Desert Fishes Council 56th Annual Symposium, 2024
Grand Junction, CO, USA

LONG PROGRAM

Artwork by Lindsey Elkins

THANKS TO LOCAL HOSTS & MEETING ORGANIZERS MELISSA TRAMMELL, DAVE SPEAS, & JENN LOGAN!

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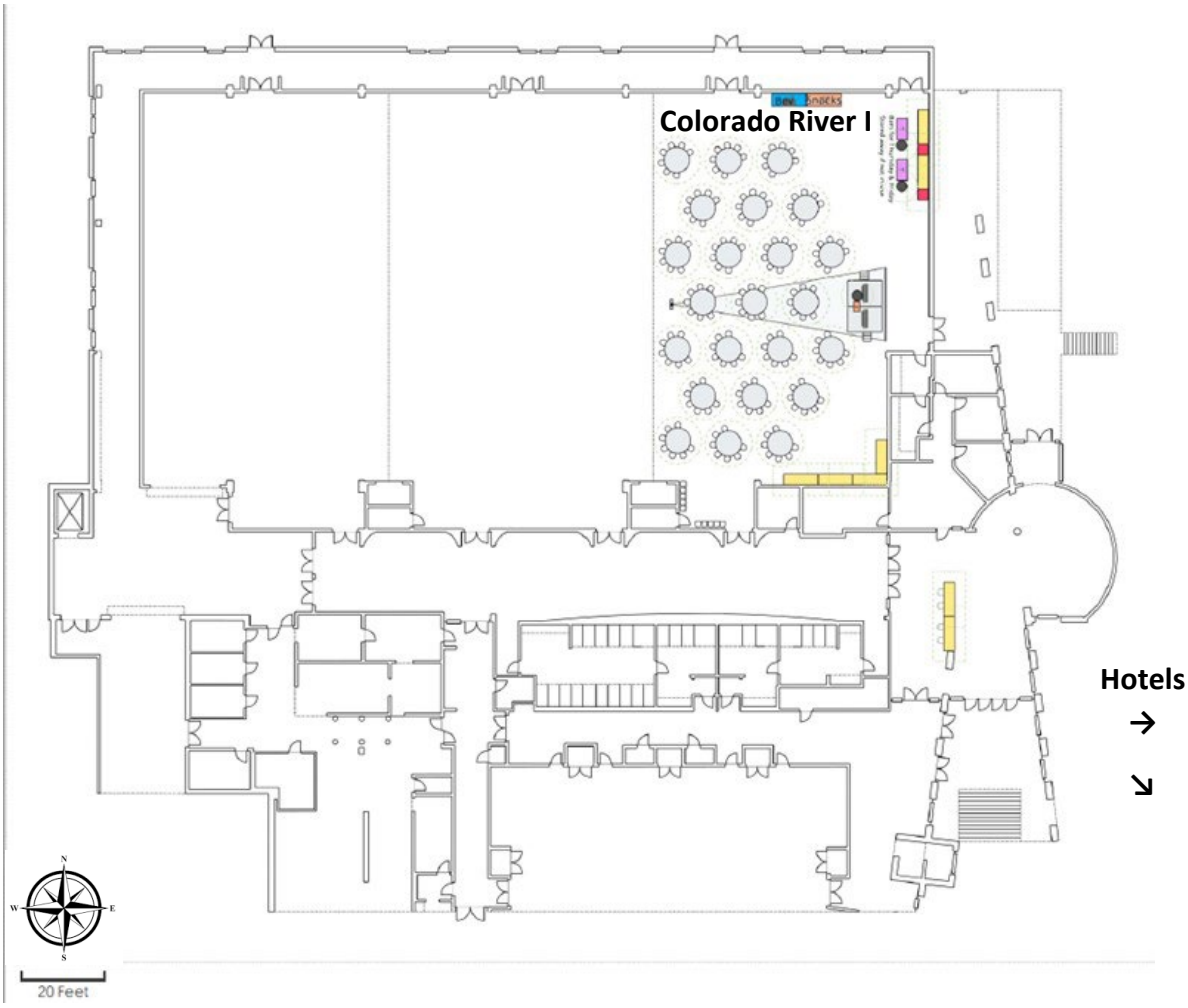
Grand Junction Convention Center layout: all DFC events will be held in Colorado River I (upper right).



Parking:

- **Free underground**
- **Free outside on south side**

WEDNESDAY NOVEMBER 20 – GRAND JUNCTION CONVENTION CENTER LOBBY

16:00-18:00: Registration

THURSDAY NOVEMBER 21 – GRAND JUNCTION CONVENTION CENTER COLORADO RIVER I

07:45-08:15: **Registration in the Lobby & coffee in Colorado I**

Opening formalities

08:15-08:30: Welcome – **Michael Schwemm**, President; **Melissa Trammell, Dave Speas and Jenn Logan**, Local Hosts

*Special Session – **Dave Speas**, moderator*

08:30-08:45: Grand Rivers: Challenges and opportunities in native fish conservation in the Upper Colorado River basin (2024 Area Report) – **Dave Speas (U.S. Bureau of Reclamation)**

The Upper Colorado River Basin is the primary water source for millions of users in the Southwestern United States for municipal, industrial, agricultural, cultural, and recreational purposes as well as hydropower generation. The native fish fauna of the basin has long suffered the ill effects of river regulation and depletion, invasive species introductions, and most recently, climate change. Four species of fish—Humpback Chub *Gila cypha*, Razorback Sucker *Xyrauchen texanus*, Colorado Pikeminnow *Ptychocheilus lucius* and Bonytail *G. elegans*—are currently protected under the Endangered Species Act, and Flannelmouth Sucker *Catostomus latipinnis*, Bluehead Sucker *C. discobolus* and Roundtail Chub *G. robusta* are the subject of conservation programs managed mostly by state fish and wildlife agencies as part of the "three species" conservation agreement. Endangered fish recovery programs in the Upper Colorado and San Juan rivers were established in 1988 and 1992, respectively, with the twin goals of endangered fish recovery while water development continues within the bounds of state and federal legal compacts and regulations. As the struggle to recover endangered fish and protect sensitive species continues, managers and scientists continue to seek out and implement innovative and novel approaches to recovery and conservation. To these ends, recent and noteworthy examples covered in this symposium/area report focus on the following topics: (1) Use of dam operations—long viewed as a primary source of jeopardy to native fauna—helps provide riverine-floodplain connection during periods of larval razorback sucker emergence and drift; (2) Understanding fish behavior in the presence of in-stream barriers and an emergent waterfall on the San Juan River helps identify passage alternatives; (3) Innovative fish screen design and materials provide endangered fish safe routes around canal intakes; (4) Finding a path to recovery for Bonytail through adaptive rearing and stocking approaches, including use of floodplain wetlands; (5) An alternative to mechanical removal of non-native fish using strategically timed dam releases to disadvantage invasive smallmouth bass; (6) Use of ancillary PIT detection data enhances active mark/recapture population estimates of endangered fish; (7) Hands-on endangered fish propagation comes to high school classrooms in Colorado and beyond, inspiring a generation of future fish biologists. While much of this work has been aimed at endangered fish recovery, it is expected that these efforts will benefit non-listed species as well and help preserve the ecological integrity of the river systems as a whole.

Email: dspeas@usbr.gov

08:45-09:00: Status and conservation of Upper Colorado River basin fishes – **Kevin Bestgen (Colorado State University), Koreen Zelasko**

The fish community of the Upper Colorado River Basin is depauperate, consisting of only 13 taxa. These include two salmonids, five cyprinids, four catostomids, and two cottids. Native taxa can be grouped into two assemblages, a warmwater group that occupies lower elevation warm water streams and large rivers, and another that occupies smaller and cool to cold streams at higher elevations. The eight taxa of the large river assemblage are mainly large-bodied and most are declining, with five listed under the Endangered Species Act: Colorado pikeminnow *Ptychocheilus lucius*; bonytail *Gila elegans*; humpback chub *G. cypha*; razorback sucker *Xyrauchen texanus*; and Kendall Warm Springs dace, a speckled dace subspecies *Rhinichthys osculus thermalis*. Three others, flannelmouth sucker *Catostomus latipinnis*, bluehead sucker *Pantosteus discobolus*, and roundtail chub *Gila robusta*, are listed by basin states as needing conservation; small-bodied speckled dace is widespread and abundant. Distribution and status of most fishes in upstream cool water reaches, where less sampling has occurred, is less well understood. Those species include speckled dace, mountain sucker *Pantosteus platyrhynchus*, mountain whitefish *Prosopium williamsoni*, mottled sculpin *Cottus bairdii*, and Paiute sculpin *C. beldingii*. Status of cold-water Colorado River cutthroat trout *Salmo clarki pleuriticus*, is well known and consists of several distinct genetic and morphological lineages arrayed across the upper Green, upper Colorado, and San Juan River basins; all are rare. Declining status of most basin taxa is from anthropomorphic affronts including habitat modification, especially in rivers where connectivity is disrupted by dams (large river fishes), introduction of diverse predaceous or competitive nonnatives (all taxa), and hybridization (suckers, trout), with additional overarching negative effects of climate change, ongoing drought, and attendant water consumption issues. Ongoing conservation programs of various non-governmental, state, and federal organizations are bolstering the status of many of these species.

Email: Kevin.Bestgen@colostate.edu

09:00-09:15: Increasing native fish survival with a fish-friendly canal screen: an Upper Colorado River basin success story – **Cat Adams (Colorado State University), Kevin Bestgen, David Speas, Mark McKinstry**

Water diversions entrain substantial numbers of fish globally and are especially concerning when the species involved are rare and endangered. In the Upper Colorado River Basin, the Green River Canal (GRC) near Green River, UT, diverts up to 80 cfs of water from the Green River in summer for irrigation, but is dried over winter so entrained fish perish. Salvage operations to remove entrained fish before drying and data from stationary Passive Integrated Transponder (PIT) tag antenna arrays between 2013–2018 confirmed entrainment of hundreds of native fish per year into the GRC, including endangered Colorado Pikeminnow *Ptychocheilus lucius*, Humpback Chub *Gila cypha*, Bonytail *Gila elegans*, and Razorback Sucker *Xyrauchen texanus*. In 2019, an innovative weir and screen structure was installed at the GRC entrance, which shunts fish back to the river while also supplying required irrigation water to the canal. Based on canal PIT tag antenna detections, tagged-fish entrainment at GRC was reduced by >99% during 2019–2023 from previous levels. While entrainment concerns were largely alleviated, survival and condition of fish after passing through the return channel, bypass channel, and over the screen was unknown because swift, turbulent flows may cause mortality or physical damage. To test this, we released 867 hatchery-reared Razorback Sucker (194–450 mm TL) and Bonytail (245–336 mm TL) between 2022–2024 to assess their survival and condition before and after passage through the bypass channel and over the screen. Survival of fish recovered after passage was 100% and injuries were negligible. An added

benefit of the weir and screen is reduced debris and sediment in the canal downstream of the facility. Based on low entrainment, mortality, injury rates, and the ability to provide needed irrigation water, the innovative fish-friendly weir and screen at GRC is a success story for water users, managers, and native fishes in the Upper Colorado River Basin. This process also highlights the continued need for rigorous evaluation of actions aimed at fish recovery so scarce resources are used to maximum effect.

Email: cat.adams@colostate.edu

09:15-09:30: If you build it, will they pass? A systematic evaluation of fish passage efficiency for three large-bodied warm-water fishes – **Kayla Kelley* (Oregon State University), Eliza Gilbert, Casey Pennock, Mark McKinstry, Peter Mackinnon, Scott Durst, Nathan Franssen**

Fish passages are constructed to facilitate movement around barriers, but few are quantitatively evaluated for non-salmonids. We quantified the efficiency of a selective, nature-like fish passage for three native fishes, Colorado pikeminnow (*Ptychocheilus lucius*), flannelmouth sucker (*Catostomus latipinnis*), and razorback sucker (*Xyrauchen texanus*), in the San Juan River, NM, USA, by estimating the probabilities of completing three navigational phases and associated delay times. We compared passage efficiency in years when fish were captured in a trap and manually moved upstream to years when the trap was removed in the spring. All species were less efficient at navigating the attraction and exit phases compared with the ascent phase. Operating the passage without the trap generally increased passage success and shortened delay times. The mean probability of passage and delay time among species when the trap was removed ranged from 34%–55% and 5–21 days, respectively. Our results suggest species- and phase-specific variation in passage efficiency and highlight the need for evaluations to aid future passage design and operation for a greater diversity of fish.

Email: kayla.kelley@oregonstate.edu

***** *This presentation is under consideration for the Carl L. Hubbs Award* ↑

09:30-09:45: Translocation in a fragmented river provides demographic benefits for imperiled fishes – **Casey Pennock (The Ohio State University), Brian Healy, Matthew Bogaard, Mark McKinstry, Keith Gido, Nate Cathcart, Brian Hines**

Fragmentation isolates individuals and restricts access to valuable habitat with severe consequences for populations, such as reduced gene flow, disruption of recolonization dynamics, reduced resiliency to disturbance, and changes in aquatic community structure. Translocations to mitigate the effects of fragmentation and habitat loss are common, but few are rigorously evaluated, particularly for fishes. Over six years, we translocated 1,215 individuals of four species of imperiled fish isolated below a barrier that restricts access to upstream habitat. We used re-encounter data (both passive integrated transponder tag and telemetry detections and physical re-captures) collected between 2016 and 2023, to inform a spatially-explicit multistate mark-recapture model that estimated survival and transition probabilities of translocated and non-translocated individuals, both below and above the barrier. Individuals of all four species moved large (>200 km) distances upstream following translocation with the maximum upstream encounter distance varying by species. Results from the multistate mark-recapture model suggested translocated fish survived at a higher rate compared to non-translocated fish below the barrier for three of the four species. Above the barrier, translocated individuals survived at similar rates as non-translocated fish for bluehead sucker (*Catostomus discobolus*) and flannelmouth sucker (*C. latipinnis*),

while survival rates of translocated endangered Colorado pikeminnow (*Ptychocheilus lucius*; mean, 95% CI: 0.75, 0.55-0.88) and endangered razorback sucker (*Xyrauchen texanus*; 0.86, 0.75-0.92) were higher relative to non-translocated individuals (Colorado pikeminnow: 0.52, 0.51-0.54; razorback sucker: 0.75, 0.74-0.75). Transition probabilities from above the barrier to below the barrier were generally low for three of the four species (all upper 95% CI ≤ 0.23), but were substantially higher for razorback sucker. Our results suggest translocation to mitigate fragmentation and habitat loss can have demographic benefits for large-river fish species by allowing movements necessary to complete their life history in heterogeneous riverscapes. Further, given the costs or delays in providing engineered fish passage structures or in achieving dam removal, we suggest translocations may provide an alternative conservation strategy in fragmented river systems.

Email: pennock.17@osu.edu

09:45-10:00: If you build it, can they get there? Managing flows & habitats to improve recruitment of wild Razorback Sucker, *Xyrauchen texanus* – **M. Tildon Jones (U.S. Fish & Wildlife Service), Kevin Bestgen, David Speas, Matthew Breen, Christian T. Smith, Robert Schelly, Michael Partlow, Saidee Hyder**

The Upper Colorado River Endangered Fish Recovery Program has been working since its inception in the 1980s to recover Razorback Sucker in the Colorado and Green river subbasins. One component of that work has been to restore floodplain wetland habitats and allow Razorback Sucker to access those sites during early life stages. In the 1990s, the habitat program focused on reconnecting wetlands by breaching levees, but this action alone was not sufficient to increase Razorback Sucker in these habitats. Further research in the early 2000s indicated Razorback Sucker needed spring peak flows to carry larvae into the floodplain, leading to the Larval Trigger Study Plan (LTSP). The LTSP proposed timing spring peak flow releases from Flaming Gorge Dam with the presence of Razorback Sucker larvae using real-time monitoring. These releases, coupled with habitat management and water control capabilities, are intended to move wild-spawned Razorback Sucker larvae from main channel river habitats into floodplain wetland sites. Ideally, large non-native fish are prevented from entering these sites during this period, although some small-bodied non-natives are typically present. Through a combination of habitat development and flow management, the Recovery Program is trying to facilitate Razorback Sucker completing their life cycle in the wild. Since the first implementation of LTSP in 2012, biologists have consistently encountered wild, juvenile Razorback Sucker in these wetland sites. Between 2012 and 2023, we have captured 9,269 of these wild-produced, age-0 fish. The Recovery Program has also expanded the number of wetland sites being managed to include sites on both the Green and Colorado rivers, and we continue to explore candidate sites to expand the concept. Currently there are six sites in regular operation, with another scheduled for construction near Grand Junction, Colorado and one in the design phase on the San Juan River. Bonytail have also used these wetlands with some success when they have been stocked in these locations, which will be covered in other talks during the symposium.

Email: tildon_jones@fws.gov

10:00-10:15: **COFFEE BREAK**

10:15-10:30: Management of Smallmouth Bass in the Upper Colorado River basin: past, present, and future – **Katherine Lawry (U.S. Fish & Wildlife Service), Christian Smith**

The Upper Colorado River Endangered Fish Recovery Program considers Smallmouth Bass (*Micropterus dolomieu*) a threat to native-fish assemblages and has been implementing efforts to control bass populations for two decades. We provide a comprehensive summary of past and present Smallmouth Bass management actions in the Upper Colorado River Basin with an in-depth look at mechanical and non-mechanical population suppression efforts in the Yampa, Green and White River subbasins. Management actions in all subbasins have largely centered on mechanical removal using electrofishing and have had mixed results. A better understanding of bass movement patterns in the context of environmental conditions, including flow and temperature regimes, may improve efficiency and efficacy of future mechanical removal. Recent use of strategically timed Flaming Gorge Dam flow releases to disadvantage Smallmouth Bass shows promise and needs continued evaluation.

Email: katherine_lawry@fws.gov

10:30-10:45: Flow spikes reduce Green River smallmouth bass reproductive success – **Kevin Bestgen (Colorado State University), Edward Kluender, Matthew Haworth, Ben Applegate, Tildon Jones**

Smallmouth bass *Micropterus dolomieu* is considered the most problematic non-native fish species in the upper Green River basin because of negative impacts on native fish populations and endangered fish recovery. Although mechanical removal is an effective, short-term management strategy, other approaches that target early life stages, coupled with removal of older life stages, may be longer-lasting and ultimately, further reduce the negative impacts of smallmouth bass. We used short-term, high magnitude, and relatively cold flow releases—flow spikes—from Flaming Gorge Dam, timed with the estimated smallmouth bass reproduction and nest-guarding period, to reduce their reproductive success in the downstream Green River. Observations of physical habitat change, downstream transport of larvae, abundance of young bass measured by seining and electrofishing, and distributions of hatching dates from otolith daily increment analysis were used to assess effects of recent flow spikes. We observed substantially increased depth and water velocity during flow spikes in many potential or observed spawning locations as well as reduced water temperature, especially when low Yampa River flows had a reduced Green River dilution effect. Seining and electrofishing showed reduced age-0 smallmouth bass abundance, the desired effect, compared to observations from other warm and low flow years. Distributions of hatching dates showed predictions of timing of smallmouth bass spawning were adequate, and demonstrated reduced reproductive success based on lower survival of young bass, and reduced spawning activity of adults. These preliminary results indicated flow spikes may be a viable tool to reduce smallmouth bass reproductive success in established populations and may improve the status of endangered fishes in the upper Colorado River basin. Suppression of bass in newly invaded reaches may require additional tools to prevent their establishment.

Email: Kevin.Bestgen@colostate.edu

10:45-11:00: Evaluation of post-stocking re-encounters of an endangered fish using a large, multi-agency database to inform recovery – **Casey Pennock, Dave Speas, Gary Thiede (Utah State University), Christopher Michaud**

Managers frequently rely on conservation hatcheries to maintain declining fish populations in the wild, which is the case for bonytail (*Gila elegans*), an endangered species endemic to the Colorado River basin, USA. We used a multi-agency database of stocking, capture, and PIT-tag detections during 2013-2021 across the upper Colorado River basin to assess if re-encounter probability of bonytail varied among seasons, stocking habitats (mainstem, tributary, and off-channel), and with length-at-stocking. Because of previous observations of recaptured bonytail in poor body condition, we tested for differences in condition among stocking habitats. Of 325,054 stocked bonytail examined, 90% were never re-encountered. Most re-encounters (93%) were PIT-tag detections near stocking locations. Re-encounter probability was low regardless of stocking habitat, and 95% of fish were at large for < 195 days. The effect of length-at-stocking on re-encounter probability varied among habitats and was positive in mainstem and tributary and negative in off-channel habitats. Slopes of length-weight relationships of recaptured fish differed among stocking habitats. Given consistently low re-encounters of stocked bonytail in all habitats, regardless of length-at-stocking or stocking season, we recommend managers consider refining the stocking program to better identify specific factors that affect survival, including stocking fish into intensively managed off-channel habitats which afford greater control of abiotic and biotic conditions than riverine habitats. If stocking continues among multiple habitat types, at a minimum we suggest stocking fish at consistent locations over time to better allow for quantitative assessment and ensuring fish are stocked into water temperatures that align with optimums for growth, recovery from handling, and survival.

Email: gary.thiede@usu.edu

11:00-11:15: Shifting the Bonytail management mindset toward innovation in the Upper Colorado River basin – **Koreen Zelasko (U.S. Fish & Wildlife Service), Zane Olsen, Jared Smith, Brian Scheer, Ricardo Romero**

Bonytail, *Gila elegans*, is endemic to the Colorado River Basin and listed as endangered under the Endangered Species Act. In the upper Colorado River basin (upper basin), Bonytail have been consistently reared and stocked since 1996 with little success; they are rarely encountered by any method more than a year after stocking. The Upper Colorado River Endangered Fish Recovery Program (Program) is changing the way it approaches Bonytail management, not just tweaking existing actions, but deliberately shifting to ensure that every action taken for Bonytail aims to increase survival and expand the vision of what is possible in the upper basin's hatchery system. The Program's propagation workgroup embraced the shift by acknowledging that some recommendations in the species' stocking plan had not yet been addressed, soliciting from hatchery staff the novel ideas they have been harboring, and requesting input and expertise from the lower Colorado River basin (lower basin). Ouray National Fish Hatchery (ONFH)-Randlett flow trained half of approximately 5,000 Bonytail stocked in spring 2024 and achieved statistically-significant higher velocities in treatment tanks using existing hatchery infrastructure. ONFH-Randlett and Wahweap State Fish Hatchery adjusted their established calendars and repeatedly stocked locations across seasons to better meet flow and temperature recommendations and understand those effects. Finally, adult Bonytail have been stocked into managed floodplain wetlands in hopes of increasing survival after release into mainstem rivers several months later. Over-summer survival of stocked fish within the wetlands is presumed low, with a maximum recapture rate of 13% during wetland draining. However, the presence of young-of-year Bonytail during wetland draining (often just a few but a high of 617 in 2023) confirmed the species' capacity for wild reproduction in those habitats. Most rearing and

stocking actions undertaken in the upper basin will be evaluated through future encounter rates from physical sampling and antennas. Other ideas proposed by hatchery managers and lower basin experts still in progress or under consideration by the Program include: provision of cover in hatchery tanks and ponds to reduce Bonytail stress, stocking of more but smaller Bonytail to emulate a possibly important life history strategy, stocking by boat to access more advantageous habitat, converting ONFH-Randlett's water supply to a natural flow-through system from Green River surface water, and resumption of stocking voluntarily-spawned juvenile Bonytail into Lake Powell or elsewhere in the upper basin. Bringing Bonytail back from the brink of extinction will take more than typical propagation measures. The Program implemented some relatively easy ideas, and more innovation is still to come.

Email: koreen_zelasko@fws.gov

11:15-11:30: Remote PIT tag detections improve precision of mark-recapture parameter estimates for Humpback Chub *Gila cypha* in the Upper Colorado River basin. – **Zachary Ahrens (Utah Division of Wildlife Resources), Brian A. Hines, Travis A. Francis, Kevin R. Bestgen, Gary C. White, David W. Speas**

Precise estimation of population size and demographic rates is critical to monitoring, conservation planning, and management of rare species. Mark-recapture techniques using passive integrated transponder (PIT) tags to mark individual fish and analytical software in Program MARK to model population parameters are now well established and commonly used. Recently, portable submersible PIT antennas have enabled researchers to use PIT technology as a detection method in difficult-to-sample environments, which allows recognition of a marked animal in the study area in the absence of a physical capture. We incorporated five years of remote PIT detections from portable submersible antennas into sampling and analysis of two complementary Humpback Chub monitoring datasets obtained from 1998 to 2021. The PIT detections improved probability of capture estimates, yielding narrower confidence intervals and reduced coefficients of variation for estimates of abundance using Robust Design closed capture models. Increased detections also allowed for more complex survival estimate modeling. Improved precision in estimates allowed discernment of temporal population trends on a finer scale than in years preceding use of submersible antennas. These results demonstrate the value of portable submersible PIT detectors for monitoring desert fishes in general, and provide valuable insights for specific applications in other settings.

Email: zachahrens@utah.gov

11:30-11:45: Colorado Pikeminnow Population Trends in the Colorado River. – **Darek Elverud (U.S. Fish & Wildlife Service)**

Multiple pass population estimates of Colorado Pikeminnow (*Ptychocheilus lucius*) in the Colorado River began in 1992. The current sampling rotation includes three consecutive years of sampling followed by three years when sampling does not occur. The study area 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 Colorado Pikeminnow population in the Colorado River peaked in 2005 and subsequently began to decline for the next decade. The most recent estimates of adult Colorado

Pikeminnow abundance in the Colorado River indicate an increasing trend and significantly higher abundance of adult Colorado Pikeminnow.

Email: darek_elverud@fws.gov

11:45-12:15: The Palisade High School Fish Hatchery Partnership. The many benefits of partnering directly with Colorado River communities to build trust & achieve long-term conservation goals… ownership for all – **Mike Gross (U.S. Fish & Wildlife Service)**

Initiated in 2015, the Upper Colorado River Endangered Fish Recovery Program has partnered with Palisade High School to create the Palisade High School Endangered Fish Hatchery. This collaboration is unique in that it directly involves the Palisade, Colorado community with the ongoing conservation of native fishes. Motivated students and faculty from Palisade High School culture, tag and release hundreds of endangered razorback sucker (*Xyrauchen texanus*) annually, stocking them into Critical Habitat along the Colorado River. The rare fish are reared at their student operated, on-campus, indoor-recirculating fish hatchery facility at the high school. This partnership is serving as a blueprint for other similar grass-roots conservation projects in the Colorado River basin, including the Uintah High School Aquaculture Lab, because of the many benefits for students, faculty, local stakeholders, supporting agencies, imperiled fish species, and the next generation of Americans.

Email: Michael_Gross@fws.gov

12:15-14:00: **LUNCH BREAK**

*Student Awards Session – **Pilar Rinker**, moderator*

*Student Presentations under consideration for **THE ROBERT RUSH & FRANCES HUBBS MILLER AWARD***

14:00-14:15: Genetic evaluation of refuge populations of Desert Pupfish (*Cyprinodon macularius*) – **Casandra Manuelitio (University of New Mexico), Megan Osborne, Tom Turner**

The desert pupfish, *Cyprinodon macularius*, was once widely distributed in low flow habitats throughout the Colorado River system. Loss of habitat, reduction in range and abundance resulted in *C. macularius* being listed as endangered. This species is now maintained in refuges to preserve genetic diversity and prevent extinction. Previous research identified significant divergence between populations in the Salton Sea and those in the Lower Colorado Delta. Results from previous evaluations of the diversity contained in refuge populations showed that across all populations, diversity was maintained although genetic drift had caused divergence of allele frequencies among populations. Our study aimed to evaluate the current genetic status of *C. macularius* refuge populations using the same molecular markers (seven microsatellite loci). We estimated genetic diversity and effective population size in 13 refuge populations. Effective population size was variable among populations, with the lowest values recorded in the Pima refuge population and the highest Ne at Bill Williams and Little Joe Spring. Little Joe Spring also had the highest allelic and gene diversity. There was also evidence of genetic divergence among refuge populations. Preliminary results will be compared to previous findings.

Email: cmanuelito1@unm.edu

Student Presentations under consideration for ***THE CARL L. HUBBS AWARD***

14:15-14:30: Characterizing river metabolism and resource availability across a gradient of flow alteration in desert rivers to inform native fish management – **Chloe Lyles (USGS Utah Cooperative Fish and Wildlife Research Unit), Phaedra Budy, Charles Yackulic, Casey Pennock**

River metabolism and aquatic communities are driven by hydrological and physiochemical regimes in rivers, but these regimes are often altered due to a suite of stressors including anthropogenic water demand and climate-change-driven drought. Despite widespread river alteration, the effects of flow-regime alteration on bottom-up processes and aquatic food webs remain understudied. To better understand the linkages between river alteration, metabolism, and food webs, we deployed oxygen and temperature sondes and measured benthic algae and macroinvertebrate standing stock in seven tributaries of the upper Colorado River Basin with varying degrees of flow alteration. We defined flow alteration as the percent difference between 21st and 20th-century spring flows. In 2023, we maintained sondes, measured benthic Chlorophyll-a, and collected benthic macroinvertebrates monthly from July to December during baseflow conditions. We found that rivers with less altered flow retained a greater range of gross primary production (GPP) and ecosystem respiration (ER) than rivers with more altered flow. Rivers with greater flow alteration also experienced a decoupling of the typically linear GPP/ER relationship. Whereas data and sample processing are ongoing, preliminary results for benthic algae suggest a negative correlation (r = -0.79; p = 0.023) between Chlorophyll-a and flow alteration. We also expect a negative relationship between flow alteration and macroinvertebrate biomass. To date, much research on limiting factors for higher trophic levels, such as fishes, has focused on habitat alteration and invasive species introductions, largely ignoring bottom-up effects. Improving our understanding of linkages between river alteration, metabolic regimes, and dynamics of higher trophic levels will enhance our ability to predict how riverine ecosystem structure and function might change in the future.

Email: chloe.lyles@usu.edu

14:30-14:45: Assessment of predator naiveté for an insular fish species: the White Sands Pupfish, *Cyprinodon tularosa* – **Molly Johnson (North Dakota State University), Brian Wisenden, Craig Stockwell**

Populations may lose anti-predator behavioral responses due to limited predation pressure over an extended period of time. This predator naiveté (hypothesis) may make them more vulnerable to non-native predators. White Sands pupfish, *Cyprinodon tularosa*, have been isolated for 2.5 million years and are the only native fish in the Tularosa Basin, New Mexico, making the predator naiveté hypothesis plausible. Previous experimental work has shown White Sands pupfish are vulnerable to non-native predators. Here, we tested if White Sands pupfish recognize and respond to conspecific alarm cue. White Sands pupfish responded to alarm cue with a significant decrease in activity, but they did not perform all behaviors typically associated with predator recognition. These findings suggest that White Sands pupfish may have retained anti-predator behaviors, despite their evolutionary history in allopatry.

Email: molly.i.johnson@ndsu.edu

14:45-15:00: Odonate predation on *Cyprinodon nevadensis shoshone* – **Bridger Scraper (North Dakota State University), Sekhar M. A., Brian Wisenden, Craig Stockwell**

We investigated the population-level effects of dragonfly nymph, *Anax junius*, presence on Shoshone pupfish, *Cyprinodon nevadensis shoshone*, in an ex-situ mesocosm experiment. Experimental mesocosms were established in twenty 1136-L stock tanks at the North Dakota State University (NDSU) North Dakota Agricultural Experiment Station (NDSU IACUC #A18054). Each mesocosm was outfitted with river rock substrate, artificial structures (FisHiding®), aeration, and screened covers to block birds and adult odonates. Tanks were stocked with six adult Shoshone pupfish (four females, two males) drawn randomly from a holding tank, and arranged linearly in experimental blocks. Mesocosms were randomly assigned to one of two treatments: pupfish in allopatry (control) or sympatry with 30 dragonfly nymphs (dragonfly treatment). After six weeks, tanks were drained, and surviving dragonfly nymphs, pupfish larvae, and adult pupfish were counted. Shoshone pupfish juvenile production was higher by a factor of 2.8 times for control mesocosms (265.9 ± 54.63; mean ± SE) compared to mesocosms with dragonfly nymphs (94.5 ± 35.09). These data show that dragonflies may be an important predator on small-bodied fish and thus may select for anti-predator traits.

Email: bridger.scraper@ndsu.edu

15:00-15:15: Abundance and detection correlates for Ash Meadows speckled dace across a heterogenous desert riverscape – **Jacob Wolff (Texas A&M University), Michael Schwemm, Ambre Chaudoin, Michael Bower, Kevin Guadalupe, Joshuah Perkin**

The Ash Meadows speckled dace *Rhinichthys osculus nevadensis* is a federally endangered minnow endemic to the Mojave Desert at Ash Meadows National Wildlife Refuge, Nevada. This subspecies was historically threatened by anthropogenic alterations such as groundwater pumping, agricultural redirection of spring outflows, non-native species introductions, and peat mining activities. Today, habitat restoration efforts to increase numbers are in place but require science-based evidence for guidance. Past surveys showed high abundances immediately after vegetation removal and channel restoration downstream of spring outflows. However, analyses that account for imperfect detection (i.e., capturing a dace when it is present) and responses to woody plant encroachment post-restoration are needed. This study identifies environmental correlates for dace abundance and detection. We distributed minnow traps across strong gradients of environmental variables hypothesized to correlate with abundance (i.e., water temperature, water velocity, canopy cover, channel area, and number of invasive crayfish). We used minnow traps to capture 244 and 314 dace in March and April of 2024, respectively, from Fairbanks, Jackrabbit, Tubbs, Bradford 1, and Bradford 2 springs, as well as a portion of the Kings Pool outflow. Preliminary results from N-mixture modelling suggest abundance correlated positively with canopy cover (i.e., more vegetation = more dace), water velocity, and channel area, while detection was negatively correlated with canopy cover (i.e., dace are less likely to be captured when vegetation is dense). These findings suggest natural vegetive cover (e.g., Coyote Willow, Ash trees) might benefit site abundances of dace despite reducing sampling efficiency. This presentation reports analyses from the first two of four sampling events.

Email: jake4230@tamu.edu

15:15-15:30: Genetic diversity and introgression in the Yaqui catfish (*Ictalurus pricei*) population from Arroyo Cajón Bonito, Mexico – **Alexsandre Gutiérrez-Barragán (Universidad de Sonora), Alejandro Varela-Romero, Francisco Javier García-De León, Mariana Mateos, José Manuel Grijalva-Chon, John Carlos Garza, José Raúl Romo-León**

The endangered Yaqui catfish *Ictalurus pricei*, a native species to northwestern Mexico and southwestern United States (USA), has been threatened by hybridization with the exotic Channel catfish *I. punctatus*. The Arroyo Cajón Bonito (ACB) in Yaqui river basin, México, harbors one of the few Yaqui catfish remnant populations. Unfortunately, Channel catfish was cultured next to the stream for several years, and eventual escapes occurred enabling hybridization with Yaqui catfish. In this study, 23 catfish from ACB previously analyzed with mitochondrial and nuclear genes, were sequenced using low-coverage Whole Genome Sequencing (lcWGS) to assess introgression between both species. Among the 23 individuals, 20 were pure Yaqui catfish, and one was a pure channel catfish. Admixture was detected in two individuals, one with 50% ancestry from both species (an F1 hybrid), and the other with 70% Yaqui and 30% Channel catfish ancestries, indicating a backcross. Local ancestry inference in the backcross revealed long tracts of admixture, which are expected under recent hybridization events. These findings confirm that hybrids are fertile, posing a major threat to the genetic integrity of Yaqui catfish. Furthermore, genetic diversity analyses revealed low nucleotide diversity, reduced heterozygosity, and medium-sized runs of homozygosity among pure Yaqui catfish individuals, suggesting early inbreeding in the ACB population. Further lcWGS analysis and sampling throughout the entire Yaqui catfish distribution are needed to better understand the negative impact of introgression, and guide informed conservation strategies between Mexico and USA.

Email: alexsandre190195@gmail.com

15:30-15:45: **COFFEE BREAK**

15:45-16:00: Seasonal movements of invasive Channel Catfish, *Ictalurus punctatus*, in the San Juan River, New Mexico and Utah – **Keegan Epping (Kansas State University), Keith Gido, John Cleveland, Sophia Bonjour, Rachel Grey, Tracy Diver, Stephani Clark Barkalow, Casey Pennock, Justin Furby**

Intensive electrofishing has been ineffective at reducing populations of invasive channel catfish, *Ictalurus punctatus* in the San Juan River, New Mexico and Utah. A better understanding of movement patterns and spawning habitat of channel catfish in this system might provide insight into novel strategies that increase exploitation rates. For example, identifying the timing of synchronized upstream movements might allow concentrated efforts with passive capture gear. We used radio telemetry and Floy-tag recaptures to characterize seasonal movement of channel catfish in the San Juan River. Adult channel catfish captured in a 68-river kilometer reach were surgically implanted with coded radio transmitters in 2023 (n=100) and 2024 (n=96). Tagged fish were located monthly outside of the spawning season and weekly during spawning season with raft-based tracking surveys. Despite a reduced sample size due to a high transmitter shed rate of 59% (n=116/196), we observed a pattern of localized movement in early summer followed by relatively large upstream movement beginning in mid-June in 2023 and mid-July in 2024. Channel catfish > 440 mm TL disproportionately contributed to the observed pattern of upstream movement. Mean net movement of fish <440 mm TL was 4.2 river kilometers and those > 440 mm TL was 14.4 river kilometers. Data from Floy-tag recaptures suggested interannual variation in movement patterns, likely dependent on flow regime. Upstream movement in 2023 largely coincided with back-calculated spawning dates from larval channel catfish, suggesting that upstream movements were spawning migrations. Our data indicate that in some years synchronized spawning movements occur in

Spring and early Summer which might increase the vulnerability of individuals to capture, but flow regime will dictate success of removal efforts.

Email: kepping@ksu.edu

16:00-16:15: Evaluating seasonal variation in basal resource use and trophic niche space among four prairie river fishes – **Wade Wilson (Texas Tech University), Jane Rogosch, Scott Collins, Bart Durham**

Environmental variation is known to influence the quality, quantity, and availability of instream and riparian food resources for stream consumers. We assessed the effects of seasonal variation on food resource use among an understudied group of southern prairie river fishes of conservation need. Focal species included plains minnow, *Hybognathus placitus*, prairie chub, *Macrhybopsis australis*, Red River shiner, *Notropis bairdi*, and Red River pupfish, *Cyprinodon rubrofluviatilis*, collected from the upper mainstem Red River during spring, summer, and fall of 2023. We hypothesized that the relative importance of instream and riparian resources would differ seasonally and predicted that fishes would exhibit greater reliance on instream resources during the summer months due to greater diversity and abundance of food items such as algae and aquatic macroinvertebrates. Mean isotope values of $\delta^{15}N$ and $\delta^{13}C$ varied among species and across seasons. However, the interaction was only significant for $\delta^{13}C$ values ($F_{6,544} = 8.12$, $p < 0.001$), suggesting that differences in basal resource use among species are dependent on season. These results were supported by observed differences in $\delta^{13}C$ diversity during spring (range = 11.82‰), summer (10.95‰), and fall (range = 12.40‰). Isotope values of $\delta^{15}N$ were highest during the summer (mean = 12.75‰) and lowest during the fall (10.67‰), with intraspecific differences observed between these two seasons for each species ($p < 0.03$). Diet diversity peaked during the summer (H/ = 2.08), though this was likely a result of increased macroinvertebrate abundance and availability (proportion of diets = 0.58). During fall, low flow conditions may have confined fish to lower trophic level items, evidenced by lower $\delta^{15}N$ values and diets that consisted of relatively higher proportions of detritus (0.40), filamentous algae (0.04), and diatoms (0.14) when compared to other seasons. Diet diversity was also lowest during the fall (H/ = 1.68). Subsequent trophic richness, breadth, and overlap analyses will provide additional data to aid in interpretation of seasonal patterns (driven by variations in flow and productivity) and how they affect food-web structure. Resulting baseline information about food-web structure may provide a reference from which to compare how prairie fishes may be affected by ongoing river regulation and fragmentation.

Email: wadewils@ttu.edu

16:15-16:30: Comparing field based temperature standards to laboratory derived standards for Bluehead Sucker, Flannelmouth Sucker and Roundtail Chub larvae – **Darian Woller (Colorado State University), Tawni Riepe, Dana Winkelman**

Identifying temperature-tolerance ranges is important when assessing risks that impact fish survival. The Colorado Water Quality Control Commission recommends the use of two acute temperature tests when determining temperature criteria to protect aquatic life: incipient lethal temperature tests (ILT) and critical thermal tests (CT) in a controlled laboratory setting. Laboratory-based ILT and CT tests require a static acclimation temperature where fish are hatched, reared, and held at for 14-30 days. However, these laboratory methods do not accurately represent the stream temperature conditions fish encounter in their natural environment, which can affect temperature tolerance. We suggest applying laboratory-

based ILT and CT temperature tests in a more biologically appropriate context by using field collected fish and weekly average temperature (WAT) to represent their recent history of temperature exposure instead of the standard acclimation temperature used in laboratory tests. Our study evaluates field derived ILT and CT using the WAT exposure history for three species on the western slope of Colorado: the Flannelmouth Sucker (*Catostomus latipinnis*), Bluehead Sucker (*Pantosteus discobolus*), and Roundtail Chub (*Gila robusta*). Field trials were conducted in the summer of 2024, with larvae collected from Roubideau Creek in a mobile laboratory using stream water. Temperatures were manipulated to assess both ILT and CT. Laboratory trials were conducted at the Colorado Parks and Wildlife toxicology laboratory following standard CT protocols, using larvae that were raised in the laboratory. Flannelmouth Sucker acclimated at 16ºC had a CTMin of 7.2 ± 0.5ºC and a CTMax of 32.6 ± 0.4ºC. Field collected Flannelmouth Sucker with a WAT of 16.7ºC had a CTMin of 8.9 ± 1.4ºC and a CTMax of 32.2 ± 1.8ºC. Bluehead Sucker acclimated at 18ºC had a CTMin of 7.2 ± 1.6ºC and a CTMax of 32.1 ± 2.4ºC. Field collected Bluehead Sucker with a WAT of 16.7ºC had a CTMin of 7.9 ± 0.9ºC and a CTMax of 33.6 ± 0.7ºC. Field collected Roundtail Chub had a CTMin of 7.0 ± 0.2ºC and CTMax of 33.6 ± 0.44ºC with a WAT of 20.9ºC; currently there is no laboratory CT data for Roundtail Chub larvae. Larvae were tested at UILT treatments of 28.0ºC, 27.7ºC, 26.1ºC, 25.7ºC, and 19.4ºC for seven days. Preliminary UILT results suggest that mortality was highest at the warmest temperatures (28.0ºC, 27.7ºC, and 26.1 ºC) with the lowest mortality occurring near the WAT of 20.9ºC. Ultimately, our findings should address whether field or laboratory methods should be used when developing temperature standards.

Email: Darian.Woller@colostate.edu

16:30-16:45: Gila Topminnow (*Poeciliopsis occidentalis*) demographics (2016-2023) in the Santa Cruz River, Arizona – **Matthew Mayer (University of Arizona), Peter Reinthal**

Gila Topminnow *Poeciliopsis occidentalis*, an USFWS listed endangered species, was rediscovered in the main stem of the Santa Cruz River in the mid-2010s. Genetic analyses in 2024 revealed the presence of an exotic *Poeciliopsis* species, the hybridogenic *Poeciliopsis monacha–occidentalis*. We examined demographics among *P. occidentalis*, *P. monacha occidentalis* and Mosquitofish (*Gambusia affinis*) in the river across eight geographic localities in the United States from 2016-2023. Sites are located from where the Santa Cruz River reenters the United States at Nogales, Arizona to Marana, north of Tucson. Subsamples were collected during fall fish survey efforts in the Santa Cruz River to determine Mosquitofish and Topminnow populations given the difficulty in field identification of these species. These collections are part of the Sonoran Institute annual Living River surveys. They provide an invaluable opportunity to determine geographic and temporal changes in the distributions of the three species during this period of changing ichthyofauna composition in the Santa Cruz River. Currently we have completed a preliminary analysis regarding abundance and sex ratios of both Topminnow and Mosquitofish across sites and years. The faunal composition shows a decreasing number of Mosquitofish, an increasing abundance of female *Poeciliopsis* species, and a shift in fish sizes across sites and time.

Email: mamayer4@arizona.edu

18:00-20:00: *Evening Social in Colorado River I*

08:00-09:30: ***Poster Session with coffee & snacks***

Student Posters under consideration for ***THE PHIL PISTER POSTER AWARD***

1. Integrated monitoring strategies for Independence Valley Speckled Dace, *Rhinichthys osculus lethoporus*, conservation: An applied approach for optimizing long-term species status assessment – **Lindsey Roberts (Oregon Cooperative Fish and Wildlife Research Unit), James Peterson**

   As desert aquatic organisms face numerous threats to survival, such as habitat degradation, ground water pumping, and climate change, stress incurred from frequent handling during data collection can further affect the persistence of vulnerable species. To mitigate these effects, it is important to reduce handling time and use trapping techniques that minimize stress, especially for at-risk species. Researchers should also evaluate potential monitoring methods and develop robust, statistically validated procedures for effective long-term population assessment. Environmental deoxyribonucleic acid (eDNA) has been shown to be a reliable tool for evaluating species presence/absence that does not require the capture and handling of focal species. Recently, eDNA has also been used to estimate species-specific population abundances, species distributions, and community assemblages. Here, we assess the feasibility of eDNA for long-term monitoring of the endemic Independence Valley Speckled Dace, *Rhinichthys osculus lethoporus*, which inhabits the Ralphs Warm Spring wetland complex in Independence Valley, Nevada. We sampled dace using minnow traps paired with eDNA samples at multiple locations within the wetland complex. Dace abundance at each location was estimated using the Huggins closed-capture model and compared using qPCR standard curve copy numbers, which indicate the quantity of DNA present. Data collection is ongoing however, but preliminary results suggest that eDNA may be useful for assessing the status of Independence Valley Speckled Dace.

   Email: robelind@oregonstate.edu

2. Insect communities and richness differences in treated vs. untreated sagebrush wet meadows, Year 1– **Sophia Reggiani (Western Colorado University), Susan Washko**

   Sagebrush wet meadows are small, ephemeral wetlands that collect surface water from the surrounding dry sagebrush ecosystem during spring snowmelt and monsoon rains. Due to human actions on the landscape, sagebrush wet meadows are often degraded and subject to erosion, limiting their capacity to store water and support wetland vegetation. The restoration of these habitats is part of the conservation management of the threatened Gunnison sage grouse. The birds rear their young in these habitats due to the high quality of vegetation and insect food available. Since the restoration of wet meadows began in the Gunnison Basin in 2012, there has been a notable difference in vegetation growth in restored sites compared to unrestored sites. Yet, how the restoration has impacted the insect community, which is necessary for sage grouse chick development, is unknown. We have been collecting terrestrial insects from five treated wet meadow sites and five untreated wet meadow sites monthly since June 2024, and plan to share preliminary results. This study will help inform management and conservation practitioners in the Gunnison basin about whether wet meadow restoration increases terrestrial invertebrate abundance and biodiversity, thereby improving habitat quality.

   Email: sophia.reggiani@western.edu

3. Energetic implications for Guadalupe Bass, *Micropterus treculii*, management under a projected climate change scenario – **Gabriel Murillo (University of Texas, San Antonio), Preston Bean, Nate Smith, Mitch Nisbet, Matthew Troia**

   The Guadalupe Bass, *Micropterus treculii*, is an imperiled endemic species that is designated as the state fish of Texas. There is a lack of physiological knowledge regarding the effects of temperature on Guadalupe Bass behavior and physiology. To fill this knowledge gap, routine respiration (Rrout) and maximum consumption (Cmax) were measured across a range of temperatures in the lab. Cmax was quantified by feeding Guadalupe Bass (*n*=56) ad libitum rations of Western Mosquitofish, *Gambusia affinis*, over three days. Rrout was quantified via intermittent flow respirometry (*n*=48). The difference between Cmax and Rrout was the energy balance (J/g/day) available for maintenance, growth, and reproduction. A generalized additive model was used to quantify the relationship between energy balance and temperature, ultimately predicting net energy balance based on contemporary temperatures observed at a representative stream within the Guadalupe Bass range. The model was then used to project net energy balance at elevated temperatures (+2ºC) representing a future climate change scenario. Cmax exceeded Rrout across all temperatures with Cmax following a hump shaped curve peaking at 32ºC then decreasing, whereas Rrout followed an exponential curve. Under both contemporary and elevated temperatures, Guadalupe Bass had an energy surplus throughout the entire year. Energy surplus across all seasons was 16.4% higher under increased temperatures relative to contemporary temperatures. Additionally, winter and summer energy surplus was 35.9% and 3.58% higher under elevated temperatures relative to contemporary temperatures, respectively. Increased energy surplus suggests that Guadalupe Bass will have more energy for maintenance, growth, and reproduction ultimately benefiting individuals and populations assuming that consumptive demands are met by prey availability. The results from this experiment and additional mass dependent experiments will be used to parameterize a bioenergetics model that will predict growth under different climate scenarios ultimately informing Guadalupe Bass management.

   Email: gabriel.murillo@my.utsa.edu

4. Environmental DNA tools to inform conservation of desert fishes at Ash Meadows National Wildlife Refuge – **Dana Shellhorn (Washington State University), Caren S. Goldberg, Jesse L. Brunner, Mary Sterling, David Navarro, Ambre Chaudoin, Michael Schwemm, Kevin Guadalupe, Michael Bower**

   Ash Meadows National Wildlife Refuge (AMNWR) is an internationally important biodiversity reserve in the Mojave Desert that encompasses over 23,000 acres and contains multiple warm-springs systems. These springs support populations of three federally endangered endemic fish: the Ash Meadows Amargosa Pupfish, *Cyprinodon nevadensis mionectes*, the Warm Springs Pupfish, *C. n. pectoralis*, and the Ash Meadows Speckled Dace, *Rhinichthys osculus nevadensis*. Restoration of the aquatic systems at Ash Meadows National Wildlife Refuge has been ongoing since the land was acquired in 1984, but these fishes are still threatened by established invasive fish populations as well as new introductions of released aquarium fish. The implementation of restoration and monitoring efforts is challenging due to the large number of springs and size of the refuge. Additionally, the spring systems at the refuge have unique invertebrate assemblages that are sensitive to introductions from species both outside and within the refuge, so any monitoring equipment must adhere to strict decontamination protocols. To help address these challenges, we are developing a multi-pronged approach using environmental DNA (eDNA) methods for detection and monitoring of aquatic species at the refuge. In this project, we developed and validated quantitative PCR (qPCR) assays for the three endemic fishes as well as invasive Green Sunfish, *Lepomis cyanellus*. Additionally, we are developing a metabarcoding workflow tailored to detecting 205 potential invasive fish species at the refuge including common aquarium pets, as well as other fishes. We will be employing these eDNA analysis tools using a pilot study to develop a rigorous framework for long-term surveillance of non-native fish invasions and monitoring of native fish status in the unique habitats found

at the refuge. As part of the development of methods for using eDNA to inform restoration programs at the refuge, we conducted a live-cage experiment in April 2024 to investigate eDNA transport in Crystal Spring, which has invasive Green Sunfish that impact the system's Ash Meadows Amargosa pupfish population. We first cleared the experimental reach of Green Sunfish using hoop netting and snorkel surveys. Then we placed caged fish at the spring head for 24 hours before eDNA sampling, followed by 24 hours of undisturbed conditions between caged fish treatments. We collected eDNA samples every 80 m from the spring head to 400 m downstream in three conditions in the following order: control with no sunfish, cage with one sunfish, and cage with three sunfish. Samples were collected on-site using Smith-Root self-preserving filter packs. We extracted DNA from the samples in the lab and analyzed them in triplicate using the Green Sunfish qPCR assay. We found that the eDNA of Green Sunfish was detectable at water temperatures greater than 30^{o}C and could be reliably detected up to 160 m downstream. We will use this information to characterize Green Sunfish distribution in the system during repeated eDNA sampling and Green Sunfish eradication efforts in 2025.

Email: dana.shellhorn@wsu.edu

5. Species composition of the Verde River: Analyzing competition against Sonora Suckers – **Sydney Wooldridge (University of Arizona), Reagan Doss**

Understanding the lasting effects of competition in river ecosystems is necessary for monitoring and managing the conservation of native species, as well as understanding how these relationships are also affected by habitat availability within these aquatic ecosystems. This project investigates the impact of nonnative species and environmental factors on the Sonora Sucker (*Catostomus insignis*) population in the upper section of the Verde River, from Childs to Sheep Bridge. By analyzing catch-per-unit effort (CPUE) data of both native and nonnative fish, the goal is to use analysis of species composition to determine how competition from nonnative species affects the CPUE of Sonora suckers. Increased competition is expected to result in a lower CPUE of Sonora suckers. Additionally, the study explores the influence of environmental factors, such as river-flow rate, with lower flow rates anticipated to correlate with a reduced CPUE. Statistical analysis will be used to identify the key factors affecting Sonora sucker populations. The results of this study will highlight the ecological effects of species competition and flow rate on Sonora suckers, contributing to better management of native fish species and river ecosystem conservation.

Email: swooldridge@arizona.edu

General Posters

6. Virgin River Chub *Gila seminuda* long-term monitoring in the Moapa (Muddy) River, Nevada, 2007–2024 – **Justin Handtke (BIO-WEST, Inc.), Brandon Albrecht, Ron Rogers, Michael Schwemm**

   Fisheries sampling efforts on the upper Muddy River, Nevada, during 2023–2024 aimed to assess the distribution and relative abundance of Virgin River Chub *Gila seminuda* from the Wells Siding Diversion (RKM 23.7) upstream to the US Bureau of Land Management's Fish Barrier (RKM 49.1). Virgin River Chub was the only native species captured, with a total of 2,738 individuals recorded during the three trips. Most chub were under 200 mm in length, suggesting recruitment of this endangered species. There has been a significant increase in Virgin River Chub catch per unit effort since 2020, which appears to coincide with nonnative fish removal efforts by the Nevada Department of Wildlife (spanning 2016–2019). Long-term comparisons of Virgin River Chub captures underscore the importance of continued monitoring to evaluate the effects of management actions on sensitive, native, desert, fish populations.

   Email: jhandtke@bio-west.com

7. Does the remnant distribution of *Macrhybopsis tetranema* constitute a panmictic population? – **Guilherme Caeiro-Dias (University of New Mexico), Megan Osborne, Tom Turner**

   The pelagic-broadcast spawning guild of fishes is negatively impacted by fragmentation, altered flow regimes, habitat degradation of rivers of the North American Great Plains. Peppered Chub (*Macrhybopsis tetranema*) was the most recent member of this guild to be listed as endangered. This species has been extirpated from more than 94% of its historic range and is now only found in a 218-kilometer reach of the South Canadian River between Ute Lake (New Mexico) and Lake Meredith (Texas). Distribution of genetic diversity across the riverscape also depends on intrinsic traits such as fecundity, reproductive strategy, and migratory behavior. In addition, recent anthropogenic habitat changes, climate change, and stochastic events can disrupt populations connectivity, change population dynamics, and cause substantial fluctuations in population size, which in turn can affect levels of genetic diversity and its distribution across the riverscape. In dendritic systems, numerous studies have found an increase in genetic diversity downstream, due to downstream-biased dispersal, increased habitat availability/complexity and larger population size downstream. Using 1,908 loci we estimated genomic diversity from upstream localities (New Mexico) from 2015 to 2020 (n = 34, 31, 21, 9, 41, and 43, respectively) and from a single downstream site (Texas) in 2017 (n = 8); and assessed the impact of genetic drift upstream. In upstream localities, we found signs of strong genetic drift but no significant changes in genomic diversity across time. We also found an increased excess of heterozygotes in the downstream site not found upstream. Moreover, downstream population in 2017 exhibits a larger genomic variability when compared to upstream collections, particularly compared to samples collected in the same year. Given these results, we hypothesize that asymmetric movement due to egg drift coupled with limited juvenile/adult upstream movement might be a source of increased genetic drift associated with reduced population size upstream and increased genetic variability downstream. Although we cannot rule out that small sample size might be a source of bias, observed heterozygosity estimates for the upstream reach across time were not significantly different and seemed relatively robust to sample-size bias (e.g., results from nine samples collected in New Mexico in 2018 did not show significantly different heterozygosity estimates from other collections). Future sampling that includes both upstream and downstream populations for the same temporal collections is needed to test our hypothesis.

   Email: gcaeirodias@unm.edu

8. Using underwater telemetry to monitor spatial and temporal patterns of invasive Northern Pike in Utah Lake – **Wesley Franklin (Marsh & Associates), Brian Kesner, Paul Reap**

   In 2021 Marsh & Associates began a three-year Northern Pike monitoring and telemetry project in Utah Lake, Utah. Forty-three Northern Pike were captured using trammel nets, implanted with combination radio/acoustic tags, and tracked throughout Utah Lake using submersible underwater receivers. Telemetry data were used to describe when and where Northern Pike were moving into near shore areas to spawn. Temporal data reveal that Northern Pike are contacted most during the Spring. Spatial data show that Northern Pike are contacted most in two locations – the Provo River Old Channel and Lincoln Beach – and that Northern Pike in Utah Lake are highly mobile. The motive of this research was to gain ample movement and location data to inform an effective suppression and removal effort of Northern Pike in critical June Sucker habitat.

   Email: wfranklin@nativefishlab.net

9. Applications and capabilities of passive integrated transponder tags – **Alex Marini (Marsh & Associates), Brian Kesner, Paul Marsh**

   Radio Frequency Identification (RFID) technology, particularly Passive Integrated Transponder (PIT) tags, plays a crucial role in monitoring and tracking aquatic species without direct observation. Since the initial releases of repatriated razorback suckers (*Xyrauchen texanus*) in Lake Mohave in 1992, monitoring techniques have evolved significantly. A major advancement occurred in 2010 with the introduction of remote PIT scanners capable of detecting 134.2 kilohertz (kHz) PIT tags, which enhanced the number of fish encounters. This technology was successfully integrated into the monitoring program, leading to expansions in 2012 and 2013. The study explores the characteristics and performance of two main types of PIT tags used in fisheries research: Full Duplex (FDX) and Half Duplex (HDX) tags. FDX tags facilitate continuous communication but are more susceptible to interference, necessitating specific antenna designs to optimize their functionality in aquatic environments. Conversely, HDX tags, while offering greater detection ranges, exhibit slower read rates due to their operational mechanics. Additionally, the research details the construction and tuning of PIT tag antennas, emphasizing the importance of inductance and capacitance in achieving optimal performance. Using the RM310 PIT scanner board as a case study, the analysis examines the configurations of capacitor banks and their impact on tuning to the desired frequency of 134.2 kHz. The findings provide essential insights into antenna design considerations, performance metrics, and practical implications for fisheries research, ultimately enhancing the efficacy of RFID technology in ecological monitoring.

   Email: amarini@nativefishlab.net

10. Hoop net capture efficiencies of previously pit tagged fish using submersible antenna detections – **Pilar Rinker (U.S. Fish & Wildlife Service), David Ward, Michael Pillow**

    Hoop netting is a common sampling technique used in the Grand Canyon which detects species that are not commonly captured using typical boat electrofishing methods. The US Fish and Wildlife Service uses hoop nets on an annual basis to sample Humpback Chub, *Gila cypha*, and Flannelmouth Sucker, *Catostomus latipinnis*, populations throughout the Canyon to track population trends and abundance. During our regular monitoring, we deployed four sets of paired baited hoop nets and baited submersible antennas to evaluate capture efficiency. Each pair was deployed within the same eddy separated by enough space that the antenna would not scan fish within the hoop net. We restricted the analysis to those fish that were recaptures, previously pit tagged, because that is the population of fish that is available for detection using antennas. Upon preliminary analysis, we found that 47.8% of the fish captured in hoop nets were also detected on antennas which may suggest the capture efficiency of pit

tagged fish in hoops nets is high. However, only 12.2% of the unique fish that were detected on antennas were also captured in hoop nets. The antennas detected more previously pit tagged fish than hoop nets. This suggests that there may be behavioral differences amongst the pit tagged population that may be attributed to size, species, or becoming trap-happy or trap-shy.

Email: pilar_rinker@fws.gov

11. No bones about it: Population structure of Bonytail in High Levee Pond – **Tiffany Love-Chezem (U.S. Fish & Wildlife Service), Ethan Rasset, Aaron Meuhler**

Cibola High Levee Pond (HLP) is an isolated backwater on the Lower Colorado River (LCR). It has the oldest self-sustaining population of Bonytail Chub, *Gila elegans*, last stocked in 2005. The size structure and population size of Bonytail in the pond is variable year to year, and age structure has not been well studied. Population estimates were completed during the winter of 2024 and 1% of the population was sacrificed for the collection of otoliths and fin rays. Both were mounted in resin and cut using a high-speed isometric saw, aged independently by two biologist, and demographic modelling was completed via von Bertalanffy growth curves and catch curves. Comparison of otolith and fin rays found no agreement in ages. Indicating that the non-lethal method of fin ray aging is unlikely be a viable alternative to otoliths for Bonytail. Bonytail were aged as old as eight years, but year five was missing from our sampling. Understanding the population dynamics of HLP could lead to a better understanding of these species in the current occupied habitat in the LCR.

Email: tiffany_love-chezem@fws.gov

12. We are going to need a bigger Razorback: Flathead age structure and predation potential in the Lower Colorado River – **Tiffany Love-Chezem (U.S. Fish & Wildlife Service), Chase Ehlo, Ethan Rasset, Aaron Meuhler**

Flathead Catfish, *Pylodictis olivaris*, were introduced into the Lower Colorado River (LCR) near Yuma, AZ in the 1960's, but have been increasing their range upstream and have been detected as high as Needles, CA. Not much is known about the age structure of this invasive species in the Colorado River, however the link between length and gape width is well understood. Their large gap width makes even large Razorback Sucker, *Xyrauchen texanus*, vulnerable to predation, and current stocking strategies that were developed to increase survival of Razorback Suckers may not work for Flathead Catfish. To explore the age structure and how it related to their predation potential, otoliths were removed from 24 Flathead Catfish of various sized captured throughout Lake Havasu. Otoliths were mounted in resin and cut using a high-speed isometric saw, aged independently by two biologist, and demographic modelling was completed via von Bertalanffy growth curves and catch curves. Ages ranged from 2 to 28 years old, with Flathead Catfish being able to eat most Razorback Sucker at stocking around four years of age, but not being able to eat all Razorback until around nine years of age. A better understanding the population structure of Flathead Catfish could lead to regulations or control programs that could reduce predation of Flathead Catfish on native species in the LCR.

Email: tiffany_love-chezem@fws.gov

13. Independent Evaluation of Voda IQ PIT Tags in Fisheries Research – **Brian Beckley (Voda IQ), Josh Maurskas, Armando Piccinini**

Passive Integrated Transponder (PIT) tags are essential tools for tracking movements and survival in fisheries research. An independent evaluation funded by Bonneville Power Administration assessed the

performance of Voda IQ's 12 mm, 10 mm, 9 mm, and 8 mm PIT tags. The testing covered physical dimensions, electrical parameters, and proximity from an antenna. The 10 mm and 9 mm tags exceeded all performance criteria, while the 12 mm tag exceeded all performance criteria, though exceeded a weight-threshold established with a reference tag by 0.0022 grams, a difference unlikely to influence fish greater than 0.5 grams. The 8 mm tag, despite a shorter read range, was effective in low-burden applications. This evaluation confirms the reliability of Voda IQ's PIT tags and strengthens stakeholder confidence.

Email: brian.beckley@vodaiq.com

*General Session – **Koreen Zelasko**, moderator*

09:30-09:45: Working to save groundwater-dependent organisms in the face of the resource-extraction boom in the Amargosa River basin – **Patrick Donnelly (Center for Biological Diversity)**

The wildlands of the Great Basin and northern Mojave Deserts are experiencing a resource-extraction boom unparalleled in the human history of these lands. The energy transition is a chief driver of this, with hundreds of proposed lithium mines, solar projects, wind farms, and geothermal projects proposed. However conventional extraction such as gold and materials mining continues unabated. The combined effects of these large-scale disturbances threaten to destabilize what is currently one of the most intact assemblages of biodiversity in North America. The Amargosa River Basin is a region on the California/Nevada border centered around several spring-fed oases where water comes to the surface, sustaining dozens of endemic plants and animals along the river's 180-mile course. Protected areas of note in the Basin include Ash Meadows National Wildlife Refuge, Death Valley National Park – including the famous Devils Hole – and the Amargosa Wild and Scenic River. The Basin has 13 federally listed endemic groundwater-dependent taxa including seven plants, four fishes, one small mammal, and one insect. The Amargosa River Basin is the site of great contestation right now over the future of these groundwater-dependent ecosystems. Twenty-five utility-scale solar projects, seven gold mines, five lithium mines, three clay mines, three transmission lines, a hydrogen plant, and a wind farm are all proposed for parts of the Amargosa River Basin in Nevada. The cumulative effects of this development threaten to completely industrialize the landscape, dramatically affecting upland and groundwater-dependent ecosystems alike. Cumulative water withdrawals for these uses would far exceed available water resources, potentially drying up the oases that form the Amargosa River. Using the Endangered Species Act, NEPA, litigation, community organizing, media outreach, on-the-ground monitoring and lobbying, a diverse coalition of environmentalists, Tribes, community members, and local governments are trying to stop these existential threats to the Amargosa River. This talk will describe the threats present and the actions being taken to save the biodiversity and communities of the Amargosa River Basin.

Email: pdonnelly@biologicaldiversity.org

09:45-10:00: Dissolved oxygen depletion for invasive fish eradication – **David Ward (US Fish and Wildlife Service), Shaula Hedwall**

Sodium sulfite is a powerful oxygen scavenger that is used to preserve meat and dried fruit and is generally recognized as safe by the EPA. It can also be used to remove oxygen out of a pond or stream, causing fish to come to the surface. We conducted three experimental treatments in 2024 to evaluate sodium sulfite as a fish-management tool. Bulkhead Cove (0.8 hectare pond in California) adjacent to Lake

Havasu, Piute Springs (0.4 cfs stream section) of the Little Colorado River, on the Navajo Nation, and pools (non-flowing) within Leonard Canyon immediately below Knoll Lake Dam, AZ were all treated with sodium sulfite to remove invasive fishes. Sodium sulfite dispensed at 0.16 g/L decreased dissolved oxygen to zero in less than 30 minutes in all treatments causing fish to gulp at the surface and allowing them to be captured with a hand net. Non-native green sunfish (*Lepomis cyanellus*), common carp (*Cyprinus carpio*), black bullhead (*Ictalurus melas*), channel catfish (*Ictalurus punctatus*), and fathead minnow (*Pimephales promelas*) were all killed while native speckled dace (*Rhinichthys osculus*) and humpback chub (*Gila cypha*) were able to be captured and revived in fresh water. Oxygen depletion may have advantages over other fish removal methods in that water quality conditions quickly return to pre-treatment conditions (a few hours to several days, depending on dosing) with no harmful residues and minimal impact to non-target species or the environment. Salinity increased by 0.1 ppt and sulfates increased by approximately 50 mg/l above baseline conditions in each treatment. In each case, water remained within drinking water standards during and following fish removal! Additional tools for control of invasive aquatic species are sorely needed and although this tool may only be effective in small ponds and streams, the addition of any new tool for invasive fish management is helpful in the ongoing battle to prevent extinction of southwestern native fishes. Moving from experimental use to a licensed and registered piscicide appears possible but will only be achievable with significant support from regulatory and wildlife management agencies.

Email: david_ward@fws.gov

10:00-10:15: Destruction is easy, but can we undo degradation and improve riverscapes? – **Skyler Hedden (Arizona Game and Fish Department), Julie Carter, George Cathey**

Desert aquatic habitats have been negatively impacted for centuries by human induced changes, and it is likely that these impacts will continue into the future. Given that habitat loss and alteration are among the leading causes of imperilment of aquatic species, conservationists should focus on improving habitats whenever possible. However, destruction is easy, but how successful are we at improving previously altered habitats? We assessed if habitat improvement projects could enhance aquatic habitat conditions across three different projects in the upper Little Colorado River basin, Arizona. Habitat renovations varied in spatial extent (0.15 km to 1.75 km) and objectives varied among projects, attempting to either create novel habitats, decrease bank erosion, improve riparian conditions, or to increase water availability for fish. For the smallest project, a disconnected side channel was reestablished, creating novel pool and riffle habitats that were 67% and 43% deeper than control sites. For the next project cut banks were stabilized and floodplain swales and back waters were created to reduce river stress and sediment loading. Based on pre and post construction data, the proportion of silt in the river was reduced by 37% immediately downstream of the project area. For the largest project, we attempted to reduce head cutting, while simultaneously attempting to increase water availability by raising the stream channel. In control reaches, the number of perennial pools were consistent through time, however in the improved reach, perennial pools increased by three-fold, allowing for native fish translocations to occur. We show that all three habitat improvement projects have met their desired results and have improved habitat conditions for fish, likely contributing to species persistence and recovery. Therefore, when clear objectives are set and the proper personnel are involved, habitat-improvement projects can contribute to successful conservation management.

Email: shedden@azgfd.gov

10:15-10:30: Simulations of YY Red Shiner *Cyprinella lutrensis* Introductions for nuisance population mitigation in a southwestern stream – **Chad Teal (University of Arizona), Erin Landguth, Casey Day, Javan Bauder, Scott Bonar, Daniel Schill, Christopher Jenney, Heidi Blasius, Peter Reinthal**

Red shiner *Cyprinella lutrensis* is a species of increasing management interest due to their invasive populations throughout North America and their negative impacts on fishes of high conservation concern. Multiple models have shown that releases of YY fishes can potentially eradicate invasive populations via skewing a population's sex ratio towards 100% male. We are assessing the feasibility of YY red shiner as an eradication tool in Aravaipa Creek AZ using a spatially-explicit, metapopulation-based program called CDMetaPOP. Using a combination of capture data from Aravaipa creek and life history data, we have started testing simulations of YY-male and YY-female Red Shiner releases. Preliminary results from simulations using a subset of seven Aravaipa Creek transects (1.4 km reach) suggest that eradication of female red shiner is achievable via 19 years of stocking 1000 YY-males in each transect annually. The time to eradication can be markedly reduced through YY-female releases with time to female extirpation taking six years by stocking 300-400 YY females in each transect annually. These preliminary results suggest that red shiner are highly susceptible to YY-female releases, which is likely due to their promiscuity and multiple spawning events throughout the year. Additional YY stocking strategies will be simulated, including adjustments of the stocking schedule, stocking locations, and the addition of mechanical suppression in combination with YY fish releases.

Email: chadteal@email.arizona.edu

10:30-10:45: Success, setbacks and perseverance: Native fish conservation efforts in the Blue River, Arizona 2012-2024 – **Brian Hickerson (Arizona Game and Fish Department), Kent Mosher, Paul Reap**

Projects to establish fish populations through translocation are commonly undertaken to conserve and recover imperiled native fishes and are often the highest priority tasks in recovery plans. Outcomes of translocation projects can often take years to determine and depend on stocking strategies employed, prevailing environmental conditions, and unforeseen circumstances. Importantly, success is rarely immediate and often requires active management over time. Native fish conservation efforts have taken place in the Blue River (Greenlee County, Arizona) since 2009. Efforts were initially focused on eradicating warmwater nonnative fishes from the lower 18 km of the river through barrier emplacement and mechanical removals, followed by translocation of three focal species: Spikedace *Meda fulgida*, Loach Minnow *Tiaroga cobitis*, and Roundtail Chub *Gila robusta*. Remarkable success was achieved by 2019 with the eradication of nonnative warmwater fishes, establishment of Spikedace and Roundtail Chub populations, and reestablishment of the Loach Minnow population. The success of translocation efforts in the lower Blue River led to translocation of Roundtail Chub and Spikedace to the middle Blue River (downstream of Blue, AZ) in 2017 and 2018 respectively. The outbreak of the Bringham Fire and Cow Canyon Fire within the Blue River watershed during the summer of 2020 prompted emergency salvage efforts of Spikedace and Roundtail Chub to the upper Blue River (upstream of Blue, AZ) out of concern of catastrophic post-fire effects to the lower and middle reaches of the river. Post-fire impacts on the lower and middle reaches of the river appeared to be mild during fall monitoring in 2020 likely due to well below average precipitation and discharge during the monsoon season. However, the continuation of well below average discharge (<10th percentile from 1999–2024) through July 2021 appeared to have suppressed native fish spawning success throughout the river. An above average monsoon season from July to September 2021 finally brought post-fire impacts (including flooding, debris flows, and sedimentation) throughout the middle and lower reaches of the river. As a result of both disturbances, the native fish populations crashed throughout the river. Below average winter and spring discharge in 2022 resulted in a second year of poor spawning conditions for native fish populations throughout the

river. In addition, Spikedace failed to quickly rebound in the lower Blue River despite stocking in March, 2022. The well above average winter and spring discharge in 2023 coupled with stocking of Spikedace and Roundtail Chub in all three reaches of the river in February 2023, promoted strong year classes of native fish throughout the river, particularly for Spikedace in the middle and lower reaches. Loach Minnow struggled to respond as quickly as other species in the middle and lower reaches of the river, likely due to lingering sedimentation impacts on this sediment intolerant species. A similar pattern was seen in the lower river following impacts from the Bear Wallow Fire (2010) where Loach Minnow was the last of the native fish species to fully recover. Throughout all three river reaches, relative abundance of all three focal species across time was best explained by the interaction between the previous year's relative abundance and various discharge metrics during the spring-runoff period from January to April. The importance of discharge in determining population trends highlights that management actions, like translocation, are only effective as the subsequent hydrologic conditions allow for. Native-fish establishment projects that plan for a single translocation followed by monitoring are not likely to be effective for many species given the increasingly extreme climactic conditions that desert fish in particular are exposed to. Managers should plan to be adaptive with their long-term management approach, be ready to react to changing environmental conditions, and most importantly be prepared to patiently wait out setbacks in the short term to reach longer term success in the future.

Email: bhickerson@azgfd.gov

10:45-11:00: Current status and management of Sonora Chub in Arizona – **Alex Cameron (Arizona Game and Fish Department), Brian Hickerson**

Sonora Chub (*Gila ditaenia*) is a small-bodied species of *Gila* endemic to the Río de la Concepción of Sonora, México, and extreme southern Arizona. Sonora Chub is a federally protected species in the U.S., in part due to their restricted geographic distribution, as the species is found in two headwater streams of the Río Magdalena watershed in Santa Cruz Co., AZ. Despite receiving federal protection, a finalized monitoring plan is currently not in place. The Arizona Game and Fish Department began conducting surveys within Sycamore Canyon on an annual basis, starting in 2022, that include collecting basic information regarding size-class distribution and measures of relative abundance. Here we present results from population monitoring and other management activities conducted by the Arizona Game and Fish Department from 2022-2024. Surveys have consistently documented the presence of multiple size classes, suggesting the population is comprised of multiple age classes and there continues to be spawning and recruitment within Sycamore Canyon. Measures of relative abundance fluctuated across annual surveys, seemingly in relation to water availability at the time of sampling. Finally, we highlight some of the challenges presented by this system and highlight future work for Sonora Chub.

Email: acameron@azgfd.gov

11:00-13:00: **LUNCH BREAK**

- **STUDENT NETWORKING EVENT** (free lunch for students & mentors, organizer Heidi Blasius)

*General Session – **Alex Cameron**, moderator*

13:00-13:15: Where have all the catfish gone? – **David Rogowski (Arizona Game and Fish Department), Dale Fonken**

Channel Catfish are an invasive species in the Colorado River Basin. At one point they were one of the most common species within the Colorado River, Grand Canyon. Over time the relative abundance of Channel Catfish has declined to a point where it is unusual to catch a Channel Catfish within our study area (Glen Canyon Dam to Pearce Ferry Rapid, 480 km). There are a couple of hypotheses that might account for the decline in Channel Catfish. When Lake Mead was near full pool, numerous side canyons were inundated that provided habitat and appropriate temperatures for spawning and growth of Channel Catfish. As Channel Catfish increased in size, they were able to move upstream into the Grand Canyon. As the water level of Lake Mead has declined over the past ~15 years lentic habitat has reverted to lotic habitat as the reservoir receded. Almost 80 km of riverine habitat has re-emerged from the former Lake Mead reservoir. In addition, a new rapid has formed, Pearce Ferry Rapid which is a partial barrier to upstream fish movement. In recent years, because of climate change and an ongoing drought, water releases from Glen Canyon Dam have been increasing in temperature over time. Despite the "warmer" water, we have not seen an increase in Channel Catfish in our study area. However, Channel Catfish remain relatively abundant below Pearce Ferry Rapid and are still a popular fish for anglers in Lake Mead.

Email: darogow12@gmail.com

13:15-13:30: Multi-model analysis reveals habitat & conservation needs of two Rio Grande fishes – **Ryan Friebertshauser (Colorado State University), Kevin Bestgen**

As human demands for water outpace supply, and invasive biota expand, persistence of freshwater fishes native to dryland systems increasingly depends on ecologically informed conservation practices. Endemic to the Rio Grande basin, declining Rio Grande Chub *Gila pandora*, and Rio Grande Sucker *Pantosteus plebeius*, currently face these challenges, and in portions of their range, rely on active management such as habitat restoration and stocking to persist. Using multiple data types and modeling techniques, this work informs these practices through a holistic understanding of the ecological requirements of these species. We integrated remotely sensed data, reach-level habitat assessments, and fish-community surveys, collected across these species' shared range in Colorado and New Mexico, to develop two ecological models designed to: 1) predict regional suitability of stream reaches across a large spatial extent and 2) identify physiochemical and biotic characteristics that influence local presence. Driven largely by warmer water temperature, predictive spatial models identified a geographic trend of increasing suitability for both species toward the southern extent of our study area, with the limitation that quantity of non-ephemeral reaches there is limited. Inferential models using local measures identified the importance of deep pools for Rio Grande Chub and the absence of riffles for Rio Grande Sucker, as well as a positive relationship with water temperatures for both species, supporting trends from predictive models. Inferential models also highlighted a strong, negative effect of White Sucker *Catostomus commersonii* (for Rio Grande Sucker) and Brown Trout *Salmo trutta* (for both species) relative abundances on presence. Spatially explicit predictions of suitability, useful to guide broad-scale efforts like exploratory sampling, can be integrated with conclusions from inferential modeling to inform more complex management actions such as habitat restoration and repatriation. This approach to predict broader spatial suitability followed by reach-level inference regarding habitat and invasive species offers a detailed view of these species' ecological requirements, a technique applicable to conservation of other imperiled organisms native to dryland streams.

Email: ryan.friebertshauser@colostate.edu

13:30-13:45: Advancing conservation, avoiding extinction: an update from the U.S. Fish & Wildlife Service on west Texas fishes – **Maritza Mallek (U.S. Fish & Wildlife Service)**

The U.S. Fish and Wildlife Service's Austin Ecological Services Field Office has agency-wide lead responsibility for recovery of six west Texas fishes listed as Threatened or Endangered under the Endangered Species Act. These species are the Big Bend gambusia (*Gambusia gaigei*), the Clear Creek gambusia (*Gambusia heterochir*), the Comanche Springs pupfish (*Cyprinodon elegans*), the Devils River minnow (*Dionda diaboli*), the Leon Springs pupfish (*Cyprinodon bovinus*), and the Pecos gambusia (*Gambusia nobilis*). All these fishes are associated with spring-fed systems—wetlands, streams, or both. Declining groundwater levels and spring flows resulting in decreased surface habitat is the single most important threat to all six species. Hybridization and competition with congeners are important secondary threats. This talk will provide an update on conservation efforts (ongoing research, funding, projects, salvage efforts, captive populations, and Service reports) for each species and identify the major challenges to recovery. These efforts are made possible through support and hard work from a diverse set of conservation partners, including the Texas Parks and Wildlife Department, several universities, The Nature Conservancy, the Fort Worth and San Antonio Zoos, Big Bend National Park, Balmorhea State Park, Bitter Lake National Wildlife Refuge, the U.S. Fish and Wildlife Service's Fisheries and Aquatic Conservation program, and private landowners. I will also briefly touch on two species under review for potential listing under the Act: the Pecos pupfish (*Cyprinodon pecosensis*) and the Rio Grande shiner (*Notropis jemezanus*).

Email: maritza_mallek@fws.gov

13:45-14:00: Post stock monitoring of hatchery-reared suckers in Upper Klamath Lake, Oregon – **Josh Gondek (U.S. Fish & Wildlife Service), Mckenzie Wasley**

Since 2016, the U.S. Fish and Wildlife Service (USFWS) has been rearing wild caught larvae to grow to ~200 mm at the Klamath Falls National Fish Hatchery (KFNFH) captive rearing facility, a priority recovery action listed in the C'Waam, or Lost River sucker, *Deltistes luxatus*, and Koptu, or Shortnose sucker, *Chasmistes brevirostrus*, recovery plan. This program is known as the Sucker Assisted Rearing Program (SARP), and plans include stocking fish twice-annually in spring and fall, at varying sizes, and at several different locations in Upper Klamath Lake and tributaries. Little data exists for juvenile Lost River and Shortnose sucker because few fish are collected in the wild annually and there is little to no survival of juveniles to recruit into the spawning population. One metric used to inform success of the Sucker Assisted Rearing Program (SARP) and KFNFH repatriation efforts into Upper Klamath Lake is the observation of hatchery reared suckers at spawning grounds detected by various PIT arrays maintained by U.S. Geological Survey (USGS) Klamath Falls Field Station. The first three cohorts of fish released by SARP show a one-percent detection at the known spawning grounds, with different rearing techniques altering recruitment as condition factor has a large impact on redetection. Larger fish than typically stocked have been released near spawning grounds in time to spawn to help recruitment into the wild adult population, with early results showing fish returning in greater numbers based on age and condition. Considering the age of release at approximately 1.5 years and the age at sexual maturity being 5+ years, there is a multiyear period between time of release and when researchers might begin observing SARP individuals returning to spawning grounds. With the goal to provide insight on the juvenile age class between time of release and detection at spawning grounds, KFNFH initiated supplemental PIT monitoring efforts in summer of 2023. Areas of interest for these additional PIT arrays were informed by heat maps created using data from a concurrent radio telemetry project conducted by the Klamath Falls Fish and Wildlife Office. The radio-telemetry project was initiated in spring of 2022 and focuses on hatchery-reared suckers. There have been four cohorts of radio-tagged SARP fish released into Upper Klamath Lake with tags lasting roughly 1-1.5 years. Primary methods of data collection include active tracking via aerial surveys and passive tracking using remote stations. Understanding how juvenile suckers

use Upper Klamath Lake habitat and what rearing techniques improve survival can assist with the recovery of both species in the upper Klamath Basin.

Email: joshua_gondek@fws.gov

14:00-14:15: Seasonal movements between mainstem & tributaries may facilitate the persistence of Roundtail Chub and Flannelmouth Sucker within an altered stream system – **Annika Walters (U.S. Geological Survey Wyoming Cooperative Research Unit), Alisa Magruder, Gabriel Barrile, Stephen Siddons, John Walrath**

Movement enables animals to complete their life history by responding to changing environmental conditions. Linking movement behaviors to life history characteristics can allow more targeted management applications for declining native fish populations. We identified seasonal movement patterns of Roundtail Chub, *Gila robusta*, and Flannelmouth Sucker, *Catostomus latipinnis*, two understudied species that currently occupy only a portion of their historical range in the Colorado River Basin. We coupled passive integrated transponder tag antenna systems with multi-state capture-recapture models to quantify juvenile and adult movement between mainstem and tributary habitat in the Blacks Fork subbasin of southwest Wyoming, U.S.A. during 2019–2021. We also evaluated how flow and temperature may cue the timing of seasonal movements. Adults from both species made spring movements likely associated with spawning to reach upstream tributary habitat, though adult Flannelmouth Sucker movements were more common and longer. Roundtail Chub primarily moved into the Hams Fork while Flannelmouth Sucker primarily moved into Muddy Creek, an intermittent tributary that was also identified as important for juvenile rearing. Juvenile movements occurred primarily during the fall months, with distance traveled comparable between species. Temperature and flow influenced the timing of spring movements for adult Flannelmouth Sucker, with rising temperatures triggering movement and low flow potentially limiting access to preferred spawning habitat. Identified movements likely contribute to Roundtail Chub and Flannelmouth Sucker persistence in this highly altered stream system and ultimately provide insights for management and recovery strategies to prevent further population declines.

Email: annika.walters@uwyo.edu

14:15-14:30: Little Colorado River Humpback Chub Monitoring: stories from the early years – **Chuck Minckley (U.S. Fish & Wildlife Service), Dean Hendrickson, David Ward**

We relate a story that we feel illustrates that grassroots, low-budget efforts by dedicated researchers and volunteers have substantial potential to kickstart sustainable long-term conservation efforts. Bottom line - lack of funding need not stop important conservation work if one can find enthusiastic and committed individuals. Many may not be aware that the current USFWS-administered monitoring program for Humpback Chub (*Gila cypha*) in the Grand Canyon has roots in the late 1980s efforts of many dedicated individuals working with the first author in Grand Canyon's brutally harsh conditions, living on meager subsistence rations bought with what most would be considered insufficient funds (managed by the second author, then Native Fish Biologist at Arizona Game and Fish Department in Phoenix). Commercial rafting companies generously donated delivery of equipment and supplies to the mouth of the Little Colorado (LCR), but all workers were volunteers who hiked in and out on the grueling and amazing Salt Trail. Most trips were 2 weeks long, with hoop net sampling for mark/recapture extending throughout the lower 6-miles of the LCR.

Email: cminckley@outlook.com

14:30-14:45: **COFFEE BREAK**

14:45-15:00: Large-scale monitoring of Humpback Chub in Grand Canyon: Determining key vital rates and informing broader conservation insights – **Benjamin Miller (U.S. Geological Survey), Linsay Hansen, Maria Dzul**

Native fishes in the Colorado River Basin are highly imperiled, including Humpback Chub (*Gila cypha*), which persists in its largest population within the Grand Canyon, despite substantial ecosystem alterations. To evaluate this keystone population, the U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center initiated the Juvenile Chub Monitoring (JCM) study, which has assessed vital rates for over a decade (2012-present) in the Colorado River in the Grand Canyon. The JCM conducts multiple intensive surveys (n = 3 or 4) annually, sampling ~ 22 river kilometers (rkm) at up to two discrete reaches (in eastern and western Grand Canyon) using remote passive integrated transponder (PIT) tag antennas, alongside three passes of electrofishing and six passes of hoop netting. Specifically, these monitoring trips currently collect ~ 2,100 hoop nets, conduct 900 electrofishing passes, and deploy 288 antenna-days per year, demonstrating the large effort involved in data collection. We describe spatial and temporal patterns in vital rates such as abundance, survival, and growth of Humpback Chub in eastern and western Grand Canyon over the last decade and find differences in growth and survival in the two sampling reaches. Additionally, the breadth of data collected also allows for exploration of supplementary questions that could benefit native fish conservation. We explore several such avenues of further investigation, including sampling efficiency (i.e., the 'depletion effect'), potential differences in survival rates between capture gear types, and demographic information of other native and non-native species of concern. Given adequate resources, initiating similar large-scale projects elsewhere in the Colorado River Basin could generate useful data to enhance conservation strategies for other imperiled native fish populations, potentially providing insights that smaller-scale studies may overlook.

Email: bjmiller@usgs.gov

15:00-15:15: Long-term temporal sampling reveals upstream-downstream differences in genetic variation and effective population size in Rio Grande silvery minnow – **Megan Osborne (University of New Mexico), Guilherme Caeiro-Dias, Thomas Turner**

Asymmetric flow of rivers, reproductive ecology and anthropogenic impacts affect abundance patterns between up and downstream localities and in turn, can influence effective population size (N_e) and how genetic diversity is distributed across the riverscape. We used genotyping-by-sequencing in thousands to evaluate temporal and spatial patterns of effective population size and diversity metrics in the endangered Rio Grande silvery minnow (*Hybognathus amarus*). Using archived Rio Grande silvery minnow DNA, we identified a significant reduction in allelic diversity and heterozygosity and a shift in allele frequencies for the period following a multi-year population bottleneck. We found that in almost all cases the wild population did not differ significantly from a 1:1 sex ratio. More recently, there was an ~80% reduction in N_e between 2022 and 2024, and in 2024 there was a significant excess of heterozygotes, very small estimates of NEB and an increase in values of g^2 consistent with a population bottleneck. Rio Grande silvery minnow is a pelagic broadcast spawner whereby eggs are released into the water column where they drift with river flow. Across the 25-year time-series, we found that contemporary Ne is reduced in the upstream-most population, and that departures from Hardy-Weinberg expectations and differences in the inbreeding metrics were also explained by river reach. Contrary to predictions, allelic diversity was not

significantly different between reaches, but was positively impacted by augmentation of the population with captive-reared fishes.

Email: mosborne@unm.edu

15:15-15:30: Quantification of genome-wide inbreeding in Bonytail (*Gila elegans*) and preliminary evaluation of reproductive success in Cibola High Levee Pond – **Guilherme Caeiro-Dias (University of New Mexico), Megan Osborne, Tom Turner**

Bonytail is among the most imperiled fishes in North America and is considered functionally extinct in the wild. Nonnative predators are one of the main culprits of population decline and remain the greatest challenge for recovery of Bonytail. Hatchery production has been a key element to preventing extinction of the species. The original broodstock of Bonytail was founded in 1981 by breeding five sires and six dams; however, eight or less individuals contributed to the offspring produced from spawning efforts. Subsequent efforts to secure additional wild individuals from Lake Mohave to supplement the broodstock were unsuccessful and therefore, existing genetic variation in Bonytail is derived from the initial founders. Given this demographic history, we first quantified individual inbreeding by calculating the proportion of the genome in runs of homozygosity (RoH) using two genomes. We found a substantial fraction of the genome in RoH for both individuals (11.2% and 13.3%) as consequence of bottlenecks that occurred in the past century. In addition to traditional hatchery production, allowing Bonytail to breed and recruit in off-channel habitats, free of nonnative predators, is an important element of management of the species. Cibola High Levee pond (CHL) and ponds at Imperial National Wildlife Refuge (INWR) are backwaters adjacent to the Colorado River that have been stocked with Bonytail. In these off-channel habitats, Bonytail breed and recruit. We developed a Genotyping-in-Thousands by sequencing (GT-seq) panel containing 231 SNP-based genetic markers that reflects the genome-wide genetic diversity, and it is suitable for parentage analysis. Using this panel, we evaluated genetic diversity in INWR (ponds 2, 5, and 6) and CHL pond and evaluated parent-offspring relationships in CHL pond. We report preliminary results that reveal important difference between these backwaters. Future work should include multiple generations from each pond to estimate variance of reproductive success, to understand population dynamics in each pond, and compare those dynamics between INWR and CHL.

Email: gcaeirodias@unm.edu

15:30-15:45: Documenting native desert fish conservation in Arizona – **Wesley Franklin (Marsh & Associates)**

Scientists and conservationists are achieving success in researching & protecting species with greater efficiency and less resources expended due to the advances in fisheries technology such as PIT scanning, environmental DNA, and acoustic telemetry. Along with breakthroughs in fisheries technology, we have seen an advance in methods to document what we are experiencing while collecting data in the field. Videography is a medium that conveys data and stories in a way that numbers and figures cannot and to groups that scientific papers do not reach. In a world where people are so encapsulated by videos on screens and at a time when we are rushing to halt extinction and extirpation of desert fish species in the American Southwest, we should be using the best resources available to us to present these fish and their stories to as many people as possible. It is vital that while we are progressing in conservation, we document the successes of fishes that have overcome years, decades, even centuries of declining populations due to habitat fragmentation, predation by exotic, invasive predators, and dewatering. These

powerful stories need to reach people outside the very small realm of fish biologists and academics. Ordinary people need to see what we see if we ever want them to care for these fish and their ecosystems as we do. Through the funding of the Western Division American Fisheries Society (WDAFS), Marsh & Associates (M&A) has secured videography equipment to document native fish assemblages in Arizona. This video displays and describes Roundtail Chub *Gila robusta* from several streams in its native range where native fish assemblages are still intact.

Email: wfranklin@nativefishlab.net

15:45-16:00: Genetic diversity of *Gila eremica* lineage populations in Sonora, Mexico – **Carlos Alonso Ballesteros-Córdova (DAG-UNISON), Alejandro Varela-Romero, Gorgonio Ruiz-Campos, Lloyd T. Findley, José Manuel Grijalva-Chón, Luis Enrique Gutíerrez-Millán**

The Desert chub *Gila eremica* DeMarais, 1991, is endemic to, to Sonora and Mátape river basins in Sonora, Mexico. Two new populations were discovered in the Arroyo El Tigre sub-basin, Mátape River, and were considered independent evolutionarily significant units, isolated from *G. eremica* populations, and henceforth named as *Gila* cf. *eremica*. Although the IUCN classifies *G. eremica* as near threatened, legal governmental protection and conservation status studies are still missing, especially regarding genetic diversity. In this study, we analyzed the genetic diversity of the mitochondrial gene ND2 to determine the putative genetic structure within both lineage and the possible origin of *G*. cf. *eremica*. The results showed that the four populations from the Sonora River basin exhibit small to moderate degree of genetic differentiation, with a high number of migrants per generation. In contrast, population from the Mátape River sub-basin displays a high degree of genetic differentiation compared to the Sonora River populations, along with very low or no migration exchange between the two basins. Furthermore, the results indicate significant genetic differentiation between *G. eremica* populations and those from the Arroyo El Tigre sub-basin, supporting the notion that *G*. cf. *eremica* should be managed as an evolutionarily significant and independent unit separate from the nominal species.

Email: caballesteros0411@gmail.com

16:00-16:15: Population status of native and non-native turtles along the effluent-dependent Santa Cruz River in Pima County, AZ – **Michael Bogan (University of Arizona), Miguel Grageda, Woods Nystedt, Isabel Ross, Sydney Ingham, Conor Varela Handley**

Historically, the Santa Cruz River was home to a diverse aquatic fauna in Pima County, Arizona, including the Sonoran mud turtle (*Kinosternon sonoriense*). However, those historic populations were lost when the river dried up early in the 20th century. Since the 1950's, treated wastewater has been used to restore flow in portions of the river, and since 2013 that water has been high quality, but no systematic surveys for freshwater turtles have been done in the river. In the summers of 2022, 2023, and 2024, we surveyed for turtles at six reaches of the river to document the status of native and non-native species and examine how habitat factors (e.g. flow velocity, water depth) affect their populations. We found native Sonoran mud turtles at five of the six survey reaches, but in very low numbers and we have only found older adults. In contrast, non-native spiny softshells (*Apalone spinifera*) were abundant at five of the six survey reaches, and occasionally present in small numbers at the sixth reach. Non-native pond sliders (*Trachemys scripta*) were uncommon, but present at most reaches, reaching their highest abundances in the northernmost reaches of the river. Spiny softshells were most abundant in deeper water with slower velocities, but abundances of mud turtles and pond sliders were not high enough to draw conclusions

about their habitat preferences. Finally, in August 2023, we translocated six Sonora mud turtles to our study reach at the Santa Cruz River Heritage Project in downtown Tucson – which has mainly shallow-water conditions that native turtles are adapted for – and we tracked their survival and movement for one year. All translocated turtles remained within 300 m of the release site and survived the full year after translocation. We will continue turtle surveys in summer 2025 and hope to create a management plan to ensure the survival of native turtles in the Santa Cruz River into the future.

Email: michaelthomasbogan@gmail.com

16:15-16:30: **BREAK**

16:30-17:30 *Annual DFC business meeting & Executive Committee elections (see meeting agenda on next page) in Colorado River I*

18:00-21:00: *Banquet in Colorado River I*

DESERT FISHES COUNCIL 56TH ANNUAL – BUSINESS MEETING AGENDA
NOVEMBER 22, 2024, 16:30-17:30

I. Welcome & call to order – **Michael Schwemm**, President
    a. Discussion & approval of 2023 Business Meeting minutes
    b. President's report

II. Executive Committee Reports
    a. Immediate Past President – Kevin Wilson
    b. Treasurer, Executive Secretary – Stewart Reid
        i. Alternative signatory on financial accounts
    c. Membership Secretary – Melissa Trammell
    d. Member-at-Large – Lindsey Elkins
        i. 2024 Grants
        ii. Nominations & voting:
            1. Member at Large
            2. Areas Coordinator
    e. Student awards – Kevin Wilson
    f. Outreach Coordinator – Heidi Blasius
    g. Program Secretary – Chris Hoagstrom
    h. Proceedings Editor & Data Management, Webmaster – David Rogowski

III. Old Business
    a. 2025 Meeting – Michael Schwemm
    b. Call for additional old Business – Michael Schwemm

IV. New Business
    a. Shining Star Award to Chuck Minckley – Michael Schemm
    b. Call for additional new business – Michael Schwemm

V. Adjourn

08:00-08:30: ***Morning coffee***

*General Session – **Cat Adams**, moderator*

08:30-08:45: Captive Devils Hole Pupfish at the Ash Meadows Fish Conservation Facility – **Desiree Moore (U.S. Fish & Wildlife Service), Olin Feuerbacher, Jennifer Gumm, Daniel Villanueva, Michael Schwemm, Ambre Chaudoin, Kevin Wilson, Jeffrey Goldstein, John Wullschleger, Brandon Senger, Bryce Donaghue**

In the spring of 2013, only 35 Devils Hole pupfish were counted in the wild, and no captive population existed. That fall, partners from multiple agencies began efforts to establish a captive population using a novel approach, collecting eggs from Devils Hole rather than removing adult fish. In 2014, the first 29 fish reared from wild-collected eggs were stocked into the 100,000-gallon refuge tank at the Ash Meadows Fish Conservation Facility. We have continued to use this approach of collecting wild eggs from Devils Hole to augment the population and maintain a genetic connection and have refined our husbandry methodologies to grow the captive population. During the most recent survey dives, 444 fish were counted in the refuge tank and many more are kept in aquaria. These fish are producing, for the first time, multiple generations in a laboratory setting. Getting to this point was far from straightforward. Along the way, we encountered diseases that necessitated new control and treatment strategies, predaceous diving beetles that eat larval pupfish, eggs being smothered in microbial biofilms, fish that do not like to spawn in aquaria, low fecundity, and the genetic burdens of massive inbreeding. This talk will cover the progress and the challenges we sought to overcome as we learned to work with these fish, the research that has been produced, and what we have yet to learn to better conserve this unique species.

Email: desiree_moore@fws.gov

08:45-09:00: What's up with the Devils Hole Pupfish: spring and autumn counts highest in over 20 years – **Kevin Wilson (Death Valley National Park), Jeffrey Goldstein, John Wullschleger, Ambre Chaudoin, Olin Feuerbacher, Jennifer Gumm, Daniel Villanueva, Michael Schwemm, John Umek, Mark Hausner**

The Devils Hole Pupfish *Cyprinodon diabolis* continues to inspire managing agencies of this critically endangered fish. Spring and autumn population counts in 2022 and 2023 have been at 22 and 20-year highs, respectively. Spring counts in 2023 and 2024 were the same with 175 observable pupfish. The highest spring counts since 2001. Autumn counts in 2022 and 2023 were also the same with 263 observable pupfish. The highest autumn counts in 20 years. Spring and autumn counts in 2024 were more variable with the spring increasing to 191 and the autumn count declining to 212 observable pupfish. The three managing agencies the National Park Service (NPS), the US Fish and Wildlife Service (FWS), and the Nevada Department of Wildlife (NDOW) continue to implement conservation and recovery actions outlined in a Strategic Plan for Devils Hole and the Devils Hole Pupfish (DHP). These include systematic monitoring of biotic and abiotic ecosystem processes, as well as developing specific research projects that investigate potential reasons for the recent fluctuations in population numbers. Two recent projects include a data-synthesis project and a food-web study. The data-synthesis project used random-forest modeling, a form of machine learning, to examine nine years of ecosystem monitoring data for causal relationships between abiotic and biotic parameters within the ecosystem and pupfish population dynamics. The food-web project will incorporate the use of amino acid stable isotope analyses to better understand the role of autochthonous and allochthonous carbon contributions to the diet of the DHP, as

well as the role of supplemental feeding. Initiated in January 2007, the supplemental feeding program is believed to have saved the DHP from extinction. Results from the random-forest modeling suggest that the energy supplement continues to significantly influence DHP population dynamics. The food-web study is designed in part to quantify this influence. This ongoing research is funded by the managing agencies to ensure that the best available science informs the adaptive management of Devils Hole.

Email: kevin_wilson@nps.gov

09:00-09:15: Ongoing restoration projects for the endangered Moapa dace (*Moapa coriacea*) and Virgin River chub (*Gila seminuda*) at the Moapa (Muddy) Warm Springs, Clark County, Nevada – **David Syzdek (Southern Nevada Water Authority), Michael Schwemm**

The Moapa (Muddy) Warm Springs in Southern Nevada is a regional carbonate warm water spring complex that forms the headwaters of the Muddy (Moapa) River. These springs and associated streams are habitat for an endemic suite of thermophilic aquatic species that includes the federally endangered Moapa dace (*Moapa coriacea*) and a federally unprotected population of Virgin River chub (*Gila seminuda*). Currently, the Southern Nevada Water Authority (SNWA), US Fish and Wildlife Service (USFWS), Nevada Department of Wildlife (NDOW) and other stakeholders are undertaking recovery actions for the Moapa dace and its habitat. These include construction and removal of fish passage barriers, removal of invasive species and habitat restoration. To facilitate recovery of the Moapa dace and other native species, SNWA purchased the 1,218-acre Warm Springs Ranch in September 2007 and designated it the Warm Springs Natural Area for conservation and environmental stewardship purposes. In 2008, Moapa dace numbers suddenly declined to a record low of 459 individuals. Following this nadir, SNWA, NDOW and USFWS conducted stream restoration work and intensive habitat improvements to improve conditions for the Moapa dace. NDOW successfully treated the Upper Muddy River with rotenone to control the invasive and predatory blue tilapia (*Oreochromis aureus*). Furthermore, stream restoration and clearing of dense stands of fan palms (*Washingtonia filifera*) are facilitating the re-establishment of native riparian vegetation, providing prevention of future wildfires and continued improvement in Moapa dace numbers. Moapa dace numbers are generally stable at a significantly higher level than in previous years but have yet to reach recovery levels of 6,000 fish. Recent snorkel counts recorded 1,935 Moapa dace in February 2024, and 2,110 Moapa dace in August 2024. Twenty-three young of year Virgin River chub were detected by snorkel count in August 2023, showing the first documented reproduction of this species in the Warm Springs Natural Area since 1994. These fish have been detected in subsequent snorkel counts. Work continues to improve dace habitat, improve stream connectivity, and to monitor for invasive species. In 2019 and 2020, 88 Moapa dace were translocated into the South Fork of the Muddy River. This population peaked at 268 in August 2021 but has been declining steadily and only 16 Moapa dace were found in this stream in August 2024. It is postulated that Moapa dace exited this stream reach to enter water with cooler water temperatures but were excluded from moving back into the reach by a fish passage barrier caused by a stream gage.

Email: david.syzdek@snwa.com

09:15-09:30: Virile crayfish in the Lower Colorado River basin: detection, distribution, and interactions with native fishes – **Matthew Troia (University of Texas, San Antonio)**

Virile crayfish (*Faxonius virilis*; hereafter crayfish) established invasive populations in the Lower Colorado River basin (hereafter LCRB) in the 1960s, are now abundant and widespread throughout the basin, and ostensibly negatively impact native fishes and herpetofauna. Still, spatiotemporally comprehensive field

studies and quantitative analyses are lacking, which limits understanding of population structure, distribution, and interactions with native species. Here, we highlight findings from our recently completed US Fish and Wildlife Service Science Applications Project for which we surveyed crayfish from 120 wadeable sites in the LCRB in May-June of 2021, 2022, and 2023. We also deployed in situ data loggers to monitor wet-dry status and water temperature over 24 months. We detected crayfish in 71% of sites at which mean abundance was 3.4 individuals per square meter (range 1.0-37.2). We also detected 10 native and 14 non-native fish species. Our first analytical objective was to map the distribution of perennial streams and suitable crayfish habitat using ensembles of statistical models and geospatial data layers. Predictive accuracy of ensemble runs was higher for wet-dry status (AUC = 0.87) than for crayfish habitat suitability (0.67). Of 130,847 stream km in the LCRB, we estimate that 22.2% have wetted channels during the May-June dry season and 50.3% of these perennial streams provide suitable habitat. Next, we quantified negative interactions between crayfish and fishes using our field-based co-occurrence data, species traits, and null model analysis. Although co-occurrence between crayfish and individual fish species depends on shared habitat similarity, the probability of co-occurrence for native fishes is significantly lower compared to non-native fishes. This suggests negative biotic interactions—predation and/or competition—impact native fishes. Lastly, we measured sex ratios, body size, and morphology of crayfish at 45 sites in 2022 and 2023, and collected eDNA samples from all 120 sites in 2023. A brief overview of these data will be provided. Overall, this project provides maps and species vulnerability rankings to support management actions and our aim is disseminate these tools to 2024 DFC attendees.

Email: matthew.troia@utsa.edu

09:30-09:45: The value of experiential learning: Examples from aquatic ecology research in southwest CO – **Susan Washko (Western Colorado University)**

Field experiences and individual research projects are important components of training new scientists. When students complete these experiences, they gain skills in field methods, teamwork, outdoor comfort, problem-solving, time management, data analysis, and professional writing. Additionally, these experiences provide opportunities for students to integrate theory and practice, contextualize their knowledge in place, contemplate new perspectives, and build an identity and confidence as scientists. When university mentor/mentee groups partner with outside organizations, these experiences can be even more impactful. For example, students' projects can fill research gaps that agency partners lack the staffing capacity to take on, and the students are highly motivated to do work that is meaningful to natural resource managers. This talk will highlight some of the aquatic ecology projects I am advising at Western Colorado University, detailing the advantages of these collaborations for both the students and the agency or nonprofit partners. By explaining the pedagogical benefits of providing students with applied research experiences, I hope to further encourage a network of collaborative efforts within Desert Fishes Council that will expand research capacity and train the next generation of desert fish conservation scientists.

Email: washko.susan@gmail.com

09:45-10:00: Influences of geologic history and climatic factors on the phylogeographic structure of two sucker species in Arizona's Little Colorado River drainage – **Derek Houston (Western Colorado University), Ashley Hurst, Cristian Román-Palacios, Mark Grover, Dennis Shiozawa**

Western North America has a complex geological and climatological history that has greatly influenced the evolution of its resident native fishes, resulting in high levels of endemism for numerous species and phylogroups. Recent research suggests that Bluehead Sucker, *Pantosteus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis*, both exhibit pronounced genetic diversity, and possible cryptic diversity, in Arizona's Little Colorado River drainage. We used a reduced-representation genomic data set to assess population genetic structure within both species' native ranges. More specifically, we addressed three research questions: 1) Do Bluehead Sucker populations exhibit pronounced phylogeographic structure? 2) Do Flannelmouth Sucker populations exhibit pronounced phylogeographic structure? 3) Do these sucker species exhibit genetic signatures of introgressive hybridization? Our results show that Grand Falls, a large waterfall on the Little Colorado River, approximately 169 km upstream from the confluence of the Little Colorado River and the Colorado River, is a barrier to gene flow for Bluehead Suckers and Flannelmouth Suckers. We observed varying levels of genetic admixture among populations (of both species) above and below Grand Falls. Some populations show little to no admixture, whereas others contain high numbers of "hybrid" individuals. This is particularly the case with the Zuni Bluehead Sucker, *Pantosteus discobolus jarrovii*, where two of the three sampled populations have introgressed with Rio Grande Sucker, *Pantosteus plebeius*. Populations of Bluehead Sucker and Flannelmouth Sucker above Grand Falls meet criteria for designation as Evolutionarily Significant Units.

Email: derek.d.houston@gmail.com

10:00-10:15: **COFFEE BREAK**

10:15-10:30: Environmental correlates for abundance, temporary emigration, and detection of Ash Meadows Amargosa Pupfish – **Joshua Perkin (Texas A&M University), Jacob Wolff, Michael Schwemm, Ambre Chaudoin, Michael Bower, Kevin Guadalupe**

The Ash Meadows Amargosa pupfish *Cyprinodon nevadensis mionectes* is a federally endangered pupfish endemic to Ash Meadows National Wildlife Refuge in the Mojave Desert of Nevada. This subspecies is threatened by non-native species introductions and alteration of habitats for agriculture, including diversion of spring outflows through irrigation canals. Conservation implementation strategies have included return of water flow to natural channels coupled with channel restoration and non-native species removal. Although pupfish have responded positively to restoration actions, additional research is needed to quantitatively link environmental correlates with abundance (i.e., number of fish at a site), temporary emigration (i.e., probability of movement in or out of a site), and detection (i.e., probability of trapping a fish when present at a site). We used a robust design repeated trapping experiment at 36 locations distributed across four spring systems to fit generalized N-mixture models to unmarked pupfish to test a series of ecological hypotheses. We found that pupfish abundance was positively correlated with warmer water temperatures and open canopies at thermal springheads, temporary emigration (measured as availability) was most likely for large stream channels, and detection was negatively correlated with increasing current velocity. These findings can be used to inform channel restoration designs to facilitate greater abundance and site fidelity as well as long-term monitoring designs to assess imperfect detection of individuals where current velocities are swift.

Email: joshuah.perkin@ag.tamu.edu

10:30-10:45: Assembling a fish fauna: insights for conservation – **Chris Hoagstrom (Weber State University)**

A native-fish assemblage represents species that passed through a series of faunal filters. The history of the filtering process for any given waterbody reveals critical events and processes that explain faunal ecology. For example, the middle Pecos River formed on the southern Great Plains and is populated by fishes adapted to this relatively harsh and inaccessible ecosystem. The initial river course developed via groundwater sapping as artesian springs created associated surface waters and ultimately established base streamflows. Spring waters were ion rich and prone to concentration in evaporative habitats. Surface outflow to the Edwards Plateau likely provided the first influx of fishes, which were spring associates. As the drainage grew, it captured adjacent watercourses, making plains streams tributary to the spring-dominated drainage and introducing plains-river fishes. Concurrently, intensification of the southwestern monsoon made late-summer thunderstorms part of the annual flow regime. By this time, the river systems likely included a mix of springfed tributaries and wetlands, evaporative wetlands, and alluvial channels and floodplains, each with native fishes. More recent glacial climates facilitated additional river captures that provided a direct connection to mountains, adding mountain gravels and snowmelt runoff to the river system and introducing more fishes that joined the assemblage. The invigorated river overflowed its closed basin into what became the lower Pecos River, allowing influx of big-river fishes. Next, industrial development added reservoirs and non-native fishes, while diminishing water sources and altering ecosystem properties. Modern compartmentalization of the drainage challenges ecological integrity by disarticulating ecosystem components, but ecological contributions of each component are poorly described and tenuously linked with native fishes. Maintaining a functioning ecosystem depends on the ability to understand the significance of each ecosystem component to preserve, reestablish, or recreate key ecosystem processes in a natural mix that provides for the full fish assemblage.

Email: ChristopherHoagstrom@weber.edu

10:45-11:00: Bluehead and Flannelmouth sucker restoration in the Big Sandy River, Wyoming – **John Walrath (Wyoming Game & Fish Department), Stephen Siddons, Beth Bear, Joe Gillis, Matt Joki, Jessica Lockwood, Robert Keith, Kevin Gelwicks**

Two Wyoming native fish species, Bluehead Sucker, *Catostomus discobolus* and Flannelmouth Sucker, *Catostomus latipinnis* have declined dramatically throughout their native range, due to dam construction and operation, as well as predation, competition, and hybridization associated with nonnative fishes. In Wyoming, previous surveys of the Green River drainage identified hybridization with nonnative White Sucker, *Catostomus commersonii* and Longnose Sucker, *Catostomus catostomus* to be the primary threat to Flannelmouth and Bluehead sucker persistence and it also identified the Big Sandy basin as one of four primary basins in which conservation actions would have the greatest impact. For more than a decade, preparations were made for an eventual restoration of the Big Sandy River, including construction of a barrier to prevent nonnative species from re-invading the river, mechanical removal of nonnative suckers, construction of two native fish rearing facilities, and experimental captive rearing of native suckers. In 2021, a major restoration project was initiated on the Big Sandy River with the goals of eliminating nonnative fish species (particularly White and Longnose sucker and Burbot, Lota lota) and restoring native Flannelmouth and Bluehead sucker populations. The project area, located directly above Big Sandy Reservoir, consisted of 52.5 miles of main stem river, as well as ephemeral and perennial tributaries, and off-channel ponds on a mixture of private, federal, and state lands. The project entailed salvaging

Flannelmouth and Bluehead sucker from the river, holding them in captivity while conducting chemical treatments, and repatriating them upon treatment completion. Native suckers were salvaged using various electrofishing units from July 6 to September 15, 2021 and while conducting the first chemical treatment. In total, 5,844 Flannelmouth Sucker and 385 Bluehead Sucker were salvaged. Mortality while in transit and at holding facilities was high in the first few months due to multiple factors (e.g., warm water temperatures, handling stress, disease). Following salvage, two separate rotenone treatments were conducted on September 14–16, 2021 and September 13–15, 2022 to remove nonnative fishes from the project area. Prior to repatriation, all salvaged fishes were sorted and identified and genetic samples were taken to verify phenotypic identification by trained biologists. Genetic results indicated high confidence in phenotypic identification and repatriation occurred from fall 2022 to spring 2024. A total of 1,992 native suckers was repatriated; approximately 1,800 Flannelmouth Sucker and 200 Bluehead Sucker. Overall survival from salvage to repatriation was approximately 30% for Flannelmouth Sucker and 50% for Bluehead Sucker. Sampling conducted in 2024 did not identify any nonnative species in the treatment area, with the exception of Lake Chub, *Couesius plumbeus*, and confirmed successful reproduction of Flannelmouth Sucker after repatriation. We will continue monitoring the project area to determine long-term treatment efficacy and demographic and dynamic functions of the native suckers after repatriation. The salvage operation also documented that the lowest 20 miles of the treatment area is vitally important for juvenile native suckers, especially overhanging woody vegetation. Unfortunately, much of this area is also severely degraded (e.g., over-widened channel, eroding banks, monotonous habitat, warm summer water temperatures, etc.), likely causing high occurrences of intraspecific competition. We are currently pursuing funds to complete restoration activities that will improve river function, which will also have the added benefit of alleviating intraspecific completion and help ensure the persistence of Flannelmouth and Bluehead sucker on the landscape.

Email: john.walrath@wyo.gov

11:00-11:15: Planned Restoration of the Crystal Spring Outflow Ecosystem at Ash Meadows National Wildlife Refuge – **Ambre Chaudoin (U.S. Fish & Wildlife Service), Michael Bower, Shannon Hurn, Christa Weise, Kevin Desroberts**

Crystal Spring, the largest spring in terms of discharge and area of influence at Ash Meadows National Wildlife Refuge, is the target of a planned restoration project. The project will build on an earlier restoration of the springhead and initial outflow reach in 1996. Downstream of the restored reach, the spring outflow currently enters a series of irrigation ditches that feed Crystal Reservoir and other areas. A nomination for Southern Nevada Public Lands Management Act funding was approved in 2023, making restoration of the remainder of the outflow ecosystem possible. The project's primary goal is to restore the ecological function of habitats and support the unique array of native and endemic fish, wildlife, and plants the wildlife refuge was created to protect. Visitor access and interpretation enhancements including a new trail segment and overlooks are being incorporated to increase opportunities for environmental education and enjoyment of the unique setting. Restoration plans include reclamation of irrigation ditches and dikes, decommissioning of Crystal Reservoir, creation of natural spring outflow habitats, treatment of priority invasive plants, and eradication of non-native sport fishes. Several science collaborations have been initiated to inform restoration design and adaptive management of sensitive resources that may be impacted during implementation. These include 1) a hydrological investigation to determine water sources supporting endangered Amargosa niterwort (*Nitrophila mohavensis*) populations below Crystal Reservoir, 2) development of an Amargosa niterwort habitat suitability model, 3) experimental propagation and planting trials in vacant Amargosa niterwort habitats, 3) a focused eDNA surveillance and active control effort to eradicate green sunfish (*Lepomis cyanellus*), 4) development of additional eDNA assays for invasive fish surveillance and monitoring of fish population status, and 5) a pilot study to test and refine formal methods for fish and aquatic invasive species monitoring. An

overview including the history of habitat alteration and restoration in the Crystal Spring system, conceptual designs for restoration of the lower Crystal Spring system, the many collaborations being developed to support the project, and an implementation timeline will be shared.

Email: ambre_chaudoin@fws.gov

11:15-11:30: Demographics and monitoring of repatriated Razorback Sucker in Lake Mohave – **Allison Downey (Marsh & Associates), Brian Kesner, Paul Marsh**

Population monitoring of repatriated razorback sucker, *Xyrauchen texanus*, has spanned for more than 30 years in Lake Mohave, Arizona and Nevada. Marsh & Associates (M&A) personnel and the Bureau of Reclamation monitored this population using passive integrated transponder (PIT) tags that were implanted into fish before repatriation. Remote PIT scanning was initiated in 2010 to supplement annual monitoring data that was reliant on capture methods and has given researchers access to a unique, long-term dataset. Since 2011, over four million contacts have been recorded through the deployment of remote PIT scanning antennas, but little is known about the movement behavior of this population. Contact data have revealed two distinct spawning areas in Lake Mohave, one in the river zone and one in the basin zone. Site fidelity is readily apparent; so much so that the two groups within the lake are treated as separate subpopulations. However, there is substantial scanning data to indicate individual movement between the two subpopulations that may be driven by spawning behavior. Contact data from a group of stalwarts, individuals that are known to have survived for at least 10 years post-repatriation, were analyzed to assess the hypothesis that there is sex-specific movement behavior among razorback sucker in Lake Mohave. This valuable dataset will continue to inform management strategies for repatriated razorback sucker in Lake Mohave and contribute to the success of the population lake-wide.

Email: adowney@nativefishlab.net

11:30: **56th Annual Meeting Adjourned – enjoy the field trips & have a great year!**

FIELD TRIPS

Sunday Nov 24

08:00-13:00: Details available at the meeting. Signup sheets will be provided

1. **Upper Colorado River Endangered Fish Recovery Program – Fish screens and Fish Passage (USFWS)**
2. **Upper Colorado River Endangered Fish Recovery Program – Fish Hatchery (USFWS)**
3. **Palisade High School Razorback Sucker Fish Hatchery (tentative).**
4. **Self-guided Walking Tour – Connected Lakes, map provided.**