to meet late spring and early summer stocking requests. During this presentation Seth Firestone, the manager of the Roaring Judy Fish Hatchery, will provide background information on these challenges and improvements made at the Roaring Judy facility to address them. He will share information about the successful use of water chillers to increase the incubation time of kokanee eggs and the switch from hatching baskets to upwelling hatching jars to decrease both labor and eyed egg mortality. During this talk Mr. Firestone will also discuss the use of a 400 foot migration barrier on the East River to reduce the number of kokanee salmon that could bypass the spawntake facility.

A year in the life of a WGFD Fish Culturist

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Most people have a misunderstanding of what being a Fish Culturist at a fish hatchery is all about. Some people assume that a Fish Culturist's work is nothing more than feeding fish and cleaning up after them. While this is an important part of fish culture work at many fish hatcheries, it is only one piece of the puzzle to this amazing career. This virtual poster presentation, "A year in the life", will show many other important aspects of fish culture work and what being employed at a Wyoming Game and Fish Department fish hatchery is all about. From office work to fish distribution, the life as a Fish Culturist at the Dan Speas Fish Hatchery is fun and rewarding.

Fishing regulations and changing philosophies of fisheries management.

Frank J. Rahel, Department of Zoology & Physiology, University of Wyoming, frahel@uwyo.edu

I will discuss how fishing regulations in Wyoming from the 1880s to the present have changed in response to changing management philosophies. Inland fisheries management began in the U.S. in the late 1800s with a focus on stocking to create new fisheries and to replenish stocks depleted from overharvest The first regulations prescribed the ways in which fish could be harvested (e.g., dynamite, nets and electricity were outlawed). By the turn of the 20th century, biologists began to realize that stocking could not compensate for overharvest, so regulations limiting the number and size of fish that could be harvested were enacted. In the Rocky Mountain region, major trends in the evolution of regulations include a continual reduction in harvest, more complexity in the types of regulations, more geographic specificity in the application of regulations, increasingly restrictive use of baitfish, enactment of must-kill regulations to control invasive species, and the development of fishing restrictions related to thermal conditions. These changes in fishing regulations reflect major changes in management philosophies that evolved through stages emphasizing fishing for sustenance, fishing for recreation, and most recently, conservation of fishes. Finally, I will consider how regulations and management philosophies may evolve in the future.

Wyoming's Whistlers – A Statewide Mountain Whitefish Assessment.

Gordon P. Edwards Jr., Wyoming Game and Fish Department, gordon.edwards@wyo.gov

Mountain whitefish are a prominent salmonid of Rocky Mountain streams and native to all drainages west of the Continental Divide in Wyoming, as well as several east of the Divide. The sport-fishing popularity of mountain whitefish is eclipsed by trout, which has afforded mountain whitefish little attention from fish managers. Some populations have declined in nearby states and some Wyoming waters. A scarcity of quantitative data motivated the Wyoming Game and Fish Department to investigate sampling techniques and gather baseline population data statewide starting in 2009, with a goal of assessing the status of mountain whitefish. Major main stem streams were sampled with raft electrofishers, aiming to complete mark-recapture population estimates where possible. Post-sampling mortality was investigated for potential influences on estimate quality by collecting fish below sampling reaches (n≤40) and retaining them in a live car (27 ft^3) for up to 72 h. Threshold power delivery to illicit electro taxis of mountain whitefish was generally lower than the power applied to collect trout (70% lower, on average). Survival of mountain whitefish sampled with raft electrofishers was above 90% for most surveys, and highest when cautious handling protocols were followed and water temperature was < 60°F. Eight of ten population estimates were reliable and abundance ranged from 151 to 2,378 fish/mile (17 to 162 fish/surface-acre). Catch per unit effort ranged from 18.3 to 304.9 fish/h, and was loosely related to abundance estimates in non-

linear regressions (R^2 = 0.38 to 0.58). A report will follow the completion of large river surveys to provide recommendations for population monitoring and chart the next direction for mountain whitefish research in Wyoming. Life history questions remain fruitful research territory.

What insight can the Wyoming Basin Rapid Ecoregional Assessment provide for fisheries and aquatic habitat management in Wyoming?

Annika Walters (Presenter), U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, annika.walters@uwyo.edu
Natasha Carr, U.S. Geological Survey, Fort Collins Science Center
Kirk Sherrill, Cherokee Services Group
Jeff Wesner, Department of Biology, University of South Dakota

The goal of the Rapid Ecoregional Assessments (REAs) being conducted for the Bureau of Land Management it to provide information that supports regional planning and analysis for the management of ecological resources. The WY Basin REA is almost completed and includes several conservation elements that may be of interest to fish and aquatic habitat managers including ecosystems (streams and rivers, riparian habitat, and wetlands) and fish (cutthroat trout, three species, sauger, and leatherside chub). For each species or ecosystem, key ecological attributes and change agents were evaluated. For example, to quantify cumulative exposure of conservation elements to development at catchment and watershed scales we created an index of aquatic development that included roads, agricultural and urban land use, dams and water diversions, and energy development. The products of the WY Basin REA will be useful for evaluating the current status of and future risks to ecosystems and species.

Prioritizing conservation of Yellowstone cutthroat trout across their range

Bradley B. Shepard, Wildlife Conservation Society, bshepard@wcs.org;
Robert Al-Chokhachy and **Robert Gresswell**, USGS Northern Rockies Science Center
Lee Nelson and **Scott Opitz**, Montana Fish, Wildlife & Parks
Dan Garren, Idaho Fish and Game
Steve Yekel and **Jason Burckhardt** (Presenter) Wyoming Game and Fish Department, jason.burckhardt@wyo.gov,
Jack Williams and **Amy Haak**, Trout Unlimited

Resources available to conserve native trout are limited and should be allocated to places and projects where conservation is most critical and likely to be successful. We are using the existing collaborative Interagency Multi-State Yellowstone Cutthroat Trout (YCT) Conservation Work Group to develop a method for prioritizing conservation across the historical range of this species. The intended purpose of this prioritization is to target national resources to critical conservation needs. We developed a set of ecological and opportunity-based conservation criteria using the experience and knowledge of field managers and have applied these criteria to prioritize river basins and individual conservation populations. Populations were prioritized using both the ecological and conservation-opportunity criteria. We then assessed threats to the highest-priority conservation populations to begin prioritizing those conservation actions that could address the most pressing threats. We concluded that there are no remaining conservation populations that are low priority because we must maintain or increase YCT distributions to ensure their long-term persistence. Ecological criteria were representation (genetic integrity and uniqueness), resilience (length or area of occupied habitat), and redundancy (number of populations or tributaries). Opportunity-based criteria were ability to address imminent threats, feasibility, and public support. Highest priority river basins were located at the core of the historical range along the Rocky Mountains. Threats

included nonnative species, human activities, habitat degradation, climate change, and disease. For many of the highest priority conservation populations the threat posed by nonnative species was of the most immediate concern and must be addressed if those populations are to persist.

Sampling techniques for Burbot *Lota lota* in the Green River of Wyoming

Zachary Klein, (Presenter), University of Idaho, Department of Fish and Wildlife Sciences, klei7686@vandals.uidaho.edu
Michael C. Quist, U.S. Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho
Darren Rhea and **Anna Senecal**, Wyoming Game and Fish Department

Burbot *Lota lota* populations are declining throughout much of their native distribution; however, they have received very little research interest. One important gap in our knowledge is the lack of standardized sampling methods for Burbot in lotic and lentic systems. Past research has focused on passive gears in lentic systems, but declining populations in many lotic systems suggests that research into effective sampling methods for Burbot is warranted. Night electrofishing, 6.4-mm bar measure mesh hoop nets, and 19-mm bar measure mesh hoop nets were compared at 41 sites in the Green River drainage of Wyoming. Occupancy models were used to estimate the probability of detection (p) and occupancy (ψ), within the context of various habitat characteristics (i.e., velocity, dominant substrate, depth, in-stream cover, bank type, temperature, conductivity). Night electrofishing was the most effective sampling method (p = .35) closely followed by 6.4-mm bar measure mesh hoop nets (p = 0.25). Gear-specific effect had more support than constant detectability for all top candidate models. Night electrofishing was most influenced by Secchi depth, whereas both hoop net types (i.e. 6.4-mm and 19-mm) were negatively correlated with mean velocity. Occupancy modeling provids insight on the most effective gear and the effect of habitat, and was particularly useful for comparing sampling methods with differing units of effort (i.e., passive and active gears).

Restoring Fish to Clear Creek through the Kendrick Dam Bypass Channel

Bill Bradshaw (Presenter) and **Travis Cundy**, Wyoming Game and Fish Department, bill.bradshaw@wyo.gov

The Powder River flows for 430 miles, is considered the last major undammed prairie stream in the country, and supports a large assemblage of resident and migratory fish species. Clear Creek flows for 112 miles and is its major tributary in Wyoming. Channel catfish, sauger, shovelnose sturgeon, and other species migrate annually into Clear Creek from as far downstream as the Yellowstone River, but are blocked from further movement by Kendrick Dam that was constructed 6 miles upstream of the mouth in 1911. A bypass channel (channel), designed after other successful projects around the west, was constructed around Kendrick Dam and opened in 2010. Kendrick Dam and the channel are on the privately owned Pee Gee Ranch, and by agreement the channel can only be operated after irrigation water rights of 35 cfs are satisfied. The channel provides fish access to 36 miles of Clear Creek between Kendrick Dam and the next upstream diversion dam. The channel has been operated annually since it was opened. Over the last four years, trapping at the upper end of the channel, PIT tags, and boat electrofishing have been used to determine which species are successfully using the bypass channel. After four years of sampling, the success of the channel is clearly established. Over the years, 20 species have been documented in Clear Creek below Kendrick Dam and 15 of them are native species. Nineteen of the 20 species known from Clear Creek below Kendrick dam were documented using the channel, and 13 of these 19 species are

native. Shovelnose sturgeon and fathead minnow are the only native species not documented using the channel.

What trace elements bioaccumulate in the Muddy Creek food web: from food sources to fish and birds

Lusha Tronstad, (Presenter) and Wendy Estes-Zumpf, Wyoming Natural Diversity Database, University of Wyoming, Tronstad@uwyo.edu

The Muddy Creek ecosystem is unique because the stream contains a distinctive fish assemblage, is physically degraded, and will soon be influenced by coalbed natural gas (CBNG) development. We attempted to separate the effects of existing physical degradation and impending oil and gas development by measuring trace element concentrations in the Muddy Creek food web prior to most energy development. To extract CBNG resources, groundwater must be pumped to the surface. Groundwater produced during CBNG development can contain high concentrations of trace elements and is often discharged into nearby water bodies. Trace elements in produced water can be taken up into food resources and transferred to higher trophic levels in the food web through predation. We collected animals from each trophic level in the Muddy Creek food web above and below impending CBNG inputs and measured tissues for trace element concentrations and $\delta^{15}N$ (trophic position). We regressed trophic position against trace element concentration for each organism to examine how trace elements moved through the food web. Only selenium and mercury bioaccumulated in the Muddy Creek food web, while other trace elements biodiminished (peaked at intermediate trophic levels) or had similar concentrations throughout the food web. Creek chub (*Semotilus atromaculatus*), white suckers (*Catostomus commersonii*), bluehead suckers (*Catostomus discobolus*), and roundtail chubs (*Gila robusta*) all appeared to accumulate selenium and mercury in Muddy Creek. By understanding the Muddy Creek ecosystem now, land managers and developers can make informed decisions about management needs and potential mitigation efforts. Our study established baseline conditions in the Muddy Creek food web. We plan to repeat this study after CBNG development has occurred to compare how trace elements are accumulating in the food web.

Monitoring Amphibians in the Rocky Mountain Region: A multi-agency occupancy-based approach

Wendy Estes-Zumpf (Presenter), Wyoming Natural Diversity Database, University of Wyoming, westes@uwyo.edu
Zachary Walker, Wyoming Game and Fish Department
Douglas Keinath, Wyoming Natural Diversity Database, University of Wyoming

Amphibians are sensitive to environmental change and many populations in the intermountain west have undergone recent declines. Chytrid fungus is believed to be a major cause of world-wide amphibian declines and has been implicated in the decline of several amphibian species in the Rocky Mountains. Climate change and recent pine beetle outbreaks also could impact amphibians through alteration of habitat. Complex interactions exist between these potential threats, making predicting impacts on local amphibian populations difficult. Monitoring of amphibian populations is critical to identifying problems and allowing management practices to be adjusted in a timely manner. The Wyoming Natural Diversity Database, Wyoming Game and Fish Department, U.S. Forest Service, University of Wyoming's Biodiversity Institute, and other entities are working together to implement an effective and sustainable long-term monitoring plan for Wyoming's amphibians. The ultimate goal of the monitoring plan is to make the most of limited funds available to monitor amphibians by having all partners use standardized protocols at established survey areas. Thus, data from all partners can be combined to assess amphibian population trends. The plan

is modeled after the occupancy-based monitoring strategy developed by the USGS Amphibian Research and Monitoring Initiative, but is modified to allow surveys to be completed in one working day. We initiated pilot work on the Medicine Bow and Routt National Forests (MBRNF) in 2011 and have been conducting official monitoring surveys there since 2012. We currently have occurrence and breeding data for 5 amphibian species at over 30 survey areas across the MBRNF. We will be expanding the plan to include the Bridger-Teton National Forest in the spring of 2014 and hope to expand to surrounding forests in the next several years. Interested volunteers can adopt a survey area either by attending one of several spring trainings or watching online training videos and picking from a suite of established survey areas. Through this collaborative effort, we hope to finally be able to track amphibian population trends as environmental conditions change in the Rocky Mountain region.

North Platte River Restoration

Nathan Jean, PE (Presenter) and **T.C. Dinkins**, EIT, Stantec Consulting, Nathan.jean@stantec.com

In 2011 and 2012, Stantec Consulting Services Inc. and SWCA Environmental prepared the North Platte River Master Plan for the City of Casper. The Master Plan provided an assessment of the existing condition of, and proposed restoration strategies for, the North Platte River in a 13.5-mile stretch that flows through the City of Casper. The Master Plan identified seven high priority restoration sites for the North Platte River. The City of Casper has raised funds to implement restoration at one 2,000 linear foot site and are currently obtaining funding to implement the remaining six priority sites, totaling 5.5 miles of the North Platte River.

Restoring the North Platte River to a stable natural channel will help reduce sedimentation from soil erosion, and maintain the natural riparian hydrology. Riparian vegetation enhancements, including the removal of nonnative vegetation and establishment of wetlands, will help filter sediments from runoff, stabilize the river bank, maintain the natural riparian hydrology, and provide native riparian habitat for wildlife. In addition, the proposed design will greatly increase the diversity of fisheries habitat within the City of Casper. The diversification of fisheries habitat will greatly increase the fishing opportunities and use within the project areas.

Effects of Large Woody Debris and Log Jams on Eastern Slope Rocky Mountain Trout Populations

Adam T. Herdrich (Presenter), Colorado Cooperative Fish and Wildlife Research Unit, Aherdrich@usgs.gov
David Walters, United States Geological Survey
Dana Winkelman, U.S. Geological Survey, Colorado Cooperative Fish and Wildlife Research Unit

High elevation streams have been cleared of jam-forming large woody debris (LWD) through direct (e.g., clear-cutting, snagging, river clearing) and indirect (e.g., eradication of beavers) mechanisms. Here, I examine how trout populations in high elevation, eastern slope streams along northern Colorado's Front Range are affected by LWD by comparing streams with high amounts of in-stream LWD to streams with medium and low amounts of LWD. I will summarize results from my first field season examining trout densities in several streams with varying amounts of LWD. Trout densities were generally highest in streams with large quantities of LWD and lowest in streams in which LWD was minimal or absent. I will also present preliminary data on how trout growth rates vary as a function of LWD volume in streams.

Fish Habitat Compensation – Eagle Gold Project, Yukon

Todd Goodsell (Presenter) and **Michael Geenen**, PE, M.Eng, Stantec Consulting, todd.goodsell@stantec.com

The Eagle Gold Project is a proposed open pit gold mine using heap leaching extraction in Yukon Territory, Canada. The Project will divert Dublin Gulch, a second order fish bearing stream for mine facilities. Under the Canadian Fisheries Act and the Yukon Environmental and Socio-Economic Assessment Act, the proponent may be required to provide compensation for impacts to fish habitat and the local arctic grayling fishery from the proposed diversion of Dublin Gulch. Watercourses on and surrounding the Project site have been intensively placer mined for over 100 years offering multiple stream restoration opportunities to offset impacts to fish habitat. Dublin Gulch is part of the South McQuesten watershed which provides habitat for Chinook salmon, arctic grayling, northern pike, longnose sucker, round whitefish, burbot and slimy sculpin.

Stantec was asked to complete the fish habitat compensation plan that includes design of channel restoration works for approximately 2 km of stream channel. Design objectives focused on productive capacity in the watershed by increasing overwintering habitat for arctic grayling. Baseline and predicted productive capacity was evaluated and compared using habitat evaluation procedures that included the use of habitat units derived from habitat suitability index curves and IFIM suitability index curves. This presentation discusses the design approach for channel restoration, cost of construction, monitoring plans, and challenges with compensation works effectiveness unique to the project.

Using Sheet Piling Structures for Riparian Bank Building along a Shifting Sand Bottom Stream in Central Wyoming.

Colin Tierney, Wyoming Game and Fish Department, Colin.Tierney@wyo.gov

The Wyoming Game and Fish Department initiated the Stinking Creek Watershed Enhancement in fall 2012. Portions of the creek are perennial, but sand washes dominate most of the stream and surface flows in these areas cease following runoff events. Several historical washes have stabilized with vegetation in recent years forming wet meadow complexes. A series of twelve grade control structures were installed beginning in 2012 in an effort to expand these wet meadow complexes. Four structures were installed the initial fall and their performance was monitored to guide the installation of remaining eight the following fall. Structure types included "flow choke" configurations, and traditional grade control configurations. The structures act as sediment and water catchments, thereby encouraging the development of the native riparian plant communities that would stabilize and narrow the sandy channel. The project aimed to repair segments of overly wide or braided channel and segments of degraded channel by emulating the effects of beaver activity, but in an accelerated and controlled fashion. These structures detain flows during discharge events and gradually release this stored water over time. This allows water to absorb into the bank and bed substrates for use by plants (raise the streamside water table), and provide fine sediment deposition. Time-lapse game cameras were used to monitor site restoration. All structures installed in 2012 appeared stable after the first year. In October, 2013, flash flooding damaged two of the 2012 structures, and caused minor erosion around others. Bankfull had been underestimated for both structures that sustained damage, resulting in "flow chokes" that were too narrow to accommodate the amount of water delivered with these storms. While we had some success with this approach, we recommend extreme caution in the future when applying this approach to shifting sand bottom streams.

Grand Valley Diversion Ditch – Stream Restoration Project

Michael Geenen, PE, M.Eng, Stantec Consulting, michael.geenen@stantec.com

The Grand Valley Ditch Located in Encampment WY has been a ditch that has serviced the Encampment area for generations; the current practice and management of controlling the water for the ditch consisted of using a push up dam of instream cobble to back water up and create enough head to deliver the water to the end users. This practice has caused instabilities in the river and created fish passage and habitat issues. The Saratoga-Encampment-Rawlins Conservation District and Wyoming Game and Fish asked Stantec to lead a design build to implement a design that would stabilize the banks and prevent land loss, rebuild the irrigation diversion structure to improve efficiency and enable fish passage, and improve fish habitat using natural channel design restoration techniques.

In October of 2013, Stantec along with North State Environmental completed the construction of the diversion project; this presentation will go over the design process, construction and monitoring plan for the project.

Waste water effluent, estrogenic exposure, and the future of eastern plains native fishes

Dana L. Winkelman (Presenter), U.S. Geological Survey, Colorado Cooperative Fish and Wildlife Research Unit, Dana.Winkelman@colostate.edu
Adam Schwindt, Colorado Cooperative Fish and Wildlife Research Unit
Kristen Keteles, EPA Region 8
Michelle McGree, Colorado Parks and Wildlife

Many freshwater streams and rivers are dominated by urban waste water effluent. For example, flow in the South Platte River downstream of the Denver, Colorado, metropolitan area ranges from 69-100% effluent depending on the time of year. Given current climate projections in the western US, stream flow can be expected to become increasingly dominated by urban and agricultural effluents. Waste water effluents typically contain many compounds associated with human use and many of these may disrupt vertebrate reproduction. Exogenous steroidal (i.e. estradiol and ethynylestradiol) and non-steroidal (i.e. nonylphenol) estrogens are particularly concerning because they alter reproductive physiology in fishes and are found in surface waters downstream from WWTPs worldwide. Great Plains fishes downstream of waste water effluents exhibit physiological evidence of reproductive disruption. However, it is difficult to predict how Great Plains fish populations are responding. I will summarize three projects undertaken to understand how exogenous estrogens may be influencing Great Plains fish populations. The first project was designed to understand if estrogenic compounds influence reproduction in a native eastern plains fish, the red shiner (*Cyrinella lutrensis*). The second project was designed to understand if exposure to estrogenic compounds result in measurable population-level effects in a native eastern plains fish, the fathead minnow (*Pimephales promelas*). The third ongoing research consists of fish caging experiments in the South Platte River east of Denver Colorado. The first two projects indicate that exposure to environmentally relevant concentrations of estrogen result in complete reproductive failure. Additionally, there appear to be transgenerational effects of exposure, mediated through parental exposure. Our results suggest that fish may not recover from early life exposure and the population consequences could be catastrophic. Field caging experiments in waste water effluent in the South Platte River clearly show that previously unexposed fathead minnows are being exposed to exogenous estrogens at levels that could indicate risk for reproductive failure.

Counting calories in your fish: why and how?

William M. Pate (Presenter), **Devin Olsen**, **Brian Wolff**, and **Brett Johnson**, Colorado State University, wm_pate@hotmail.com

Energy content (calories) is an important metric for a variety of fisheries studies. Energy content is a useful indicator of fish body condition and health. Knowledge of energy content of both predator and prey is required for bioenergetics models that calculate consumptive demand. It is feasible to measure energy content directly by bomb calorimetry, but access to such instruments is limited. Thus, many biologists rely on literature values which are sparse and may not be applicable. Alternatives would be useful. We measured energy content of five salmonids, two percids, two catostomids, Smallmouth and White Bass, and several other prey species sampled from three Colorado reservoirs of differing productivity. We compared our data to published energy contents, and evaluated functions that use percent water to estimate energy content. We also compared our measurements with relative weight, and Fulton's Condition Factor. Energy content of Kokanee in one reservoir was much higher than in the literature, but other species more usual. Percent water and energy content were highly correlated in all species ($r^2 > 0.98$), suggesting an easy and robust alternative to calorimetry. The relationship between energy content and condition indices was weaker, suggesting that such indices are not the best indicator of physiological condition of fish.

Spatial structuring within a reservoir fish population by an unintended protected area: implications for management

David R. Stewart (Presenter), **James M. Long**, and **Daniel E. Shoup**, Oklahoma State University, dstewa11@uwyo.edu

Aquatic protected areas (APAs) have their origin in the marine environment and have only recently been implemented in freshwater settings. APAs work to create protected areas and reduce anthropogenic stressors influencing aquatic species resulting in greater abundance, larger size, lower mortality, and increased longevity compared to populations outside the protected area. We investigated whether the population of white crappie at Lake McMurtry, Oklahoma exhibited evidence of population structure where the northern-half of the lake was closed to fishing to provide waterfowl hunting opportunities (an unintended APA). White crappie is an ideal candidate because it has limited home ranges, exhibits little movement among areas, and is highly desired by anglers. We modeled the population response to angling for each sub-stock of white crappie (north and south areas), the entire lake assuming a panmictic stock and additively assuming two sub-stocks. Based on mark-recapture surveys using electrofishing and age-based population parameter estimates, white crappie in the north area were more abundant, consisted of larger, older individuals, and exhibited a lower total annual mortality rate than in the south area. Population modeling results found fishing mortality between 0.1 and 0.3 resulted in sustainable populations, determined by spawning potential ratios (SPR) > 0.30, for all model simulations, whereas sustainability decreased with higher fishing mortality estimates (SPR > 0.5). The population in the south area appeared to be more resilient, with SPR < 0.30 at the highest fishing intensities, but considered additively as two sub-populations, the whole-lake fishery appeared more resilient than the single stock assessment. Our results provide strong inference that the hunting restrictions at Lake McMurtry indirectly created an APA, which played a role in creating spatial complexity within the crappie population. As a result, population models used to guide management decisions would need to consider the spatial complexity to produce more robust predictions.

Ecological consequences of climate change for mountain lake-stream populations of cutthroat in the Southern Rocky Mountains

James J Roberts (Presenter), USGS – Fort Collins Science Center, jroberts@usgs.gov
Kurt D Fausch, Colorado State University - Department of Fish Wildlife and Conservation Biology
Travis S Schmidt and **David M Walters**, USGS - Fort Collins Science Center

Changing climatic conditions threaten to modify the physical conditions of mountain aquatic systems through altered thermal and hydrological regimes; these changes are also likely to influence biotic processes in mountain lakes. However, the specific changes in lake abiotic characteristics (e.g., surface temperature, timing of ice off, and period of stratification) resulting from climate change and the consequences for imperiled native cutthroat trout populations in lakes of the southern Rocky Mountains are understudied. We use a combination of field studies and modeling to examine how changes in lake surface temperature are related to life history patterns (i.e., adfluvial movement) of cutthroat trout populations. Initial modeling results from 30 southern Rocky Mountain lakes suggest a 0.16&degC per decade increase in mean lake surface temperature over the next 70 years. We relate these changes in thermal regimes to continuous observations (via PIT tag antenna arrays) of adfluvial movements from a mountain lake cutthroat trout population. These predicted changes in thermal conditions are likely to have important implications for food-web dynamics of these systems and population dynamics of imperiled native cutthroat trout.

Evaluating and Enhancing Colorado's Trophy Largemouth Bass Opportunities

Kyle Christianson (Presenter), **Jesse Lepak**, **Andrew Treble**, Colorado Parks and Wildlife, kyle.christianson@state.co.us
Chris Myrick, Department of Fish, Wildlife and Conservation Biology, Colorado State University,
Ben Swigle, Colorado Parks and Wildlife

Largemouth bass are one, if not the most popular sport fish throughout the lower 48 states, and Largemouth Bass fisheries provide recreation, recruit new anglers and contribute large amounts of money to the economy. In Colorado, managers are interested in improving Largemouth Bass fisheries by increasing opportunities for anglers to catch Largemouth Bass of trophy size. To inform managers, we used a random forest approach to simultaneously evaluate a variety of factors (e.g., harvest regulations, angling pressure, stocking history, system size) as predictors of which systems were most likely to support trophy-sized Largemouth Bass. This approach is helpful for using a suite of factors (even those that are correlated) in a single model to predict which systems have the highest potential to produce trophy Largemouth Bass, and where future Largemouth Bass introductions might be the most successful. Further, we wanted to quantify the relative influence of the most important factors (especially those that could be used as management tools) as determinants of Largemouth Bass size. To do this we used a linear regression approach and found that all else being equal, harvest regulations significantly influenced the size of Largemouth Bass sampled with larger fish being observed in systems with more restrictive harvest regulations. The vast majority of systems included in our dataset had the two most relaxed harvest regulations (five fish of any size and five fish over 15 inches in length). Not surprisingly, these systems had the smallest Largemouth Bass sampled. Lastly, we found that completely restricting harvest (catch-and-release only) may not produce significantly larger-sized fish relative to more relaxed regulations with some opportunity for harvest. These results have the potential to be used by managers to maintain and enhance Largemouth Bass fisheries throughout Colorado and elsewhere.

Creation of the Monte Vista Isolation Facility

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An isolation facility is a specialized hatching and/or nursery space or facility for the purpose of separating and isolating fish and eggs of indeterminate fish health status from the general population through physical separation. Dewatering of streams due to drought, disease problems with free ranging brood sources and maintaining genetic diversity between different populations have led to a need for more isolation facility rearing space within Colorado. Tight budgets prohibited the construction of a large permanent structure for this purpose. We were able to plan and construct a relatively inexpensive isolation facility to increase available rearing space. This presentation describes the construction of the Monte Vista Isolation Facility located on the Colorado Parks and Wildlife's Monte Vista State Fish Hatchery.

From a ditch to a destination: flushing flows and the evolution of the Gray Reef tailwater fishery.

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The North Platte River in central Wyoming became a tailwater with the completion of Pathfinder Dam in 1909. From 1909 through 1961 no winter flows were provided from upstream reservoirs. During this period, trout management consisted of stocking catchable size fish in the spring with no expectation of continued survival. Gray Reef Dam was constructed in 1961 and allowed for a constant winter flow of at least 330 cfs. The fishery improved considerably but was constrained by accumulation of fine sediment. With the cooperation of the US Bureau of Reclamation, five-day flushing flows were tested in 1993 and have occurred annually since. Flushing flows proved highly beneficial to the rainbow trout population with large increases in trout standing stock occurring. Recently, downward trends in trout populations were evident despite annual flushing flow events. Substrate sampling indicates while flushing flows have been very beneficial, the current flushing flow regime may not be sufficient for the long term maintenance of spawning substrate in the absence of much higher flows. Investigations into the benefits of a 10-day flushing flow cycle began in 2013 and are ongoing.

Performance characteristics of Fall Rainbow Trout produced from three, four, and five year old brood fish through rearing cycle

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In the past, Speas Fish Hatchery received its Fall Rainbow (*Oncorhynchus mykiss*) eggs from different year classes of brood combined in one big lot. Starting in December 2013 Speas received eyed eggs from the incubating facility (Dubois) separated by brood age (3y, 4y, 5y). Speas will conduct a three year study to uncover possible differences in performance characteristics. Over the course of the study, fish culture related data (percent stage survival, on feed size, growth rate, conversion, size variation, condition factor, etc.) will be recorded in an effort to tease out any performance advantages between each group of progeny. It may be interesting if continued tracking after stocking would yield any significant survival or performance comparisons. This may come after a few years of conducting this same performance study at the hatchery.

History and Status of Leasing Water in Lake DeSmet

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Lake DeSmet is the most heavily used standing water trout fishery in northeast Wyoming supporting nearly 35,000 angler days annually. The reservoir is currently owned by a coalition of two counties but there have been recent offers by private interests to purchase the reservoir and dedicate a large portion of the water to support various commercial and industrial interests. In addition to the investment of time and resources to manage the fishery, the Wyoming Game and Fish has spent significant public dollars to develop access areas that include boat ramps, improved roads, fee title purchases and comfort stations. These significant investments of public funds and the relative importance of the reservoir to local anglers led Wyoming Game and Fish to offer leasing about 28% of the storage rights for up to 99 years. The lease will ensure adequate water is available for boats to be able to launch regardless of what happens to the rest of the available storage. This water level would also maintain the fish community and angling opportunities. The lease is funded through the Sport Fish Restoration Program.

Battle of the invaders: Can a nonnative parasite alter hybridization between native and invasive trout?

Kellie Carim (Presenter) and **Lisa Eby**. University of Montana, kellie.carim@gmail.com

Invasive species and habitat destruction are the two largest threats to freshwater ecosystems. While restoration and maintenance of habitat connectivity facilitates life history diversity and dispersal, it also increases the spread of nonnative species that may negatively impact the native community. Declines in many wild trout populations in Western North America have been attributed to the spread of whirling disease, caused by an invasive parasite, *Myxobolus cerebralis*. Rainbow Trout (*Oncorhynchus mykiss*), have been introduced extensively throughout the Rocky Mountains, where they hybridize with native Cutthroat Trout (*O. clarkii*). Rainbow Trout are more susceptible to whirling disease than Cutthroat Trout and may be more vulnerable due to their preferred spawning location in lower stream reaches. We hypothesized that the presence of whirling disease may reduce the spread of hybridization in a stream. To evaluate this hypothesis, we studied connected populations of *Oncorhynchus* in six disease negative and four disease positive tributaries to the Blackfoot River Basin of west central Montana. Results show that the extent of hybridization in a stream is not altered by the presence of disease. Instead, geomorphic characteristics, such as stream slope, appear to have the strongest influence on the extent of hybridization in a given population. Unlike temperature and precipitation, characteristics such as stream slope are not likely to be altered by climate change. As a result, habitat favoring geomorphic preferences of native fish in connected riverscapes may provide natural refugia from interactions with some invasive species. As spread of invasive species continues to alter native communities, we should continue to address multi-species interactions when forming expectations for impacts on the native species. Additionally, a broader investigation of how geomorphic characteristics may create barriers to invasive species would inform conservation expectation and help identify focal populations and habitat for conservation and restoration.

Tracking movement of Colorado River Cutthroat Trout in a small stream using mobile PIT tag interrogators.

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We used passive integrated transponder (PIT) telemetry to track movement of Colorado River Cutthroat Trout (CRCT) *Oncorhynchus clarkii pleuriticus* in a small stream. In June and October

2012 and October 2013, CRCT in a 1.6-km reach of a headwater tributary were captured by electrofishing and implanted with PIT tags. Mobile PIT tag interrogators were used bimonthly in summer and fall of 2012 and 2013 to passively recapture tags in the study reach. Mean tag detection distances of mobile interrogators ranged from 3 cm to 56 cm, depending on orientation of the tag and detection plane. The passive recapture rate of PIT tags varied among sampling events (range = 16 - 44%). In 2012, the mean single-pass recapture rate of PIT tags during mobile interrogation was lower than the single-pass recapture rate of PIT-tagged cutthroat during electrofishing (28% vs. 41%); in 2013, the mean single-pass recapture rate of PIT tags during mobile interrogation was higher than the single-pass recapture rate of PIT-tagged cutthroat during electrofishing (19% vs. 13%). Episodes of movement varied from less than 5 m to more than 400 m; most cutthroat occupied a range of less than 100 m. Movement patterns suggest that CRCT in Poose Creek are relatively sedentary; however, low recapture rates during both passive interrogation and electrofishing suggest that PIT-tagged CRCT may have exited the study reach, and thus escaped detection, during long-range movements. Our results illustrate both utility and limitations of using mobile PIT tag interrogators to track movement of fishes in small streams.

Raft and Floating RFID Antenna Systems for Detecting PIT-tagged Fish in Rivers

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Eric R. Fetherman, Colorado Parks and Wildlife
Dana L. Winkelman, U.S. Geological Survey, Colorado Cooperative Fish and Wildlife Research Unit

Portable Radio Frequency Identification (RFID) passive integrated transponder (PIT) tag antenna systems are increasingly being used in studies examining aquatic animal movement, survival, and habitat use. Their design flexibility permits application in a wide variety of ecosystems. We describe the construction, use, and performance of two portable floating antenna systems designed to 1) detect PIT-tagged Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta* in relatively long (i.e., ≥ 10 km) river reaches, and 2) be used as an alternative to traditional sampling methods, such as electrofishing, for estimating PIT-tagged Rainbow Trout and Brown Trout abundance. A raft antenna system for detecting fish in relatively long river reaches consisted of two arrays, a 4 × 1.2 m elliptical array installed on the bottom of the raft (horizontal) used to detect fish in shallower river sections (< 1 m), and a 2.7 × 1.2 m rectangular dropper array (vertical) used to detect fish in deeper pools (> 1 m). Field tests showed that the raft antenna system effectively detected PIT-tagged Rainbow Trout and Brown Trout over a 11.3 km reach of the Cache la Poudre River, Colorado. A shore-deployed floating antenna system for estimating abundance of PIT-tagged Rainbow Trout and Brown Trout in shorter (i.e., < 2 km) river reaches consisted of a single 14.6 × 0.6 m rectangular array. The shore-deployed floating antenna system produced similar estimates of abundance to electrofishing in most cases; however, similarities between estimates were closest for stream reaches with maximum depths that did not exceed 0.7 m. Our portable antenna systems provide a noninvasive method that minimizes disturbance to individual fish for estimating PIT-tagged fish abundance and survival in both small (hundreds of m) and large (km) river reaches.

Dissolved Oxygen and Formalin Tolerance of Whirling Disease-Resistant Strains of Rainbow Trout

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Eric R. Fetherman and **Stephen F. Brinkman**, Colorado Parks and Wildlife

Four whirling disease-resistant strains of rainbow trout (*Oncorhynchus mykiss*) commonly produced in Colorado hatchery systems were exposed to various dissolved oxygen (DO) levels and formalin concentrations. The study was designed to determine whether these strains/crosses exhibit differences in DO minimum tolerances, and how these differences may affect hatchery culture practices. The strains/crosses tested included the Hofer (GR), Harrison Lake (HL), Hofer × Harrison Lake 50:50 (GR×HL 50:50), and Hofer × Harrison Lake (GR×HL 75:25). Experiments were conducted at each of four ages (30, 60, 90, 120 days post-swim-up) acclimated at 12°C, and critical DO minimums were measured in the absence (0 ppm) and presence of formalin (167, 250 ppm). At 30 days post-swim-up, there were significant differences in weight among the rainbow trout. Therefore, weight influenced critical DO minimums at 30 days post-swim-up, with critical DO minimums differing among the strains/crosses, but not among the formalin treatments. Average critical DO minimum was significantly lower in the HL (1.17 ± 0.07 mg/L) than the H×H 75:25 (1.33 ± 0.11 mg/L) or the GR (1.32 ± 0.09 mg/L); however, DO minimum did not differ from the GR×HL 50:50 (1.21 ± 0.02 mg/L). The GR, GR×HL 50:50, and GR×HL 75:25 did not differ from each other in average critical DO minimums. At 90 day post-swim-up, critical DO minimums did not differ among the strains/crosses, but did differ among the formalin treatments. Fish within the 0 ppm treatment had significantly higher average critical DO minimums (1.42 ± 0.12 mg/L) than did fish within the 250 ppm treatment (1.22 ± 0.13 mg/L). Fish within the 167 ppm treatment (1.29 ± 0.09 mg/L) did not differ in critical DO minimums from those in either the 0 ppm or 250 ppm treatments. At both 60 and 120 day post-swim-up, critical DO minimums did not differ among the strains/crosses or among the formalin treatments. This experiment demonstrates that DO levels must get below 2.0 mg/L before potential problems may be observed in a hatchery setting, whether or not during formalin treatment.

Use of Summer Profundal Index Netting to Estimate Lake Trout Abundance in Wyoming and Colorado Waters

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Brett Johnson, Colorado State University
Jason Burckhardt and **Travis Neebling**, Wyoming Game and Fish Department
Jesse Lepak, Colorado Parks and Wildlife

A protocol for estimating lake trout abundance in Canadian Shield lakes (Summer Profundal Index Netting or SPIN), was developed by Canadian researchers Steve Sandstrom and Nigel Lester. The SPIN protocol has been calibrated after use in hundreds of systems with independent Lake Trout abundance estimates using mark-recapture techniques and known populations. The method uses a depth-stratified, randomized sampling design during peak summer temperatures when fish are assumed be confined below the epilimnion. Special eight panel, 64 meter bottom set gill nets are used in series of three to sample up to 7 different depth strata in a lake. Number of net sets per stratum each day is determined based on the number of Lake Trout sampled the previous day, the relative area of each stratum and the number of strata in the lake. The number of total net sets is calculated based on the area of the water body that is deeper than 10 meters. This technique has been used in a small number of Colorado lakes and reservoirs and on Buffalo Bill Reservoir in Wyoming. Here we give background on the technique and provide examples of how it has been used in Wyoming and Colorado.

Hydroacoustic Repeatability in High Savery Reservoir

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The repeatability of, or ability to get consistent population estimates from, hydroacoustics is dependent on a number of factors. The chief concern is ensuring adequate "coverage", or sufficient transect distance relative to surface area to account for variability in fish density. A number of small studies have been conducted on High Savery Reservoir, south-central Wyoming, to evaluate seasonal and daily variability (or repeatability) of fish population estimates from hydroacoustics. The reservoir was sampled in the spring, summer, and fall of 2011 using standardized hydroacoustic transects and mid-water curtain netting locations. Sport fish population estimates were fairly stable throughout the year (+/– 18% of average); however, the estimate of non-native, non-game individuals increased throughout the year, as the reservoir became anoxic from the bottom up. Spring sampling yielded the population estimate closest to the average and also reduced the number of non-native fish in the gill nets. In the spring of 2012, the reservoir was sampled for four consecutive days using the standardized methods. Daily population estimates were repeatable within +/– 10% of the average. Population estimates were highly correlated (R^2 = 0.9) with wind speed (i.e., as wind speed increases, so too does the population estimate) which is likely due to increased acoustic noise and thus false targets.

The Dry Piney Study: Energy development effects to native fish communities along the Wyoming Range

Carlin Girard (Presenter), Wyoming Cooperative Fish and Wildlife Unit, University of Wyoming, carlingirard@gmail.com
Dr. Annika Walters, Assistant Unit Leader- Fisheries, U.S. Geological Survey, Cooperative Fish and Wildlife Unit, University of Wyoming

Extraction of oil and gas will continue as demand requires. In Wyoming, energy development will likely continue to be a primary employer and tax revenue source (~35% GDP). Extractive industries are regulated to minimize collateral damage to environmental resources, another vital asset in Wyoming's economy (~3% GDP). The Wyoming Game and Fish Department considers energy development a major threat to aquatic resources in the Upper Green River of Wyoming, home to 3 of the nation's 20 largest natural gas fields.

We are evaluating the extent to which energy development has degraded aquatic ecosystems within the Labarge Oil and Gas Field, by focusing on surface disturbance, habitat fragmentation and water pollution. In 2012 and 2013, we observed reduced riparian vegetation, increased fluvial sediment transport, and hydrocarbon contamination within developed portions of the study area. Our research showed differential sensitivity of native fauna to the aforementioned stressors, which is exemplified by the recent loss of Colorado River Cutthroat trout; the near extirpation of mottled sculpin; and the robust mountain sucker populations found in our energy development affected streams. This project is designed to assist fisheries' management during energy development, by providing research methods and mitigation suggestions from the drainage to species' scale.

Endocrine Disrupting Compounds in Wyoming Surface Waters: Assessment of the Presence, Suspected Sources, and Impacts to Exposed Fishes

Eben O. Johnson (Presenter) and **Harold L. Bergman**, University of Wyoming, ejohns35@uwyo.edu

In the last two decades, studies in North America and Europe have demonstrated the widespread occurrence of intersex and other reproductive abnormalities in fish related to the presence of endocrine disrupting compounds (EDCs) in surface waters. Many of these studies point to the discharge of steroid hormones and industrial chemicals from wastewater treatment plants as the principle cause of these abnormalities, but the deposition of airborne pollutants and leaching of

steroids from livestock waste pose additional risks. Because there is little information about the presence of EDCs in Wyoming, and because livestock outnumber the human population more than 2:1, Wyoming provides a unique scenario for studying the impacts of EDCs from both wastewater and agricultural sources. We collected white sucker (*Catostomus commersonii*) and brown trout (*Salmo trutta*) from four sites on the Laramie River above and below potential sources of EDCs. Histological examination of the gonads and quantification of the egg-yolk protein, vitellogenin, revealed very low occurrence of EDC related pathologies. Water samples were also analyzed from all four sites showing very low levels of steroid hormones, alkylphenols and other endocrine active compounds, with the highest contaminant concentrations in the Laramie wastewater effluent. Finally, in an effort to detect EDCs across a greater geographic range, we deployed caged male fathead minnows (*Pimephales promelas*) at seven surface water sites across the state of Wyoming, including those sites on the Laramie River where white sucker and brown trout had previously been collected. Quantification of vitellogenin gene expression following the deployment showed no signs of estrogen exposure in any of our caged male fish. The results of our study suggest that endocrine disruption is not a serious management concern in the Wyoming locations we have assessed.

Exploitation and Population Dynamics of Burbot in the Upper Wind River Drainage

Sean Lewandoski (Presenter), Montana State University
Christopher Guy, Montana Cooperative Fishery Research Unit
Joe Deromedi, **Paul Gerrity**, and **Kevin Johnson**, Wyoming Game and Fish Department
Michael Mazur, U.S. Fish and Wildlife Service

In the Wind River drainage, burbot are a popular sport fish and an important cultural resource for the Eastern Shoshone and Northern Arapahoe tribes. However, there is concern that overexploitation may be limiting these populations. To address this issue, we estimated exploitation by tagging 1041 Burbot in Bull Lake and 476 Burbot in the Torrey Creek drainage with Carlin-type tags from 2011 through 2013. We also estimated tag loss (20% for the 2011 cohort and 4% for the 2012 cohort) and tag reporting (16%) to minimize bias in our exploitation estimates. In Bull Lake, exploitation was 13% (95% CI: 3–43%) in 2011 and 11% (6–19%) in 2012; in the Torrey Creek drainage, exploitation was 3% (0–36%) in 2011 and 2% (0–28%) in 2012. Mean exploitation estimates are low; however, the upper ends of both 2011 confidence intervals approach values that merit concern. Using population size-structure and parameter estimates, including exploitation, natural mortality, abundance, and growth rate, we constructed a stage-structured model to investigate the effects of varying exploitation rates on the Bull Lake and Torrey Creek drainage Burbot populations. The model delineates threshold levels of exploitation that will cause fishery metrics (e.g., biomass of all harvested fish or biomass of trophy sized harvested fish) to fall below acceptable levels— allowing for more informed management decisions with regard to harvest regulations for Burbot.

Investigating fish community composition and brown trout diet and condition in a high plains river.

Jessica Dugan (Presenter) and **Frank Rahel**, University of Wyoming, Laramie, jdugan2@uwyo.edu

Adding habitat improvement structures during habitat restoration projects is a common conservation and management technique used to improve fish habitat. Habitat improvement efforts have shown to positively influence coldwater game fishes, like brown trout (*Salmo trutta*). Fewer studies have examined the effects of habitat improvement efforts on entire fish communities. The Laramie River is a high plains river, located in southeast Wyoming. The fish community is dominated by warmwater nongame species; however, the top predator is brown trout (*Salmo trutta*), the only

abundant coldwater game fish in the study area. Land use types that dominate the area include agriculture and urban development. Two stream restoration projects have occurred at sites along the Laramie River. At each site, habitat improvement structures made of boulder and wood have been added to the river to improve fish habitat. We evaluated the community composition, analyzed the diets of brown trout, and determined the condition of brown trout at sites along the Laramie River. Results were compared between sites with and without habitat improvement structures.

Using partial and full recirculating reuse to increase productivity at the Dubois Fish Hatchery

Guy Campbell, **Pete Starr**, and **Bill Yaracz**, (Presenter), Wyoming Game and Fish Department, bill.yaracz@wyo.gov

The Dubois Hatchery is one of ten state fish culture facilities belonging to the Wyoming Game and Fish Department. Back in 2006, construction was completed on a comprehensive hatchery remodel. This transformed an aging facility, operating on a flow through system, to a state of the art facility utilizing a partial reuse system. At the current setup, water going to the incubators is discharged after first use which limits our available water for hatchery use. Two incubation recirculation trials were conducted to evaluate the feasibility of recirculating water for the incubation of fish thereby opening up the valued water resource for hatchery production. Using two different strains of fish, incubating techniques, and the level of development, we proceeded to observe the efficacy of recirculating incubators. The eggs from the experimental group were supplied with 10% fresh flowing water and 90% recirculated water while the eggs from the control group were supplied 100% fresh flowing water. Once the eggs reached the eyed stage of egg development the eggs were shocked, picked and enumerated to determine percent survival from each group. Based on the results, we concluded it is possible to successfully develop trout eggs to the eyed egg stage using 90% recirculated water in a Robertson drip and Heath Tray (vertical) incubators.

Reproduction and recruitment dynamics of flathead chub relative to flow regime in Fountain Creek, Colorado.

Matt R. Haworth (Presenter) and **Dr. Kevin R. Bestgen**, Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Matt.Haworth@colostate.edu

Flathead chub Platygobio gracilis is a North American cyprinid with a historic distribution spanning the Great Plains region from Canada south to the Gulf of Mexico. Populations have declined regionally and flathead chub is now considered abundant in only a portion of its historic range. In Colorado, flathead chub is presently listed as a Species of Special Concern. A stronghold exists in Fountain Creek, an Arkansas River tributary that may be altered by a municipal water project. To better understand potential effects of flow manipulation, we are investigating the reproduction and recruitment dynamics of flathead chub in Fountain Creek.

In spring and summer 2012-2013, daily drift net and live egg samples documented an extended reproductive season for flathead chub, spanning May-August in both years. Daily increment counts from otoliths of larger age-0 flathead chubs were then used to construct distributions of hatching dates and identify timing and patterns of recruitment related to extreme flow events caused by summer thunderstorms. Understanding how flow regimes influence reproduction and recruitment will contribute to the understanding of flathead chub ecology, provide insight into how flow manipulations may affect fishes in Fountain Creek, and inform recommendations for their conservation.

Gill Lice in Colorado

Estevan Vigil (Presenter), Colorado State University, estevan.vigil@state.co.us
Jesse Lepak, Colorado Parks and Wildlife

Gill Lice are parasitic copepods that target fishes, primarily salmonids. Gill lice limit oxygen exchange through gill filaments on which they are attached and negatively impact fish behavior, immune system function, growth, warm water tolerance, sexual maturation, fecundity, and survival. To date, very little research has been conducted on gill lice. We are conducting laboratory and field research to evaluate their distribution and relative abundance. We are also sampling native salmonid species, as well as other popular sport fish, in Colorado to assess the thermal tolerance of infested fish, thermal tolerance of gill lice, fish performance as a function of infestation rates, and the species and sizes of fish that are most heavily affected. We are also interested in how these interactions might be altered and potentially exacerbated by a warming climate and potential changes in water availability. Understanding impacts gill lice have on fish populations will help managers in the state mitigate the negative consequences of gill lice infestations.

Range shifts from climate change across three Colorado rivers

Daniel Gibson-Reinemer (Presenter), **Frank Rahel,** and **Shannon Albeke**, University of Wyoming, dgibsonr@uwyo.edu
Ryan Fitzpatrick, Colorado Parks and Wildlife

Rising temperatures have produced shifts in the geographic distribution of species, but most evidence comes from terrestrial and marine ecosystems. We examined changes in the distribution of 16 native species and 2 naturalized salmonids in the Poudre, Big Thompson, and St. Vrain rivers. Our analysis spans several decades, during which there was a pronounced warming trend in mean annual air temperatures. Mean upstream range limits across species shifted up to 11 river km. Mean changes in the downstream limits of species were more modest. Range shifts at the upstream and downstream limits were generally consistent with expectations of climate tracking; however, a minor portion of species shifted downstream during this period. We will discuss the range shifts in these species in relation to species' detectability during historical sampling and barriers to fish movement.

Use of Coal Creek, White River drainage, CO, by flannelmouth and bluehead sucker.

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Flannelmouth sucker *Catostomus latipinnis* and bluehead sucker *Catostomus discobolus* are native fishes of the Colorado River Basin. Each species has been extirpated from over 50% of their historic range due to negative effects of habitat alteration and establishment of nonnative fishes. Strong populations persist in some river reaches including the upper White River, Colorado, where those negative effects have been minimal. Our research focuses on the distribution, movement, and timing of reproduction of these species relative to streamflow and water temperature patterns in the upper White River, CO, including tributary Coal Creek. Fyke net captures documented suckers entering Coal Creek to spawn as water temperatures warmed in early May, 2012-2013. The large pulse of sucker movement into the creek began when the daily average temperature in Coal Creek reached 14°C. In general, flannelmouth suckers arrived earlier than bluehead suckers and in larger

numbers. Suckers captured in Coal Creek were implanted with a passive integrated transponder (PIT) tag. We recaptured suckers with fyke nets and with remote RFID PIT tag antennae. Recapture data showed site fidelity, as reproductively ready suckers returned to Coal Creek the year after tagging. Antennae data also show that suckers leave Coal Creek immediately after they have been trapped and handled, which confounds our ability to estimate demographic parameters that require closed population assumptions. Our data show that tributaries are important for native suckers in the upper White River. Protecting and enhancing these habitats should be a priority conservation action.

Population abundance and dynamics of introduced Northern Pike, Yampa River, Colorado, 2004 – 2010

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We modeled demographic parameters of invasive Northern Pike (*Esox lucius*) in the Yampa River, Colorado, 2004–2010, using tag-recapture data. Sampling occurred in three regions: "Hayden to Craig", a buffer zone upstream of endangered species habitat in the next two regions; "South Beach, Little Yampa Canyon, Juniper"; and most-downstream "Maybell, Sunbeam". Analyses in Program MARK showed important region, time interval, and pike length effects on survival rate estimates and interacting region, year, and pass effects with additive length effects on capture probability estimates. Annual survival was lowest for pike upstream (mean: 0.25, range: 0.12–0.38), but abundance estimates were highest. Pike downstream had highest survival and lowest abundance estimates. Capture probabilities ranged from 0.03 to 0.51 for average-length Northern Pike, but over 70% of estimates were <0.20. Removal rates were variable and relatively low, while total mortality rates (including removal and emigration) remained consistent across years. Average mortality rates in the two upstream regions were high (70–75%), but population increases due to recruitment and/or immigration offset those effects. Present removal rates may not be adequate to reduce populations of Northern Pike in the Yampa River if immigration and recruitment are not reduced. Within the Yampa and Green river basins, Northern Pike movements among reaches were overwhelmingly (88%) in a downstream direction and few spanned more than two adjacent river reaches. However, we documented movements from the most upstream sampling locations in the Yampa River basin (including in Catamount Reservoir) down to the middle Green River - a distance of more than 241 river miles. Northern Pike previously translocated to Yampa State Park Headquarters, Yampa River State Wildlife Area, and Loudy-Simpson Park were subsequently recaptured in mainstem sampling.

Phenotype predicts genotype for lineages of native cutthroat trout in the southern Rocky Mountains

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Morpho-meristic characteristics of cutthroat trout *Oncorhynchus clarkii* were described from 48 populations in the Rio Grande, and Colorado, South Platte, and Arkansas River basins in Wyoming, Colorado, Utah and New Mexico. These include presumptive Rio Grande (*O. c. virginalis*), Colorado

River (*O. c. pleuriticus*), and greenback (*O. c. stomias*) cutthroat trout subspecies and the unusual Bear Creek, Colorado, population. Our main goal was to determine if phenotypes of individuals and populations, first assigned to lineages with mitochondrial DNA techniques, corresponded better to the subspecies recognized in the traditional Geographic Classification Model or to lineages under the newer Molecular Classification Model. Ten morpho-meristic characters, including spot distribution and density patterns, were variable across taxa and discriminant function classification analyses better supported assignment of populations to the Molecular Model than the Geographic Model. Bear Creek and Rio Grande lineages were distinct, as were Blue Lineage populations of the Upper Green River Basin. Green Lineage populations of the Colorado, Gunnison, and Dolores River drainages, as well as Front Range populations from the Arkansas and South Platte River drainages, were more difficult to classify and may represent more than one taxonomic entity. Classification success was also high within lineages at the drainage scale, suggesting smaller-scale organization of diversity. All lineages are rare and findings will be useful to managers tasked with listing decisions and conservation actions for these cutthroat trout.

The effects of anthropogenic barriers on movement patterns of Yellowstone cutthroat trout in the Greybull River drainage

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Yellowstone cutthroat trout (YCT) have experienced dramatic reductions in their historical distribution due to anthropogenic activities. Most populations of YCT have been relegated to small headwater populations. The Greybull River in Northwestern Wyoming harbors one of the few remaining metapopulations. Development of the Greybull watershed for irrigation agriculture has fragmented habitats and restricted connectivity among YCT populations. In early 2012, a cooperative effort was undertaken to install a fish ladder at the Upper Sunshine Diversion – a primary diversion point centrally located on the mainstem Greybull River. We used radio telemetry to determine upstream passage of YCT through the old diversion structure and radio telemetry and radio-frequency identification (RFID) tags to document the use of the Upper Sunshine Diversion fish ladder following its construction. We found that the old Upper Sunshine Diversion was serving as a partial barrier to upstream passage of YCT. The construction of the Upper Sunshine Diversion fish ladder increased the upstream passage of YCT not only through the fish ladder, but also through the radial arm gates of the structure itself. These data will be used to determine the most effective means of operating this diversion structure to allow for the upstream passage of YCT.

Reconnecting Yellowstone cutthroat habitat on the Greybull River

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Since 2008, Trout Unlimited has prioritized the Greybull River Drainage to identify and implement restoration projects to improve fish passage opportunities for Yellowstone cutthroat trout (YCT) and other native fish. To date, nearly $1.5 million has been invested in the drainage to reestablish historic migratory corridors.

TU's approach in the Greybull River to implement large scale reconnect projects requires active participation from landowners, water users and agency staff. Creative solutions for resource needs are developed based on stakeholder interests and active participation from partners is solicited to achieve better results. This strategy and the willingness of numerous project partners has made nearly 200 miles of historical habitat accessible for YCT and other native fish in the Greybull and its tributaries.

This presentation will primarily focus on the implementation and completion of a new fish ladder on the Upper Sunshine Diversion operated by the Greybull Valley Irrigation District (GVID). This project required active participation and investment from state/fed agency staff, landowners, GVID board members, the Wyoming Water Development Commission, the Wyoming Wildlife and Natural Resource Trust board and numerous other partners. A discussion about the inception, process, fundraising and outcomes will include photos, lessons learned and tips on how to keep similar projects moving forward.

Other projects in the drainage will be briefly discussed to provide background for the project and highlight the partnerships that have made YCT habitat improvements to the Greybull River possible.

The Hoback River: A tale of fisheries management.

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The Hoback River is a free-flowing tributary to the Snake River in northwest Wyoming. The native fish community in the Hoback River is largely intact, with the exception of a few isolated populations of introduced salmonids. Snake River Cutthroat Trout *Oncorhynchus clarki clarki* and Mountain Whitefish *Prosopium williamsoni* are the only native game fish and comprise the majority of the fish assemblage. Fish stocking was prominent in the Hoback River for most of the 20th century. Stocking practices during the majority of the 1980's and 90's involved stocking large numbers of catchable cutthroat to improve angling quality in the lower reaches of the river, an area presumed to lack suitable recruitment and over-winter survival. Due to changes in angler "catch and release" ethics and an increased knowledge of overwinter survival, stocking was slowly phased out beginning in the late 90's and was eliminated completely in 2005. Since the elimination of stocking, wild Snake River Cutthroat Trout numbers have increased and angler catch rates have remained high. This story highlights fisheries management changes in river systems as a result of nationwide trends of management, decreased consumptive angling, and increased knowledge of fish survival.

Contributions of Robert J. Behnke to salmonid biology and conservation

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This presentation details the life and accomplishments of Dr. Robert J. Behnke, who passed away in September 2013. At an early age Doc Behnke was an avid angler and keen observer of the natural world, detailing his findings in his personal journal "Piscatorial". Doc earned three university degrees, culminating in the Ph.D. at University of California, Berkeley. He traveled extensively to study fishes in North America as well as distant lands including Iran, Japan, Mongolia, Siberia, and several European countries. Professional contributions were to the literature on taxonomy and systematics of trout and salmon across the globe, sorted out in the early part of his career. Later, he promoted conservation of coldwater fishes and their habitat, especially those in arid regions, and communicated that message to professional and lay audiences alike. One wonders what might be left of our rich native salmonid heritage in North America if Bob Behnke had not studied and appreciated them. Doc was a mentor, colleague, friend, and polymath, who influenced and enriched the many he knew in life. His scholarship and philosophy lives through teachings and writings, and his spirit through many shared memories.