38TH ANNUAL RESEARCHERS MEETING

Upper Colorado River Endangered Fish Recovery Program

&

San Juan River Basin Recovery Implementation Program

JANUARY 10-11, 2017

Upper Colorado River

Endangered Fish Recovery Program

Doubletree by Hilton
743 Horizon Drive
Grand Junction, CO, 81506

San Juan River Basin

Recovery Implementation Program

Registration is Monday Evening 4-6 pm

Day 1, Tuesday January 10, 2017

Time	Presenter	Title
		Moderator: Tom Czapla
8:00	Chart/Whitmore	Welcome
8:05	Mohrman	Average Year, Average Graphs: Hydrologic Summary for 2016.
8:20	Minear	Deployment and Testing of In-situ and Mobile Hydrophones for Coarse Bedload Sediment Mobilization Studies on the Gunnison River, Colorado, Spring Release 2014 and 2016.
8:40	Day	Contaminants and Native Fish Conservation in the Upper Colorado Basin: The forgotten stressors, mercury and selenium.
9:00	Speas	Management of floodplain wetlands for endangered fish recovery in the middle Green River, Utah.
9:20	**Break**	
		Moderator: Kevin McAbee
9:40	Logan	Northern pike management in the Upper Colorado River Basin: 2016 update.
10:00	Bestgen	River regulation affects reproduction, early growth, and suppression strategies for invasive smallmouth bass in the Upper Colorado River Basin.
10:20	Jones	Smallmouth bass removal in the Upper Colorado River Basin: evolution of our strategy, summary of 2016 data, and recommendations from 2016 reports.
10:40	Michaud	Walleye Management on the Green and Colorado Rivers.
11:00	**Break**	
11:20	Stricker	Natal origins of nonnative walleye in the Upper Colorado River basin.
11:40	Vanderkooi	Rainbow Trout abundance, distribution, and movement in Glen and Grand Canyons, AZ.
12:00	**Lunch**	
		Moderator: Dale Ryden
1:20	Trammell	Short and Long Term Risk Reduction for Green Sunfish *Lepomis cyanellus* in Lees Ferry Reach of the Colorado River in Glen Canyon National Recreation Area.
1:40	Brandenberg	Early life history investigations from the San Juan and Colorado river inflows to Lake Powell, 2011, 2012, 2014, 2015.
2:00	Keggerries	Razorback Sucker *Xyrauchen texanus* in Lake Mead and Lake Powell Inflows.
2:20	Van Haverbeke	Monitoring and translocations of humpback chub (*Gila cypha*) in Grand Canyon, Arizona.
2:40	**Break**	

Day 1, Continued

Moderator: Krissy Wilson

3:00	Zeigler	Age-0 Colorado Pikeminnow Captures in the San Juan River – 2016.
3:20	Elverude	Status of Colorado Pikeminnow in the Colorado River.
3:40	Zelasko	Population dynamics of razorback sucker *Xyrauchen texanus* in the Green River basin, Utah and Colorado, 2011–2013.
4:00	Ahrens	Monitoring of razorback sucker reproduction and recruitment in Utah's lower Green and Colorado rivers.
4:20	**Adjourn for Social**	

Day 2, Wednesday 11, 2017

Moderator: Melissa Trammell

8:20	Bestgen	First reproduction by stocked Bonytail Gila elegans in the upper Colorado River basin.
8:40	Bestgen	Response of the native fish community of the Yampa River to nonnative fish removal and flows.
9:00	Kluender	Hybridization among native and nonnative catostomids in the Green River in Colorado and Utah, 2002 – 2016.
9:20	Bohn	Genetic evaluation of Upper Basin Colorado River *Gila cypha* with comparisons to *G. robusta* and *G. elegans.*
9:40	**Break**	

Moderator: Dave Speas

10:00	Seal	The Larval Fish Laboratory Fish Collection: A 2017 Update.
10:20	Deng	Acoustic telemetry development for fish passage.
11:00	Stahli	STREAMSYSTEM.ORG – an update on the online pit-tag database.
11:20	Stout	PIT tag movement in the absence of fish: Preliminary results from a mobile PIT tag antenna study.
11:40	Stahli	The value of pit-tag and stationary antenna data from the Green River Canal, 2013–2016.
12:00	**Adjourn**	

Abstracts

Hydrology & Physical Habitat

Average Year, Average Graphs: Hydrologic Summary for 2016.

Jana Mohrman, Hydrologist, U.S. Fish and Wildlife Service

A review of the 2016 hydrology will be presented. A summary of how a range of fish flow targets were met will be presented. Accomplishments in instream flow protection will be summarized.

Deployment and Testing of In-situ and Mobile Hydrophones for Coarse Bedload Sediment Mobilization Studies on the Gunnison River, Colorado, Spring Release 2014 and 2016.

J. Toby Minear[1] and Matt Marineau[2]

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Traditional methods for measuring coarse bedload sediment transport by discrete physical sampling tend to be slow, labor intensive and expensive. As such, bedload samples often are collected too infrequently to capture the temporal and spatial variability inherent in bedload transport. For river restoration programs, having accurate estimates of where and when bedload transport is occurring are key components for determining successful restoration strategies.

To help support river restoration and sediment mobilization studies, we have developed two hydrophone systems that measure in-water sediment-generated noise (SGN) when sediment transport is occurring: the first system is an in-situ hydrophone instrument that is stationary and can be deployed at a single site (e.g. a riffle or glide) with temporally-dense measurements (>1 sample / hour) and long remote deployment times (>1 month); the second system is a mobile hydrophone mounted on a boat for performing long-profile large spatial surveys (up to 20 river miles / day). Both of these systems rely on a Fast Fourier Transform (FFT) of the hydrophone sound files, which are then averaged over frequencies that have previously been found to be dominated by coarse sediment transport (0.6 – 3.7 khz). In addition, on the mobile hydrophone, an acoustic Doppler current profiler (ADCP) coupled to a survey-grade GNSS receiver was used to collect synoptic water-surface elevations, water depths, and water velocity profiles.

A 12-mile section of the lower Gunnison River, between Delta and Whitewater, CO, was selected for testing the hydrophones, partially because it contains Endangered Razorback Sucker habitat, but also because there were several past bedload calculation studies performed here for comparison. Deployments of the in-situ and mobile hydrophones occurred over the spring release in June – July, 2014, and mobile hydrophone only during June 2016.

The results of the testing in 2014 and 2016 indicate that sediment transport occurs over a much wider range of discharges than calculations would suggest, with important implications for riverine habitat and river change over time. For example, nearly all the riffles in the reach mobilized at flows at the far lower end of the calculations, whereas pools only began transporting at much higher flows. In addition, riffle transport slowed substantially compared to pools at the higher discharges, suggesting deposition and construction on the riffles, which is often an important management objective. In the receding tail of the peak hydrograph, many riffles were still transporting sediment at 1/5 of the calculated flow required for mobilization.

In conclusion, hydrophones are an excellent newly-developed tool for river restoration programs given their inexpensive cost and ability to provide managers and scientists with highly-relevant and dense temporal and spatial bedload transport data.

Contaminants and Native Fish Conservation in the Upper Colorado Basin: The forgotten stressors, mercury and selenium.

Day, Natalie[2], Travis Schmidt[1], James Roberts[1], James Willacker[3], David Walters[1], Craig Stricker[4] and Collin Eagles-Smith[5]

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

Management of floodplain wetlands for endangered fish recovery in the middle Green River, Utah.

Dave Speas[1], Tildon Jones[2], and Matt Breen[3]

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[3] Utah Division of Wildlife Resources, Northeast Regional Office, Vernal UT

Spring peak releases from Flaming Gorge Dam in northeastern Utah are timed with emergence of razorback sucker *Xyrauchen texanus* larvae in the middle Green River. When combined with flows from the Yampa River, these peak releases provide larvae access to floodplain wetlands where they experience excellent potential for growth and survival. 2016 was the fifth consecutive year of implementation of these “larval triggered” flows, which have resulted in mean production of 886 (range 97 – 2105) wild-spawned young-of-year razorback sucker per year from Stewart Lake, a managed wetland near Jensen, Utah. Such production from a naturalized setting in the Green River is significant, and the Stewart Lake experience has afforded researchers and managers insight into basic requirements for successful rearing of entrained razorback sucker larvae in floodplain wetlands. These requirements include the ability to control wetland water levels prior to, during and after the entrainment period, the ability to exclude non-native fish from rearing habitats, and the ability to harvest or provide access to the river for young-of-year fish. Opportunities are being explored to apply such measures to additional floodplain wetlands with the hope of increasing abundance of wild-spawned razorback sucker (and perhaps bonytail) in the middle Green River.

Northern Pike, Smallmouth Bass & Walleye

Northern pike management in the Upper Colorado River Basin: 2016 update.

Jenn Logan[1], Ben Felt[2], Lori Martin[2], Cory Noble[3], Bill Atkinson[4], Kevin Bestgen[5], John Hawkins[5], Ed Kluender[5], Donald Tuttle[5], Cameron Walford[5], Koreen Zelasko[5], Travis Francis[6], Tildon Jones[7], Chris Smith[7], Matt Breen[8], Bob Schelly[8], Richard Staffeldt[8]

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Control and management of non-native Northern Pike has occurred in the Upper Colorado River Basin (UCRB) since 2003. Northern Pike pose a predatory threat to native fish populations and compete for resources with Colorado Pikeminnow. Current Northern Pike control strategies include mechanical removal utilizing boat electrofishing, fyke netting and gill netting. In addition, the use of fish screens or barrier nets, incentivized public fishing tournaments and habitat manipulations have been implemented to prevent escapement from reservoirs, reduce populations and disrupt Northern Pike spawning habitat.

Numbers of Northern Pike removed from the Colorado River and the Green River are relatively unchanged with mainstem captures remaining low. For the Colorado River, efforts to prevent escapement and to address populations in-off channel reservoirs and seasonally connected ponds is considered a high priority. Sampling of off-channel reservoirs expanded during the 2016 field season. Overall, captures of Northern Pike in the mainstem Green River remain relatively low with most captures occurring in tributaries or backwater habitats. Efforts in 2016 also attempted to identify Northern Pike spawning areas in Brown's Park, a reach where juvenile Northern Pike have been detected frequently since 2005.

The Yampa River has the highest density of Northern Pike in the UCRB, likely due to abundance of preferred habitat and presence of source populations in off-channel reservoirs and ponds. The catch rates and numbers of Northern Pike removed from the Yampa have decreased since 2015. This decrease however, can be attributed to young of the year Northern Pike captured during the 2015 "surge" efforts rather than a true decline in fish densities. Gill netting focused on backwater and slackwater habitats in the Yampa River began in 2014 and continues to show potential as an efficient method of capture of Northern Pike adults, particularly before and during the onset of spawning. Due to a collaborative effort by the Recovery Program and partners, a barrier net to prevent fish escapement from Elkhead Reservoir was also put into operation in 2016. Beyond Recovery Program funded projects, Northern Pike removal efforts in the Yampa River basin continued in upstream reservoirs. A public fishing tournament also contributed to removal of adult Northern Pike from Elkhead Reservoir. Reducing available Northern Pike spawning habitat by blocking access or eliminating backwaters and side channels continues to be a priority in the upper Yampa River.

Northern pike management in the UCRB for 2017 is expected to continue with similar electrofishing efforts as 2016. Expansion of backwater gill netting as an additional removal method will continue. Program partners will continue collaboration and opportunities for additional management activities such as preventing non-native fish escapement from reservoirs and ponds, hosting incentivized public fishing tournaments and completing habitat manipulations.

River regulation affects reproduction, early growth, and suppression strategies for invasive smallmouth bass in the Upper Colorado River Basin.

Bestgen, K. R. and A. A. Hill

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Understanding the reproductive ecology of organisms enables predicting effects of environmental factors to control population growth. Otolith microstructure was used to estimate hatching dates and growth of invasive smallmouth bass *Micropterus dolomieu* collected in regulated or partially regulated reaches of the Green River, and the free-flowing Yampa River, Colorado and Utah, 2003-2015. Smallmouth bass hatching in the unregulated Yampa River was initiated in June through mid-July consistent with a 16°C water temperature threshold over a range of flow levels. In dam-regulated and partially regulated Green River reaches, spawning occurred only after habitat was available and was several to many days after the 16°C threshold, so bass reproduction was controlled by water temperatures and flow level. In all reaches, bass hatched later in cooler and higher flow years and earlier in warmer and lower flow years. Total length of Age-0 smallmouth bass in mid-September was positively influenced by length of growing season as well as water temperature and indicated flow reductions from water storage or climate change would increase bass growth and negative effects on native fishes. Management actions such as abrupt flow increases (managed floods), reduced water temperatures, increased sediment load, or physical disturbances directed at disrupting spawning smallmouth bass may reduce reproductive success but need to consider effects on other native and nonnative fishes as well as water availability tradeoffs. Effects of a 2015 flow spike in the Yampa River from a summer rainstorm demonstrates the potential benefits of flow management at Flaming Gorge Dam to reduce reproductive success of smallmouth bass in the Green River. Increased use of flow and water temperature regimes from dams to reduce negative effects of nonnative fishes, and to increase growth and survival of native kinds, is discussed as a viable use of reservoir

water storage and may offer management agencies another tool to achieve a more naturally functioning river ecosystem and enhance recovery of native biota.

Smallmouth bass removal in the Upper Colorado River Basin: evolution of our strategy, summary of 2016 data, and recommendations from 2016 reports.

Tildon Jones[1], Chris Smith[1], Jenn Logan[2], Cory Noble[2], John Hawkins[3], Cameron Walford[3], Ed Kluender[3], Matt Breen[4], Katie Creighton[4], Julie Howard[4], Bob Schelly[4], Randy Staffeldt[4], and Travis Francis[5].

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A major component of the Upper Colorado River Endangered Fish Recovery Program is the reduction of threats posed by nonnative fishes to endangered, native fish species. Since the mid-2000s smallmouth bass (*Micropterus dolomieu*) have expanded their range in the basin, and the Program has adapted its removal projects as the scope of this emerging threat became better understood. We will present a summary of the evolution of this removal program and the research that led to these changes. In 2016 the Program, through its cooperating partners, conducted smallmouth bass removal projects in nearly 400 miles of the Colorado, Green, White, and Yampa Rivers. This presentation will summarize the results from all smallmouth bass removal projects conducted in 2016 and will relate recommendations from principal investigator calls held in December 2016. A common trend across reaches was the apparent decline in numbers of fish spawned during the drought years of 2012 and 2013. We also present data related to successful spawning in key areas in 2016.

Walleye Management on the Green and Colorado Rivers.

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Walleye (*Sander vitreus*) are a large-bodied predatory fish native to portions of the United States and Canada east of the continental divide. This popular sport-fish was introduced to waters far outside its native range beginning in the late 1800s. By the mid 1960s walleye populations were established in several reservoirs within the Colorado River Basin, however,

they were rarely encountered in the rivers themselves. This changed in 2007 when a rapid increase in walleye encounters within the lotic habitats of the Upper Colorado River Basin began. Between 1992 and 2006 annual basin-wide walleye captures averaged 16 per year, between 2007 and 2016 this average had increased to 302 fish per year. Encounters peaked in 2013 with 721 fish and have gradual declined over the past 3 years. The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) considers walleye a threat to the continued existence of four endangered fish species in the Upper Basin. The U.S. Fish and Wildlife Service and the Utah Division of Wildlife Resources began a targeted walleye control effort in 2014 on two sub-reaches of the Green River and one on the Colorado River. During the 2016 field season targeted walleye removal efforts were focused on habitats frequently occupied by walleye and timed during spring (123b) or spring and fall (123a, 126a) when capture efficiency is at its highest. Walleye were also removed as ancillary captures during projects 128 and 110. A total of 345 walleye were encountered and removed in 2016 within the Upper Colorado River Basin. In addition to mechanical removal, headway was made in the establishment of permanent infrastructure intended to contain source populations within the reservoirs they inhabit, the replacement of fertile walleye with triploid conspicifics in these reservoir populations and the promotion of angler harvest of walleye in reservoirs containing these source populations.

Natal origins of nonnative walleye in the Upper Colorado River basin.

Craig Stricker[1], Mike Pribil[2], Travis Francis[3], and Kevin McAbee[4]

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Nonnative fishes are considered a primary threat to the recovery of Colorado River large bodied endangered fishes. In-river removal efforts have been challenging and unlikely to be successful unless in-river reproduction and immigration into riverine habitat is halted. For the latter, otolith microchemistry is a widely used tool that can reveal natal origins, migratory patterns, and even habitat use. The strontium isotope composition of otolith material can be particularly useful because it provides a conservative tracer of the geology through which aquatic systems transit. The Upper Colorado River basin is composed of rocks that span a broad range in geologic ages, where older rocks are more radiogenic and therefore enriched in ^{87}Sr. We expand previous work on the natal origins of nonnative walleye collected in the Upper Colorado River Basin, specifically filling in knowledge gaps related to recent expansion in the lower Green and Colorado rivers, as well as a more detailed investigation of Lake Powell walleye. We prepared and measured the strontium isotopic composition of otoliths (lower Green = 24, lower Colorado = 30, Lake Powell = 29), focusing on just outside of the primordia (core) and on the most recent growth band (edge) by laser ablation-multicollector ICP-MS. Our goals were to i) re-evaluate endmember strontium isotope compositions for the lower Green, lower Colorado, and Lake Powell, ii) evaluate residency within these regions of the lower basin, and iii) assess potential source populations contributing walleye to these areas. The median $^{87/86}Sr$ endmember value for Lake Powell walleye otoliths was 0.71004, within error of the previous estimate based on smallmouth bass. However, the median $^{87/86}Sr$ value for the Colorado River was 0.70994, far less radiogenic than the previous estimate and more congruent with the range of aqueous $^{87/86}Sr$ compositions near Moab, UT (0.70963 – 0.70997). Isotopic analyses of lower Green River walleye otoliths are still pending. However, assuming a variance of +/-0.00012 (standard deviation for Lake Powell walleye otolith edge compositions), we found approximately 23% and 45% of fish collected in the lower Colorado River and Lake Powell were likely long-term residents, suggesting natural reproduction as in the latter and/or natal origins from waters with similar isotopic compositions. Additionally, otolith core compositions indicated that approximately 50% of the lower Colorado River and 66% of the Lake Powell fish analyzed reared in waters with similar $^{87/86}Sr$ compositions. Currently, the lack of endmember contrast within the lower basin precludes quantitative assessment of potential source populations. However, fish that were significantly higher (or lower) than the median Colorado River and Lake Powell endmembers likely sourced from other sub-basins and we anticipate that otolith data from the lower Green River will provide additional insight.

Lake Powell & Grand Canyon

Rainbow Trout abundance, distribution, and movement in Glen and Grand Canyons, AZ.

VanderKooi, Scott P.[1], Josh Korman[2], Michael D. Yard[1], and Charles B. Yackulic

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Nonnative Rainbow Trout (*Oncorhynchus mykiss*) were introduced to the Colorado River downstream from Glen Canyon Dam in 1964 shortly after the dam was completed. The objective of this and other nonnative fish introductions was to create recreational sport fisheries. Negative effects on native fish populations may have been unintentional, but now present real and serious threats to the continued persistence of some native fishes. In Grand Canyon, Rainbow Trout can compete with the endangered Humpback Chub (*Gila cypha*) for food and habitat and also predate on juveniles. We initiated a large-scale mark-recapture study to better understand the threat presented by a large Rainbow Trout population approximately 100 km upstream from the greatest concentration of Humpback Chub in Grand Canyon near the Little Colorado River confluence with the Colorado River. Objectives for this study included quantifying the abundance, distribution, and movement of Rainbow Trout between Glen Canyon Dam and a segment of the Colorado River just downstream of the Little Colorado River confluence. Since 2012, approximately 115,000 Rainbow Trout have been marked with passive integrated transponder (PIT) tags and released. About 16,000 marked fish have subsequently been recaptured. The distribution of Rainbow Trout from Glen Canyon Dam to the Little Colorado River is highly skewed with the greatest densities closest to the dam (> 10,000 fish per km) and lowest at the Little Colorado River confluence (< 1,000 fish per km). Abundance was highest in upstream reaches at the beginning of the study and has generally declined since. In contrast, abundance increased in downstream reaches over the first two years of study then dropped sharply coincident with similar declines observed in upstream reaches. The proportion of Rainbow Trout moving distances of 20 km or more downstream was very small, < 1%. Despite low rates of emigration, increases in Rainbow Trout abundance observed near the Little Colorado River can be explained by downstream dispersal from Marble Canyon, and the occasional episodic movement of age 0 trout from large recruitment events in Glen Canyon.

Short and Long Term Risk Reduction for Green Sunfish *Lepomis cyanellus* in Lees Ferry Reach of the Colorado River in Glen Canyon National Recreation Area.

Melissa Trammell[1], Ken Hyde[2], Mark Anderson[2], and David Ward[3]

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[3] US Geological Survey,Grand Canyon Monitoring and Research Center

In November 2015, Green Sunfish (*Lepomis cyanellus*) were eradicated from the Upper and Lower Sloughs adjacent to the Colorado River mainstem in Glen Canyon National Recreation Area (GCNRA) with rotenone in partnership with Arizona Game and Fish Department (AGFD) and U.S. Fish and Wildlife Service (FWS). The population found in 2015 and the subsequent work on its eradication resulted in foregoing a High Flow Event (HFE) from Glen Canyon Dam that would have normally occurred in November 2015. After two monitoring trips in June and July 2016 which captured no Green Sunfish (GSF), in August 2016 they were found to have reinvaded the sloughs. NPS developed a phased response involving mechanical removal, and a proposed experimental ammonia treatment in the isolated 1/3 acre Upper Slough; few GSF were captured in the Lower Slough in 2016. Repeated mechanical removal was not expected to eliminate the Green Sunfish but did reduce abundance by $^{2}/_{3}$ rds in 2015 and by about ¾ ths in 2016, before the experimental permit was approved. Previous work by Ward et al. (2013) demonstrated that ammonia can be an effective non-native fish control tool, but it is not yet registered as a piscicide. Fortunately, the Arizona Department of Environmental Quality approved the experimental use of ammonia for this research project. A successful treatment was conducted in late October, eliminating GSF in the upper slough, allowing the 2016 HFE to go forward in November 2016. To avoid the risks of establishing GSF downstream and the risk of foregoing another HFE in the future, we have committed to conducting NEPA compliance to evaluate a full range of alternatives for a long term risk reduction action to minimize the potential of GSF or other warm-water nonnative fish to establish populations in the Lees Ferry reach of GLCA. The compliance and implementation is planned for completion by October 2017.

Early life history investigations from the San Juan and Colorado river inflows to Lake Powell, 2011, 2012, 2014, 2015.

Brandenburg, W.H.[1], T.A. Francis[2], B.A. Hines[3], B.J. Schleicher[2], D.S. Elverud[2], S.P. Platania[1], D.W. Ryden[2], D.E. Snyder[4], K. R. Bestgen[4]

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A collaborative study, initiated in 2011 and involving multiple agencies and recovery programs, has been investigating Razorback Sucker *Xyrauchen texanus* use of the San Juan River and Colorado River inflow areas of Lake Powell. This study has provided information on Razorback Sucker reservoir populations, inter-basin movement, and reproduction by this species in the lentic environment. Larval fish collections from the inflow area have resulted in collection of larval Razorback Sucker as well as other species. In the San Juan River arm of Lake Powell, larval collections acquired at night beneath a suspended surface light with dip nets yielded 14,186 specimens. The 69 collections from this portion of the lake were comprised primarily of non-native lacustrine species. The only native specimen collected was a metalarval Razorback Sucker captured near lake mile (LM) 38.2. Light traps were used to collect larval fish in the Colorado River arm of Lake Powell (2014–2015). This technique produced 59,576 specimens and confirmed lentic spawning by Razorback Sucker. Larval Razorback Sucker had the second highest catch rate (2.9 fish per hour) in 2014 and forth highest in 2015 (1.9 fish per hour). Razorback Sucker catch varied between study years with highest abundance documented earlier in 2015 than in 2014. The youngest larval phases (protolarvae and flexion mesolarvae) of Razorback Sucker numerically dominated the catch in both survey years. Colorado River arm larval fish collections primarily contained non-native species including the first documented reproduction by Grass Carp *Ctenopharyngdon idella* in the Colorado River Basin. Larvae of this species (n=154) were collected near Castle Butte (LM 124) on 12–13 June 2015. Native catostomids and cyprinids, including *Gila* sp. were documented in both survey years. These results highlight the value of early life history investigations as a monitoring program. The 2016 larval fish collections, from both inflow areas, are being processed and data will be available in 2017.

Razorback Sucker *Xyrauchen texanus* in Lake Mead and Lake Powell Inflows.

Ron Kegerries, Brandon Albrecht, Harrison Mohn, Mark C. McKinstry, Ron Rogers, Travis Francis, Brian Hines, James Stolberg, Dale Ryden, Darek Elverud, Benjamin Schleicher, Brandon Gerig, Katherine Creighton, Brian Healy, and Brandon Senger

Endangered Razorback Sucker *Xyrauchen texanus* populations have been reduced throughout their historic range during the last century. Dramatic changes in habitat through dam construction, irrigation and other withdrawals, altered flow regimes, anthropogenic modifications, and the introduction of nonnative fishes have limited movements, survival, and recruitment. A majority of recovery program efforts have been directed toward riverine recovery since the disappearance of wild Razorback Sucker in the early 1990's. However, studies in Lake Mead since 1996, have documented wild spawning and natural recruitment near inflow areas. Recent telemetry efforts at the Colorado River inflow area also documented movement of sonic-tagged Razorback Suckers between Lake Mead and the Colorado River within the Grand Canyon. Additional larval and small-bodied fish sampling has confirmed reproduction within the Grand Canyon; however, in-river recruitment has not been documented. Similar Razorback Sucker investigations at the San Juan and Colorado rivers inflow areas of Lake Powell have also documented the presence of adult and larval Razorback Sucker in both areas. However, stocking programs in the Colorado and San Juan rivers complicates the documentation of recruitment, if it exists. Given the results from Lakes Mead and Powell, we propose that inflow areas provide important, and perhaps necessary, habitat for natural Razorback Sucker recruitment and reproduction under contemporary river and reservoir conditions. Thus, inflow areas, along with adjacent lacustrine and riverine habitats, may be important locations to focus Razorback Sucker conservation and recovery efforts.

Monitoring and translocations of humpback chub (*Gila cypha*) in Grand Canyon, Arizona.

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Since 2000, a series of two-pass, closed Chapman Petersen mark-recapture efforts using hoop nets have been conducted annually during the spring and in the fall in the Little Colorado River (LCR) to track the abundance of humpback chub. During spring 2016 the estimated abundance of humpback chub ≥150 mm in the lower 13.57 km of the LCR was 4,850 (SE = 376). Of these fish, it was estimated that 3,974 (SE = 314) were ≥200 mm. During fall 2016 the estimated abundance of humpback chub ≥150 mm in the lower 13.57 km of the LCR was 4,053 (SE = 232). Of these fish, it was estimated that 1,665 (SE = 132) were ≥200 mm. These numbers indicate that the spring spawning and fall abundances of adult humpback chub in the LCR have significantly declined in the past two years. The cause of this apparent decline is unknown, but may be related to a larger portion of the population residing in the nearby mainstem Colorado River than is typical.

In addition, to assist in recovery efforts and to meet conservation measures, since 2003 approximately 3,106 juvenile humpback chub have been harvested from the lower reaches of the LCR and translocated to: 1) above Chute Falls in the LCR, 2) Shinumo Creek, 3) Havasu Creek, and 4) the Southwest Native Aquatic Resource and Recovery Center (SNARRC). The humpback chub moved to SNARRC are meeting a conservation goal for a genetic refugium, and high growth and survival rates of humpback chub translocated within the Grand Canyon suggest that translocation can function as a useful conservation tool.

Finally, ongoing monitoring of humpback chub aggregations in the mainstem Colorado River in Grand Canyon have recently "discovered" a relatively large group of humpback chub (possibly several hundred individuals) residing in the river near 34.5 Mile, has documented augmentation of the Shinumo and Havasu creek aggregations, and have documented what appears to be a new and developing population of humpback chub in western Grand Canyon.

Endangerd Fish Population Dynamics & Status

Age-0 Colorado Pikeminnow Captures in the San Juan River – 2016.

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Small-bodied fishes monitoring in the San Juan River is designed to assess the densities of small-bodied native and nonnative fishes and the recruitment of large-bodied native fishes, in particular endangered Colorado Pikeminnow and Razorback Sucker. In 2016, 23 wild age-0 Colorado Pikeminnow were captured during small-bodied fishes monitoring, the first wild post-larval age-0 Colorado Pikeminnow to be captured in the San Juan River since the current monitoring protocol was initiated in 1998. Captures occurred in only the lower portion of the river (Geomorphic Reaches 2 – 4) and in zero or near-zero velocity habitats. High spring runoff (> 8,000 cfs) in 2016 was a likely cause of increased survival of larval to post-larval age-0 Colorado Pikeminnow in the San Juan River. Preliminary data on the captures will be presented and their implications discussed.

Status of Colorado Pikeminnow in the Colorado River.

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

Population dynamics of razorback sucker *Xyrauchen texanus* in the Green River basin, Utah and Colorado, 2011–2013.

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Population dynamics of Upper Colorado River Basin (UCRB) razorback sucker *Xyrauchen texanus* were unknown for many years because limited recapture data precluded a structured monitoring effort. However, increases in razorback sucker captures during Colorado pikeminnow *Ptychocheilus lucius* abundance estimate sampling from 2011–2013 prompted further investigation. We used multi-state, robust design models in Program MARK with Huggins' closed captures to estimate razorback sucker abundance, as well as survival, transition, capture, and recapture rates among three reaches and nearly 700 river km of the Green River basin: upstream middle Green River, intermediate Desolation-Gray canyons, and downstream lower Green River. Data from the White River, a tributary which flows into the Green River between upstream and intermediate reaches, was too sparse to produce useful parameter estimates but was related to patterns of population dynamics in other reaches. No razorback suckers were stocked and few were recaptured in the Yampa River, an upstream tributary to the Green River, so parameter estimates were not possible. Abundance for the entire three-reach study area was similar across years (mean: 25,019; range: 24,785–25,221 annually), but varied considerably within reaches. Estimated abundance was highest in middle Green (mean: 10,006; range: 6,199–14,658 annually) and lowest in lower Green (mean: 6,274; range: 2,854–9,132); however, equipment malfunction in 2013 resulted in fewer captures and the lower estimate in that reach. In Desolation-Gray canyons, mean estimated abundance was 8,739 (range: 6,927–11,750 annually); razorback suckers were only stocked there in 2006 and survival was estimated to be near zero in our previous analysis, but the reach is located between heavily stocked middle and lower Green River reaches. Abundance estimates for 2011–2013 were all higher and more precise (based on % coefficient of variation) than those from 2006–2008. Razorback sucker transition probabilities were estimated using only 34 reach changes but indicated most movement was upstream: Desolation-Gray canyons to middle Green (0.21, 95% CI: 0.04–0.64), Desolation-Gray canyons to White River (0.39, 95% CI: 0.05–0.90), White River to middle Green (0.26, 95% CI: 0.06–0.65), and lower Green to Desolation-Gray canyons (0.21, 95% CI: 0.08–0.43). Razorback sucker survival estimates varied by reach and were high but imprecise for upstream reaches (middle Green: 0.90, 95% profile likelihood confidence interval [CI]: 0.48–1.00; Desolation-Gray canyons: 0.88, 95% CI: 0.54–1.00). The survival rate estimate for lower Green was lower (0.37) and more precise (95% CI: 0.28–0.59). Although razorback sucker length at capture did not affect survival estimates in this analysis, we intend to investigate the effects of

time since stocking and length at stocking since those factors were important covariates in our previous analysis of stocked fish survival. Regardless, razorback sucker survival is assumed to be low overall, considering that approximately 175,000 fish have been stocked into the UCRB in the past 10 years but abundances are still relatively low. Furthermore, in the absence of stocking and recruitment, abundance would decline quickly under even optimistic survival rates. Low capture probabilities (0.02, on average, across reaches and years), primarily due to sampling efforts that did not specifically target razorback suckers, continued to hinder our ability to produce precise parameter estimates – a task imperative to evaluating success of recovery actions. However, capture probabilities and precision of razorback sucker abundance estimates improved from previous sampling periods. This study will improve understanding of razorback sucker population dynamics and aid managers in allocating monitoring and recovery resources.

Monitoring of razorback sucker reproduction and recruitment in Utah's lower Green and Colorado rivers.

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Determining the location, timing, extent, and success of razorback sucker (*Xyrauchen texanus*) spawning is essential for evaluating the effectiveness of the stocking program, identifying recruitment, and guiding future management. Increased razorback sucker encounters, the presence of multiple age classes and congregations of ripe individuals prompted sampling for larval and juvenile razorback sucker presence and distribution via light traps and seining in off-channel habitats. First implemented in 2009 in the lower Green River from the town of Green River, Utah to the confluence with the Colorado River, the study expanded in 2014 to include the Colorado River from Moab, Utah to the confluence with the Green River after an increase in encounters of ripe adult razorback sucker and age-1 fish in 2012 and 2013. No age-0 razorback suckers were collected in 2015 or 2016. However, preliminary analyses of recently-processed 2015 larval collections show record-high numbers of razorback sucker in both reaches and demonstrate potential for valuable insights via habitat metrics as these data sets grow.

First reproduction by stocked Bonytail Gila elegans in the upper Colorado River basin.

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Bonytail *Gila elegans*, a large-bodied cyprinid endemic to the Colorado River basin of the American Southwest, was historically widespread and abundant in large warm water streams but is now critically endangered. To increase recovery prospects, over 500,000 Bonytail have been stocked in the upper Colorado River basin since 2000, but adult survival has been low and reproduction undetected. Here, we provide first documented evidence of successful reproduction by stocked Bonytail in the upper Colorado River basin. Adult Bonytail stocked in the Green River accessed Stewart Lake and Johnson Bottom, managed floodplain wetlands in the middle Green River, Utah, during high flows in May 2015 (only Stewart Lake) and 2016. Draining Stewart Lake in September 2015 revealed 19 age-0 *Gila* sp. (37 to 64 mm TL) among over 405,000 fish. Four preserved specimens (41–48 mm TL) were verified as *G. elegans* using morphological and molecular techniques. Otolith daily increment analysis confirmed reproduction by Bonytail in Stewart Lake. Bonytail reproduction was also noted in 2016 in Stewart Lake (probable) and Johnson Bottom. Young Bonytail survived in spite of abundant non-native fish predators. Use of floodplain wetlands for reproduction may enhance recovery of critically endangered Bonytail in the upper Colorado River basin.

Native Fish Population Dynamics & Status

Response of the native fish community of the Yampa River to nonnative fish removal and flows.

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Mechanical removal of several non-native fish predators has been implemented in several rivers of the Upper Colorado River Basin in an effort to restore once-abundant native fishes. From 2003-2016, we sampled small-bodied fishes in low-velocity habitat in treatment (piscivorous fish removal) and control (no removal) reaches with a variety of gears to assess whether predator removal benefited the native fish community in the Yampa River, Colorado. Through 2007, main channel fish communities were dominated by non-natives, particularly young-of-year (YOY) smallmouth bass. Native fishes were rare in main channel habitat, and were usually present only in isolated pools where smallmouth bass were uncommon. Although still relatively uncommon, higher frequencies of native fishes in main stem samples since 2008 were coincident with increased removal of YOY smallmouth bass, particularly in the treatment reach. Native fish abundance in main channel samples in the control and treatment reaches increased in 2008-2012 and was particularly high in 2011. Higher flows and relatively cool water prevailed in that period, especially in 2011, compared to earlier years. In the warmer and low flow year 2012-2016 native fish abundance declined from 2011 levels likely as a result of higher bass abundance and larger bass body size. Positive native fish response since 2008 was likely due to synergistic effects of smallmouth bass removal and return to a higher, more normal hydrologic regime, which delayed bass spawning, growth, and perhaps abundance of smallmouth bass in the Yampa River, Colorado.

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

Edward R. Kluender, Kevin R. Bestgen, Koreen A. Zelasko – Colorado State University Larval Fish Laboratory, Fort Collins, Colorado

Native catostomids are faced with a suite of threats in the Colorado River basin, particularly the encroachment of nonnative white suckers (*Catostomus commersonii*). White suckers hybridize with flannelmouth (*C. latipinnis*) and bluehead suckers (*C. discobolus*), and produce viable offspring. Introgressive hybridization is especially extensive between white and flannelmouth suckers, resulting in degradation of flannelmouth sucker genetic purity where the species are sympatric. We have sampled the fish community of the Green River in Brown's Park National Wildlife Refuge and Dinosaur National Monument since 2002 to document catostomid hybridization patterns. Analysis of catostomid abundance shows white sucker abundance is greatest in upstream reaches nearest Flaming Gorge Dam and declines downstream. Abundance of hybrids also declines in a downstream manner, indicating white sucker abundance may drive hybrid abundance. These trends follow an increasing temperature gradient, indicating Flaming Gorge Dam creates habitat and thermal conditions that favor presence of white suckers over native catostomids. White suckers and white x flannelmouth sucker hybrids are the dominant taxa in Brown's Park, and hybridization has resulted in localized extirpations of flannelmouth and bluehead suckers in other rivers in the Upper Colorado River Basin. A further complication is accurate field identification of hybrid suckers, which is particularly challenging considering the gradient of morphological characteristics caused by introgressive hybridization. Conservation of native catostomids should include white sucker control as a key part of management programs, and those programs should approach the intricacies of hybrid identification with rigor.

Genetic evaluation of Upper Basin Colorado River *Gila cypha* with comparisons to *G. robusta* and *G. elegans.*

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Conservation of the federally endangered humpback chub *Gila cypha* in the Upper Colorado River Basin (Upper Basin) has been hampered by challenges in distinguishing *G. cypha* from roundtail chub *G. robusta* and a history of hybridization with *G. robusta* and bonytail *G. elegans*. This report analyzed 377 *G. cypha* from Cataract Canyon, Black Rocks, Desolation/Gray Canyon, and Yampa Canyon in the Upper Basin and from the Little Colorado River in the Lower Basin. Included in the analysis were 172 *G. robusta*, 22 *G. elegans*, and 8 suspected hybrids. Samples were genotyped for 18 microsatellite loci and sequenced for a mitochondrial (mtDNA) locus. We found three discrete populations in *G. cypha*. Two were found in the Upper Basin: 1) Black Rocks and 2) Desolation/Gray and Cataract Canyons; one was found in the Lower Basin: Little Colorado River. The *G. cypha* sampled from Yampa Canyon were genetically identical to the *G. robusta* sampled from Yampa Canyon. Genetic diversity levels were slightly higher in the Upper Basin than the Lower Basin. Private alleles and haplotypes were found in all *G. cypha* populations. Two distinctly separate haplotype groups were found: *G. elegans* and *G.cypha/G. robusta*. *Gila cypha* and *G. robusta* shared the most common haplotypes, but each species had private haplotypes that diverged from the shared

haplotypes. Black Rocks had the most hybridization of *G. cypha* and *G. robusta*, and *G. cypha* diverged from *G. robusta* as distance from Black Rocks increased.

Collections, Technologies & Databases

The Larval Fish Laboratory Fish Collection: A 2017 Update.

Sean Seal, Larval Fish Laboratory, Colorado State University

The Larval Fish Laboratory (LFL) collection of fishes is one of the fastest growing and active collections in North America. Established in 1978 by Darrel Snyder and Dr. Clarence Carlson, the Larval Fish Laboratory has accomplished some amazing goals. Under the direction of three directors since inception, the collection has grown to over 138,000 lots, almost 4.3 million specimens, and 215 species (30 families, 83 genera), of which over 95% are from the Upper Colorado River Basin (UCRB). The LFL Collection also has specimens from three continents, five countries, and 26 states in the United States. Housed in the Department of Fish, Wildlife, and Conservation Biology at Colorado State University (CSU), the JVK Wagar building received a facelift in 2001 that required moving the collection within the building. The collection was moved again in 2009 when compactor shelving was installed to double our storage capacity and condense space needed for the growing collection. In the meantime, the LFL continues to seek more permanent housing with other CSU Natural History Collections to formalize a university museum. Specimens in the collection have been the basis for research defining flow needs of endangered fish such as razorback sucker (*Xyrauchen texanus*) and Colorado pikeminnow (*Ptychocheilus lucius*) as well as studies to inhibit reproduction by invasive smallmouth bass (*Micropterus dolomieu*). This collection-based work was possible because of support from the Upper Colorado River Endangered Fish Recovery Program and the U.S. Bureau of Reclamation. With future support, the LFL collection will continue as a repository of information available to guide fish and river management and conservation in the UCRB and will remain a valuable addition to North American ichthyology collections.

Acoustic telemetry development for fish passage.

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Acoustic telemetry has been identified as a technology to observe and assess the behavior and survival of various fishes. However, the size and/or nature of the existing transmitters limits their usefulness for studying certain fish types and sizes, introducing a potential bias to the study results. Therefore, we developed several tags, each with unique size and function. In 2014, we developed the first acoustic transmitter that can be implanted by injection instead of surgery. It is 15.00 mm in length and 3.35 mm in diameter, and weighs 216 mg in air. The tag can last > 100 days at a pulse rate interval of 3 s.

Little is known about the behavior and habitat use of small juvenile (< 1 year old) sturgeon. Their small size has precluded intensive research using telemetry techniques because the transmitters commercially available are too large, have too short of a lifetime, or have an inadequate ping rate. We developed a new acoustic transmitter for juvenile sturgeon. The sturgeon tag weighs approximately 700 mg in air, is 5.0 mm in diameter and 24.2 mm in length. Its source level can be up to 163 dB re 1 µPa compared to the 156 dB for the injectable tag. It has a tag life of 365 days at a source level of 161 dB and a PRI of 15 s.

We developed a self-powered acoustic transmitter (patent pending) that uses a flexible piezoelectric beam to harvest mechanical energy from the swimming motion of fish as the transmitter's power source. It is 5.3 mm wide and 1 mm thick. Piezoelectric beams of various lengths can be used in this transmitter. It was successfully demonstrated in a white sturgeon and rainbow trout in the laboratory. A field trial with juvenile white sturgeon will be conducted in the Snake and Columbia Rivers in 2017.

Knowledge of juvenile eel and lamprey behavior and survival are critical for developing mitigation strategies for dam passage, including design of bypass systems at hydroelectric facilities. In 2016, we completed the design of an acoustic micro-transmitter (patent pending) that can be used to study the behavior and survival of juvenile eel and lamprey. It is 2 mm in diameter and 12 mm in length. It weighs 0.08 g in air. The prototype tag lasts 20 to 30 days at 5-s ping rate interval. Implantation protocols were developed for juvenile pacific lamprey and American eel. We will conduct a pilot-scale field trial tagging juvenile eels and lampreys in collaboration with industry partners and other agencies in 2017.

STREAMSYSTEM.ORG – an update on the online pit-tag database.

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The Species Tagging, Research and Monitoring System (STReaMS) is an online database of all stocking, capture, and detection data occurring in the Upper Colorado and San Juan River basins. The database has grown in both complexity and amount of data over the past year and is available for program partners to use with certain caveats. STReaMS currently holds 1.3 million encounters from almost 969,000 fish between 1979 and 2016. We will do a live demo of the database, review the types of information available, give examples of what the data can be used for, and examine potential data errors users may encounter.

PIT tag movement in the absence of fish: Preliminary results from a mobile PIT tag antenna study.

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We report on preliminary results of a two year project at its midpoint and how those results have already substantially changed our perspective on potential PIT tag movement in river systems. Accurate estimates of organism's vital rates are essential for tracking and understanding the successful recovery of endangered species. Passive Integrated Transponder (PIT) tags to allow researchers to track movement and estimate vital rates of fishes. Mobile PIT tag antenna systems (e.g., on a floating raft) have recently been developed to increase resight rates in order to provide robust estimates of survival and population trend, and to identify influential management actions. Although promising, mobile systems present new challenges to estimation techniques. Tags, not fish, are detected thus increasing the chance that shed tags or dead fish with tags are being detected, which can lead to dramatic over-estimation of survival. With the number of PIT tags being used constantly increasing, the detection of more and more dead/shed tags is a given. Classification of tags as live or dead is essential and a preliminary rule set was developed. In order to test our assumptions about dead tag movement, we distributed 2,500 PIT tags in the San Juan River track their movement with mobile antenna systems. Over the course of five sampling trips, tag locations were used to determine the distance and direction of tag movement. The movement of known dead PIT tags in the river was more variable than expected with distances up to 4,000 meters. The addition of known live tags will also inform our rules, as will continued sampling in 2017, both of which will document additional movement due to spring runoff and spawning runs. We will use the additional movement information along with already collected data to refine rules and a procedure to classify tags as live or dead.

The value of pit-tag and stationary antenna data from the Green River Canal, 2013–2016.

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Entrainment in unscreened irrigation canals is believed to be a substantial source of mortality for endangered fishes in the Upper Colorado basin. The Green River Canal (GRC, near Green River, Utah) is an unscreened canal at the end of a large raceway that diverts water for the canal (~80 cfs) and a hydropower plant (~635 cfs); the canal is currently unscreened because screening the entire raceway is cost prohibitive and physically challenging. We evaluate entrainment of native fish (PIT-tagged non-listed and endangered individuals) in the GRC using passive interrogation arrays (PIA) installed near the headgate of the canal and downstream past a

subsequent underground siphon. Each installation is comprised of two antennas each; the four antennas installed in a closed system allow for assessment of antenna effectiveness which confirms the need for paired antennas and multiple pairs to assess direction.

In 2016, 243 individual fish were detected in the GRC during the irrigation season (March – November), which represents the lowest total since antennas were installed in 2013. Of these, 151 were identified through Species Tagging, Research and Monitoring System (STReaMS; streamsystem.org) and were comprised of 126 razorback sucker, 7 bonytail, 15 Colorado pikeminnow, 2 humpback chub, and 1 flannelmouth/razorback hybrid. Additional records in STReaMS show subsequent captures and detections throughout the Upper Colorado basin which can lead to assumptions about survival vs. permanent entrainment in the canal. These data also show interesting long-term patterns including site/season fidelity in some razorback suckers, overwinter survival of bonytail, movement of humpback chubs post-sampling and long range movement of Colorado pikeminnow.