Desert Fishes Council

Consejo de los Peces del Desierto

Dedicated to the Conservation of North America's Arid Land Ecosystems

53rd Annual Meeting Long Program

17-18 November 2021
Online
Hosted by
Texas A&M University

Date and Time	Event	
Wednesday, 17 November 2021		
09:00-09:30	Welcome	
09:30-12:00	General Session I	
12:00-13:00	Lunch	
13:00-15:00	General Session II	
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Thursday, 18 November 2021		
9:00-10:00	Business Meeting	
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15:45-16:00	Awards	

Important Information

Note that all times are U.S. Mountain Standard Time. Please take this into consideration if you are participating from a different time zone.

Posters abstracts can be found at the end of the program. Posters will be available for viewing on a website throughout the meeting . Sessions to interact with the authors occur after the oral presentations each day. Posters have been assigned to either the Wednesday or Thursday interactive session. Depending on participation there may be flexibility, so authors *may* wish to attend both sessions.

Submissions competing for one of the student awards are indicated in superscript in the left column of the Program. CLH = Carl Hubbs Award; PA = Student Poster Award.

Details for logging into the meeting, uploading oral presentations and posters and viewing pre-recorded presentations as well as other pertinent information will be forthcoming prior to the meeting.

Wednesday, November 17

9:00-9:30 Welcome

9:30-12:00 General Session I

9:30 Dam its Cold: Spatial and Temporal Changes in Fish Occurrence in the Grand Canyon

Crosby Hedden[1], David Rogowski[1], Jan Boyer[1] and Lauren Mason-Sarantopulos[1] (1-Arizona Game and Fish Department)

In the arid American Southwest, the rivers are regulated to manage water required to sustain agricultural, municipal, and industrial needs. A consequence of this intensive management is the largescale alteration to the riverine habitats in the region. Glen Canyon Dam on the Colorado River has lowered mean temperature of the river, reduced annual variability in water temperature, decreased turbidity, hindered sediment transport, and caused a deviation from the natural flow regime. Initially the effects of the dam resulted in largescale declines in the native fish assemblage within the Grand Canyon and caused spatial structuring of fish distributions due to the artificial temperature regime. In recent years, widespread drought throughout the Southwest has led to reservoir level declines, exposing riverine habitats in areas that were previously inundated by reservoirs. Water levels on Lake Mead have declined by over 40 meters since 2000, exposing over 80 km of newly emerged riverine habitat in the western Grand Canyon that possesses higher temperatures and increased turbidity relative to upstream portions of the Grand Canyon. This newly emerged riverine habitat has resulted in an increase in native fish abundance. Our objective was to observe how the probability of fish occurrence has changed within the Grand Canyon as abiotic conditions have changed in relation to the declining reservoir levels and emergence of previously unavailable habitat. We used 21 years of long-term monitoring data on the mainstem of the Colorado River in Grand Canyon collected by the Arizona Game & Fish Department to map the probability of occurrence based upon modelled water temperature for native and common nonnative fish species through space (river kilometer) and in relation to declining water levels in Lake Mead. Our results indicate that as reservoir levels declined and driver habitat re-emerged in the Western Grand Canyon, the probability of native fish occurrence increased while nonnative occurrence decreased longitudinally in the river. Information on past distribution of fish prior to reservoir declines, and how the community has responded to these changes can be a useful tool for future management of native and nonnative fish in highly regulated river systems.

9:45

10:00 **Assessing competition between Razorback Sucker and Flannelmouth Sucker?**

David Rogowski[1], Pilar Wolters[1] and Cory Nielson[1] (1-Arizona Game and Fish Department)

The Colorado River within the Grand Canyon has been altered by the construction of Glen Canyon Dam and Hoover Dam. Over recent years drought has resulted in the lowering of Lake Mead and the re-emergence of an additional 90 km of river. During this time period, Flannelmouth Sucker have experienced widespread population expansion in the Grand Canyon. Currently Flannelmouth Sucker are the most abundant fish species captured in the Colorado River, Grand Canyon, while Razorback Sucker remain exceedingly rare. Although Razorback Sucker have been documented reproducing within the Grand Canyon, we have not captured any juvenile or sub-adults. The differential success of these two catostomids suggest that Flannelmouth Sucker may be competitively excluding Razorback Sucker from the Grand Canyon. To test this we conducted a laboratory experiment investigating growth rates and food conversion rates of juvenile Flannelmouth Suckers and Razorback Suckers at two food levels, and two nominal temperatures: 15 and 20º C. These temperatures reflect contemporary and pre-dam conditions. In addition, we compared species housed singly and together. Higher food levels and warmer temperatures resulted in higher growth rates and improved food conversion rates. Razorback Suckers had greater growth and better food conversion rates than Flannelmouth Suckers across all treatments. Food conversion rates for Razorback Sucker were similar across the tested temperature range, suggesting that current water temperatures within the Colorado River, Grand Canyon are adequate for growth. Surprisingly, Flannelmouth Sucker were not as efficient in converting food into mass at cooler temperatures, particularly in the higher food treatment. Our results suggest that competition with Flannelmouth Sucker does not explain the absence of juvenile Razorback Sucker within the Grand Canyon.

10:15 **The food web has not moved a mussel: no evidence of quagga mussel effects on plankton communities, endangered Razorback Sucker (*Xyrauchen texanus*) abundance after 15 years of monitoring in Lake Mead, Nevada-Arizona, USA**

Elizabeth Renner[1], Michael Schwemm[2] , Brandon Albrecht[3], and Ron Rogers[3] (1-Kansas State University, 2-US Fish & Wildlife Service - Southern Nevada Fish & Wildlife Office, 3-BIO-WEST)

Quagga mussels are an aquatic invasive species known to cause cascading ecosystem effects on freshwater ecosystems. We sought to characterize variation in Lake Mead's limnological characteristics and plankton communities over time and by basin using long-term sampling data gathered by the US Bureau of Reclamation. We examined relationships between quagga mussel veliger biomass, plankton community composition, and endangered Razorback Sucker abundance at multiple spatial (sampling station, basin) and temporal (month, year) scales. We failed to detect significant shifts in phytoplankton or zooplankton community composition or biomass in response to increases in

quagga mussel veliger biomass. Veliger biomass was not correlated with Razorback Sucker abundance, but reservoir water level was associated with Razorback Sucker abundance. Ongoing drought and declines in water availability in the Colorado River Basin may be hindering Razorback Sucker recovery efforts in Lake Mead.

10:30[CLH] **Three-Species on the move: tracking movement patterns to inform conservation of three native fishes in the Dolores River basin**

Reece Samuelson[1], Derek Houston[1], Russ Japuntich[2], Daniel Cammack[3] and Hannah Carrol[4] (1-Western Colorado University, 2-Bureau of Land Management Fisheries Southwest District, 3-Colorado Parks and Wildlife, 4-University of California Los Angeles)

The so-called 'three-species', (Flannelmouth Sucker, *Catostomus latipinnis*; bluehead sucker, *C. discobolus*; roundtail chub, *Gila robusta*), broadly co-inhabit the Dolores River basin of southwestern Colorado and eastern Utah. This basin, made up of the Dolores and San Miguel rivers, is unique in that it has relatively few human-made instream structures that impede connectivity, and it is still primarily dominated by native fish, despite being directly connected to the non-native dominated upper Colorado River. However, much of the basin is notoriously difficult to sample because of highly remote reaches and a severely modified flow regime due to a large impoundment in the Dolores River. Because of these issues, many reaches of the basin can only be sampled sporadically when flows allow, and the abundances and distributions of three-species are highly variable both spatially and temporally. Our goal was to gain a better understanding of three-species populations in the Dolores River basin and to guide conservation efforts by investigating movement patterns using passive integrated technology. Beginning in 2013, three-species individuals were implanted with passive integrated transponder (PIT) tags opportunistically during sampling efforts led by state and federal agencies in the Dolores, San Miguel, and Colorado Rivers. We analyzed stored detection data from 2014-2021 on two passive interrogation arrays (PIAs) located in the lower (river mile 11.5; Rio Mesa Array) and upper (river mile 131; Disappointment Creek Array) Dolores River. Detection magnitude and timing were compared among species and between arrays, site fidelity and connectivity were assessed, movement direction associated with each detection event was calculated, and dispersal from original capture location was evaluated. Despite the coarse spatial resolution of the study, over 1,000 individuals and 34% of the total three-species individuals tagged provided detection data on the PIAs. Timing of peak detections varied between PIAs and among species on each PIA. Site fidelity of detected individuals was generally high, and individuals of each species were detected three consecutive years on each PIA. Detection records illustrated the excellent connectivity both within the Dolores River basin and between the Dolores River basin and the Colorado River. High numbers of three-species tagged in the Colorado River and San Miguel River were detected on the Rio Mesa Array, with individuals of each species making the 120-mile movement between the two PIAs within the same year. Upstream movements were frequently observed at the Rio Mesa Array in the spring, while movement direction was more variable on the Disappointment Creek Array. We suggest these movement patterns indicate that many three-

species use the Dolores River basin as a spawning tributary, and conclude that remaining flows and connectivity must be protected to conserve one of the last remaining three-species strongholds.

10:45 **Ten-year review of conservation actions and status of the Pahrump Poolfish**

Kevin Guadalupe[1], Brandon Senger[1] and James Harter[2].(1-Nevada Department of Wildlife Southern Region, 2-United States Fish and Wildlife Service Southern Nevada Field Office)

The Pahrump Poolfish *Empetrichthys latos* has been managed solely at refugia locations since the mid-1970s. Refugia have served a vital role in poolfish conservation but are not without challenges. Habitat degradation and illegal introduction of nonnative species have led to multiple population crashes over the past decade, requiring emergency actions by State and Federal agencies. These actions have included treating with rotenone, desiccating habitat, and on-the-ground habitat restoration. Along the way, poolfish have been salvaged, held at the Nevada Department of Wildlife's Lake Mead Hatchery, and translocated to existing refugia to avoid losing entire populations. Presently, poolfish are found at four refuge locations: Corn Creek, Shoshone Ponds ACEC, Spring Mountain Ranch State Park, and the Las Vegas Springs Preserve. Each locations serves as a case study for how poolfish have been successfully managed on the landscape. Given the history of population crashes, the Nevada Department of Wildlife and U.S. Fish and Wildlife Service are nearing completion of a multi-county safe harbor agreement that will allow for the establishment of additional populations over the next 50 years.

11:00 **Re-Purifying the Virgin (River): Alleviating Native Fish Stressors through Red Shiner Management**

Skyler Hedden[1], Julie Carter[1], Brandon Albrecht[2], Ron Rogers[2], Kevin Guadalupe[3] and Brandon Senger[3] (1-Arizona Game and Fish, 2-BIO-WEST, 3-Nevada Department of Wildlife)

Native fish populations, in the American Southwest are in a dire state because of numerous stressors negatively acting upon communities. Often managing these stressors is difficult because of the uncertainty of impact and the synergistically relatedness of such stressors. Nonnative fish removal is a management strategy that is often a priority because of the perceived negative impacts nonnatives impose on native communities and the direct ability to quantify number of nonnatives removed. However, controlling nonnative fish populations can be limited in their temporal and spatial extent, leading to mixed results and benefits to native fish. This study highlights ongoing management strategies in the Virgin River, a tributary to the Colorado River, controlling the negative associations between red shiners (*Cyprinella lutresnsis*) and the native fish community. Furthermore, we compared alternative management solutions, to ongoing chemical control, by assessing fish responses to flow metrics from 2009–2020. Successful eradication of red shiners has occurred from over 50 miles of the Virgin River. Additionally, flow manipulation strategies may be a viable option for controlling red shiners in reaches where they are still

present, as red shiner densities were 60% lower when peak summer flows were higher. Our results suggest that increases in reservoir outflow during monsoonal rains may help reduce red shiner populations in reaches that still contain this species. With the use of multiple management techniques, we may become better able to successfully eradicate and control red shiner populations for the benefit of native fishes across a broad spatial extent.

11:15 Ongoing restoration projects for the endangered Moapa dace, Moapa coriacea, at the Warm Springs Natural Area, Clark County, Nevada

David Syzdek (Southern Nevada Water Authority)

The Moapa Warm Springs in Southern Nevada is a regional spring complex that forms the headwaters of the Muddy River. These thermal springs, and associated streams, are habitat for an endemic suite of thermophilic aquatic species that includes the federally-endangered Moapa dace (*Moapa coriacea*). Currently, the Southern Nevada Water Authority (SNWA) and other stakeholders are undertaking recovery actions for the Moapa dace and its habitat. These include construction of fish barriers, reduction in or removal of non-native and invasive species, riparian and aquatic habitat restoration, and development of an ecological model for the Moapa dace. To facilitate recovery of the 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. Working with the US Fish and Wildlife Service, Nevada Department of Wildlife (NDOW), and other stakeholders and researchers, SNWA is conducting stream restoration work and intensive habitat improvements to reverse the population's decline. Following the February 2008 nadir, dace numbers improved somewhat but have yet to reach recovery levels of 6000 fish. Latest snorkel counts recorded 2,444 Moapa dace in August 2021. Since 2008, NDOW and SNWA have 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 invasive tamarisk (*Tamarix* spp.) and 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.

In 2015, a removable fish barrier was opened that allows the dace access to its entire historical range. In 2018, additional habitat was acquired on the North Fork with a property purchase and that stream is currently being restored. In 2019 and 2020, 88 Moapa dace were translocated into the South Fork and those fish have successfully reproduced. SNWA, NDOW and USFWS are currently planning a hatchery augmentation program. Moapa dace numbers are currently increasing and work continues to improve dace habitat, improve stream connectivity, and to monitor for invasive species.

11:30[CLH] **Does evolutionary naïveté explain the anti-predator response of the Moapa White River Springfish (*Crenichthys baileyi moapae*)?**

Bridger J. Scraper[1], Sekhar M. A.[1], Cody M. Anderson[1], Shawn C. Goodchild[2], Brian D. Wisenden[3] and Craig A. Stockwell[1] (1-Department of Biological Sciences North Dakota State University, 2-Fig Lake Environmental Consulting, Department of Biosciences, 3-Minnesota State University)

The evolutionary naïveté hypothesis has been invoked to explain the impacts of non-native predators on various desert fishes. In a previous study, the endangered Pahrump poolfish, *Empetrichthys latos*, did not respond to conspecific alarm cues, a finding consistent with the evolutionary naïveté hypothesis. Here, we present data on conspecific alarm cue responses of the Moapa White River springfish, *Crenichthys baileyi moapae*, one of the closest living relatives to the Pahrump poolfish. We studied the response of MWR springfish to alarm cue created from the epithelial tissues of conspecifics. Vertical position in the water column was recorded for 5 minutes before (pre-stimulus) and after (post-stimulus) the introduction of either alarm cue or distilled water (control). Springfish did not respond to the control stimulus, but consistently responded to alarm cue by lowering their position to the bottom of the water column. The results suggest that, unlike the endangered Pahrump poolfish, Moapa White River springfish have retained antipredator behavior related to conspecific chemical alarm cues.

11:45 **Southwestern endemic Macrhybopsis: legacies of peripheral isolation**

Christopher Hoagstrom[1] and Anthony Echelle[2] (1-Weber State University, 2-Oklahoma State University)

The *Macrhybopsis aestivalis* complex (nine recognized species of small-bodied, riverine cyprinids) includes four or five distinct taxa endemic to the Great Plains-Chihuahuan Desert region. We detail the origins of these taxa following a mitochondrial (ND2) chronogram interpreted against the background of a published nuclear gene phylogeny (S7 intron 1). In addition, we consider present taxonomic distributions and paleo-geomorphology. The complex arose in the Early Miocene Red River drainage. *Macrhybopsis marconis* diverged in the Middle Miocene as the Brazos-Colorado River system captured tributaries from the Red River. Elevated aridity in the Late Miocene potentially confined *M. marconis* to springfed rivers within the Edwards Plateau portion of the Colorado River drainage. However, it may have reached the lower Río Grande in the Late Miocene, giving rise to *M. aestivalis sensu stricto*. The Late Miocene lower Río Grande also maintained springfed climatic refugia and harbors other endemic species of similar ages, each also having closest relatives on the Edwards Plateau. Although presently synonymized with *M. sterletus* of the upper Río Grande drainage, *M. aestivalis sensu stricto* is so-far missing from DNA studies and previous morphological evaluation appears insufficient to support synonymization. In any case, the origin of *M. cf. sterletus* corresponds with Pliocene expansion of the middle Pecos River, which captured a major Red River tributary. Its sister lineage, left behind in the Pliocene Red River, became the common ancestor of *M. australis* and *M. tetranema*, which most likely separated from each other in the Pleistocene

when the Arkansas River captured the northern portion of the Red River drainage (upper Arkansas, Cimarron, Canadian). Ancestral *M. tetranema* appears to have introgressed with Arkansas River *M. hyostoma*, while *M. australis* introgressed with Red River *M. hyostoma*. Nevertheless, both western endemics remained distinct from *M. hyostoma*. Meanwhile, head cutting across the Balcones Fault allowed the Blanco, Guadalupe, and Medina rivers to capture Colorado River tributaries. One or more of these captures transferred *M. marconis* into the San Antonio Bay drainage. Finally, integration of the upper Río Grande, Río Conchos, and Pecos River with the lower Río Grande allowed *M. cf. sterletus* to colonize the Río Grande mainstem, where it expanded far upstream. It evidently expanded downstream as well, hypothetically making secondary contact with *M. aestivalis* in the lower Río Grande. Thus, all western endemics appear to be peripheral isolates, with ages determined by geomorphic events (i.e., river captures). They are imperiled because their need for fluvial, riverine habitat conflicts with human water-resource development (e.g., damming, dewatering). All require conservation action and the synonymy of *M. sterletus* with *M. aestivali*s needs detailed reevaluation (including DNA sampling) with emphasis on populations in the lower Río Grande, Río Salado, Río San Juan, and adjacent Río San Fernando.

12:00-13:00 Lunch

13:00-15:00 General Session II

13:00 Evaluating Gila Topminnow *Poeciliopsis occidentalis* Survival During Transport

Elizabeth Grube[1], Brian Hickerson[1] and Anthony Robinson[1] (1-Arizona Game and Fish Department)

Gila Topminnow (*Poeciliopsis occidentalis*) were historically widespread throughout the Gila River Basin, however, by the time the first recovery plan was drafted in 1984, Gila Topminnow were restricted to ten naturally occurring localities. The recovery plan for Gila Topminnow specified reintroduction as one of the primary recovery actions for the species. Many reintroduction sites are in remote locations with limited access. Fish were typically transported to these remote sites in insulated buckets (with battery-powered aerators) attached to pack frames carried by individual hikers. Mortality was occasionally high during the hiking portion of the transportation process which prompted our exploration of alternative methods that could be employed to reduce fish mortality. Sensitive trout species are often hiked into remote locations in buckets attached to pack frames containing sealed bags filled with water and pure oxygen. Similar methods are also used by fish hobbyists when shipping fish, and we believed these methods could be adapted to reduce Gila Topminnow mortality during backcountry transport. The objective of our study is to compare transportation mortality of Gila Topminnow during translocation to backcountry sites using the standard method (battery operated aerators) to an alternative method (sealed bags with oxygen). A sub-objective of our study is to evaluate the relationship between mortality and factors that may influence mortality during transportation like, density of fish in containers, gender, duration of transport, water temperature, dissolved oxygen, pH and acclimation

time, and temperature difference at stocking. We evaluated both transportation methods during two backcountry Gila Topminnow stocking events with four paired trials. Treatments with the battery-operated aerator had an average mortality of 4.05% (range 0.00-13.60%) and treatments with the pure oxygen bags had an average mortality of 0.61% (range 0.00-0.82%). We evaluated factors contributing to topminnow transportation mortality using a dataset with Gila Topminnow stockings occurring from 2007-2021 and found temperature and density of fish had the largest influence on topminnow mortality. More data is needed to fully understand the influence of each transportation method on topminnow mortality, however these preliminary results suggest that oxygenated bags could improve upon existing methods.

13:15 **Managing an iconic species during a global pandemic**

Jeffrey Goldstein[1], Ambre Chaudoin[1], Kevin Wilson[1], John Wullschleger[1], Michael Schwemm[2], Olin Feuerbacher[2], Jennifer Gumm[2], Alex Jones[2], Michael Bower[2], Javier Linares-Casenave[2] and Brandon Senger[3]. (1-National Park Service, 2-U.S. Fish and Wildlife Service, 3- Nevada Department of Wildlife)

Management and research activities focused on the Devils Hole pupfish, *Cyprinodon diabolis*, in Devils Hole, Nevada have been reduced and modified during the COVID-19 pandemic to protect the health of agency staff and cooperators. Standardized biannual counts, which have been used to track the population since 1972, were suspended from Spring 2020 through Spring 2021. The first standardized count since Fall 2019 is scheduled for September 2021 and the results will be reported in this presentation. Early life stage (ELS) surveys and egg collection to maintain a refuge population at the Ash Meadows Fish Conservation Facility were paused initially after the onset of the pandemic but resumed under modified protocols. Long-term Ecosystem Monitoring (LTEMP) was suspended for most of 2020 and resumed in June 2021. Phase 2 of the Devils Hole Strategic Plan was completed by the interagency Devils Hole Pupfish Incident Command Team (ICT) in the Spring of 2021. The Plan guides management actions at Devils Hole with emphasis on responses to catastrophic and long-term changes that threaten the viability and persistence of the pupfish population. Devils Hole and the Devils Hole pupfish continue to be affected by natural phenomenon at multiple scales. There is some evidence to indicate that water levels in Devils Hole have not recovered from a decline that occurred following a 2019 earthquake with an epicenter near Ridgecrest, CA. In July 2021, unprecedented back-to-back flash flood and seismic events modified critical habitat on the Devils Hole shallow shelf. The ICT continues to assess the impacts of these events and consider potential mitigation actions.

13:30 **Advances in Captive Rearing of the Devils Hole Pupfish, *Cyprinodon diabolis***

Olin Feuerbacher[1], Jennifer Gumm[1], Kevin Wilson[2], Jeffrey Goldstein[2], Ambre Chaudoin[2], Michael Schwemm[1], Mitchell R. Stanton[3], Brandon Senger[4], Alex Jones[1], John Wullschleger[2], Javier Linares[1] and Corey Lee[1] (1-US Fish and Wildlife Service, 2-National Park Service, 3-Great Basin Institute, 4-Nevada Department of Wildlife)

The Ash Meadows Fish Conservation Facility (AMFCF) began operation in 2013 with the intent of establishing a lifeboat population of Devils Hole pupfish, refining captive-rearing methodologies, and conducting research to better inform management decisions. To these ends, AMFCF has established a population of Devils Hole pupfish in a 100,000-gallon refuge tank using fish reared from wild-collected eggs. From that population we have succeeded in collecting eggs and rearing the hatched fish in the laboratory. Most notable in the last few years has been the ability to spawn fish in laboratory conditions. In all, approximately 200 wild-derived fish have been stocked into the refuge tank, over 1700 eggs have been collected from the refuge tank, and over 1000 eggs have been produced in the laboratory. Control of microbial pathogens and invertebrate predators have been challenges we have faced beyond the general challenges of keeping a rather difficult pupfish species. Working intently with a comparatively large number of fish in controlled conditions has allowed us to gather life-history and developmental information beyond what would be attainable working only with the single wild population.

13:45 **Staying true to form? Growth rates and morphology of wild, refuge and lab derived Devils Hole pupfish (*Cyprinodon diabolis*)**

Jennifer Gumm[1], Mitchell Stanton[2] and Olin Feuerbacher[1] (1-US Fish and Wildlife Service, 2-Great Basin Institute)

Devils Hole pupfish (*Cyprinodon diabolis*) are morphologically distinct from closely related species by having a smaller body size with a large head and lacking pelvic fins. Manipulative experiments in closely related species have established a proposed mechanism for their morphological differences and have shown that environmental variables, specifically high temperatures and limited food availability, have effects on hormones and growth leading to vastly differing morphologies. The Ash Meadows Fish Conservation Facility houses a captive population of the endangered Devils Hole pupfish in a 100,000-gallon refuge tank designed to mimic the extreme desert habitat and ecosystem of Devils Hole. It is well established that environmental parameters contributed to altered morphology and behavior of *C. diabolis* in past refuge populations, but the population at Ash Meadows is exposed to less environmental variation. Herein, we capitalize on breeding events in the refuge environment and in a lab environment to compare growth rates and morphology of larval and juvenile fish to those derived from wild collected eggs. We also compare data from *C. diabolis* to previous studies on closely related species to tease apart environmental vs genetic effects on morphology. Understanding early patterns of growth may provide insight to morphological changes in adulthood that are important considerations in management of the captive population.

14:00 **Genetic management of the Devils Hole pupfish: More fish, more fins, more data**

Michael Schwemm[1], Jennifer Gumm[1], Olin Feuerbacher[1], Jeffrey Goldstein[2], Ambre Chaudoin[2], Kevin Wilson[2], John Wullschleger[2], Brandon Senger[3] and Alex Jones[1]. ((1-US Fish and Wildlife Service, 2-National Park Service, 3-Nevada Department of Wildlife))

Despite the many the significant contributions to the conservation and management of Devils Hole pupfish *Cyprinodon diabolis* over the last 50 years, population-level studies guiding the management of genetic resources have been limited, due in-part to extreme precautions to avoid even minimal impacts of fish handling and tissue collection. Past studies have showed consistently, and unsurprisingly, extremely low levels of genetic variation in the natural population at Devils Hole, and proposed genetic hypotheses for drastic population declines that occurred in the middle 1990s and beyond. The ultimate conservation goal for the Devils Hole pupfish is the establishment of secure refugia populations to guard against stochastic and catastrophic events. The Ash Meadows Fish Conservation Facility (AMFCF), established in fall 2013, represents the only lasting and extant refuge population of Devils Hole pupfish. As such, the best management of the AMFCF (and species) requires the genetic monitoring and maintenance of both the wild and refuge populations. Incremental improvements in the collection, propagation, and operation of the refuge tank has reached the stage where managers have the fortunate position and need to consider the active management of genetic resources. This paper will discuss the current protocols to maintain demographic and genetic resources in the species, and the in-progress studies to inform future genetic management. The relative stability in operation of the AMFCF to maintain population size in recent years will likely provide increased opportunity to monitor genetic variation, and cautiously manage the genetic resources within the comfort of the collective managing agencies.

14:15 **Unprecedented decline of fishes in the northern Murray-Darling Basin, Australia: Darling Hardyhead experience major losses**

Peter Unmack[1], Karl Moy[1] and Alejandro Trujillo-Gonzalez[1] (University of Canberra)

Southeastern Australia experienced extreme drought during 2019 which caused the sudden decline of the Darling Hardyhead, *Craterocephalus amniculus* (DHH). DHH went from being a relatively common species at known sites to being extirpated across a significant portion of its range. We surveyed most known populations in Dec 2019 just prior to widespread rainfall which ended the drought, but failed to find DHH at most sites. In some cases sites were completely dry, in others there was water that had persisted, but DHH could not be found. The big problem is how do we know if they are still there or not? How long should it take to expect them to bounce back if they have survived in a refuge somewhere. We combined traditional sampling using seine nets which are usually good for sampling DHH with a more sensitive eDNA based technique. In November 2020 we sampled most localities where DHH had previously been recorded. We sampled 21 sites across the Namoi catchment, one DHH individual was captured by seine and five additional sites were positive based on eDNA. All but the site the one individual was captured at had low detection rates. In the Gwydir catchment five sites were sampled with zero detection. DHH populations recovered well in the Macintyre catchment with several previous populations (but not all) supporting DHH detected via seine net and eDNA. DHH was IUCN assessed as being Least Concern in early 2019, by the end of 2019 it was probably deserving of at least

Vulnerable or Endangered, highlighting the broad and extreme impact the 2019 drought had on fish populations across the entire northern Murray-Darling Basin. In theory these fish could easily be reproduced in captivity to re-establish populations. However, the long term prospects for this species are bleak in the face of climate change which is predicted to make droughts more extreme.

Funding from the W.L. Minckley Memorial Grant helped to make this project possible.

14:30[CLH] **Using Conservation Genomics Inference and Prediction to Inform Future Management Decisions**

Nicolas Alexandre[1], Alexander Cameron[2], David Tian1, Faisal Alzaben[1], Sree Kolora[1], Manjusha Chintalapati[1], Kamalakar Chatla[1], Thomas Turner[2], Priya Moorjani[1], Peter Sudmant[1], Noah Whiteman[1] and Peter Reinthal[3] (1-University of California, 2-Berkeley University of New Mexico, 3-University of Arizona)

Here we use reduced representation sequencing from Spikedace (*Meda fulgida*) sampled from across the species range. This has been done in tandem with sequencing of high coverage whole genomes from major population clusters for imputation of missing data to optimize comparative analyses. These samples are representative of wild vs. broodstock, time series, and extinct vs extant populations permitting inference of future local trajectories of genetic diversity in the wild and the historic context of extinction of the Verde River population. Allele frequency data further permits the estimation of connectivity among populations across the species range to disentangle the effects of local adaptation and migration while polymorphisms can additionally allow estimation of population-specific mutation rates, locally selected variants, and mutation load. The integrative nature of these analyses aim to better inform future management of local populations to maintain stable levels of genetic diversity in threatened freshwater fish.

14:45 **A Comparison of Effective Population Size (Ne) of Spikedace, *Meda fulgida*, in Aravaipa Creek, using Population Estimate and Census Methods versus Whole Genomic Inferences.**

Peter Reinthal[1], Nicolas Alexandre[2], Alexander Cameron[3], Thomas Turner[3] and Noah Whiteman[2] (1-University Arizona, 2-University of California, Berkeley, 3-University of New Mexico)

The Effective Population Size (Ne) of a real population is equal to the number of individuals in an ideal population (i.e., a population in which all individuals reproduce equally) that produces the rate of genetic drift seen in the real population. Ne is what matters to the long-term viability of endangered species. Here we use three pass depletion sampling to estimate population size of Spikedace at four locations in Aravaipa Creek that are representative of the area occupied. Population estimates using a maximum likelihood model range estimate populations of 18 individuals/100 meters to 81 individuals/100 meters. The Ne based on census population is much greater (~7X) than Ne estimates

from genomic data. Combined with annual census data, we identify the importance of genetic bottlenecks in Spikedace populations.

15:00-16:00 Interactive Poster Session I

Thursday, November 18th

09:00-10:00 Business Meeting

10:00-12:00 General Session III

10:00 The Endangered Species Act Is Good, Actually

Patrick Donnelly (Center for Biological Diversity)

The Endangered Species Act is the most powerful conservation law in the world and has an unparalleled track record of success at its stated goal of preventing extinction: over 99% of listed species under its protection avoided extinction. The Act also enjoys broad and bipartisan support from the American people – with approval ratings consistently over 80% in polling.

Desert fishes are among the most imperiled group of taxa in North America, with dozens of species facing extinction due to habitat loss, climate change-driven drought, groundwater over-appropriation, invasive species or other factors. While some 40 desert fishes are protected under the Endangered Species Act, many other species and populations remain at grave risk of extinction.

Many state wildlife officials oppose new Endangered Species Act listings or seek de-listing of species, perceiving listing as intrusion on state authority. This position is difficult to reconcile with the increased dollars, staffing and research that accompanies listing through section 6 and other sources.

While state wildlife agencies are adept at habitat management and restoration, they frequently lack the tools to address larger-scale threats. Endangered Species Act listing offers desert fishes a level of protection to landscape-scale threats that state wildlife agencies simply cannot match. Groundwater over-appropriation, dam construction, mine dewatering, fracking, geothermal development, and other land and water uses which threaten desert fishes are all examples of projects that state wildlife agencies are functionally powerless to stop or substantively change in any meaningful way.

This talk will highlight several examples of threats to desert fishes and other aquatic endemics which can only be ameliorated sufficient to prevent the extinction of these species through protection under the Endangered Species Act.

10:15 **Water Storage Decisions and Consumptive Use Constrain Ecosystem Management under Severe Sustained Drought**

Lindsey Bruckerhoff[1], Kevin Wheeler[2], Kimberly Dibble[3], Bryce Mihalevich[4], Bethany Neilson[4], Jian Wang[5], Charles Yackulic[3] and Jack Schmidt[6] (1-U.S. Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, 2-Environmental Change Institute and Oxford Martin School, 3-U.S. Geological Survey Southwest Biological Science Center Grand Canyon Monitoring and Research Center, 4-Utah Water Research Laboratory Utah State University, 5-Department of Civil and Environmental Engineering, Utah State University, 6-Center for Colorado River Studies Utah State University)

Drought has persisted in the Colorado River basin for the past 20 years and is predicted to continue. In response to ongoing drought, decisions about how much water should be stored in large reservoirs and how much water can be consumptively used will be necessary. These large-scale decisions have the potential to limit riverine ecosystem management options through the effect water-supply decisions have on reservoir elevations. We used projected hydrology and river temperatures to analyze the outcome of combinations of water storage scenarios and consumptive use limits on metrics associated with ecosystem management of the Colorado River in Grand Canyon, including the ability to implement designer flows, temperature suitability for fishes, and fragmentation. We compared current water management operations to prioritizing storage in either Lake Mead or Lake Powell combined with three levels of consumptive use limits. Projected reservoir levels limited potential environmental flow delivery and increased fragmentation regardless of where water was stored if consumptive use was not limited. Warmer river temperatures associated with low reservoir levels are likely, but the outcome of interactions among warm-water native and non-native species is uncertain. While water storage decisions provided variability and therefore management flexibility when consumptive use was limited, water storage was less important when less water was available, highlighting the importance of keeping water in the system to provide flexibility for achieving ecosystem goals.

10:30 **Reviving a desert river: benefits, challenges, and opportunities of a multi-stakeholder effort to restore flow in the Santa Cruz River**

Michael Bogan (University of Arizona)

During the 20th century, many desert rivers were dewatered by surface diversions and groundwater pumping. Several large desert cities developed along these dewatered riverbeds, including Phoenix, Las Vegas, and Tucson, USA. Flow has since returned to some urban portions of these rivers thanks to the discharge of treated wastewater (effluent). However, this effluent generally had poor water quality, and planners rarely considered ecological or societal concerns when deciding where to release effluent. The Santa Cruz River Heritage Project, created by the city of Tucson’s municipal water agency, is an innovative project to release high-quality effluent into a historically dewatered reach in the city’s urban core. Although the initial goal of the project was groundwater recharge, it has resulted in myriad ecological and societal benefits, including an impressively diverse odonate fauna, increased bird

diversity, and numerous recreational opportunities. The project itself has received wide community support beyond what its initial stakeholders had predicted. However, challenges have included flood control concerns and how to resolve issues among diverse groups and agencies. Here, we provide an overview of the project's ecological and society benefits and lessons learned about public communication and collaborative planning.

10:45 **Non-Native Fish Detection in the Central Arizona Project Canal Using eDNA Metabarcoding**

Yale Passamaneck[1], William Stewart[1] and Kent Mosher[1] (1-U.S. Bureau of Reclamation)

The Central Arizona Project (CAP) is a 336-mile-long aqueduct that extends though Arizona, delivering water to municipal, tribal, agricultural, and industrial customers. After the completion of the CAP in 1993, the U.S. Fish and Wildlife Service determined that the transportation and delivery of CAP water had the potential to introduce and spread non-native aquatic species into the Gila River basin. Under this 1994 Biological Opinion and two later revisions, the U.S. Bureau of Reclamation was required to develop and implement a long-term monitoring program to examine the presence and distribution of non-native fish in the CAP and its primary connected waters. Over the years, sampling in the CAP using traditional methods (boat electrofishing, trammel nets, minnow traps, etc.) has proven to be resource intensive and logistically challenging. Environmental DNA (eDNA) metabarcoding provides the potential to identify the presence of non-native fish in a cost-effective manner with reduced field sampling effort. To evaluate the information available from eDNA metabarcoding, sampling was conducted at approximately 5-mile intervals along the canal, including at pumping plant forebays, in conjunction with traditional sampling methods. DNA barcode fragments were amplified using universal primers and subjected to high-throughput DNA sequencing. Resultant data were compared to a reference database of fish DNA sequences to identify source taxa. Results of eDNA metabarcoding were compared to data from traditional sampling efforts to evaluate the comparative benefits and costs of the two approaches.

11:00 **Going the distance: Multiscale assessment of Conchos Pupfish (*Cyprinodon eximius*) abundance and distribution in West Texas**

Lindsey Elkins[1], Matthew Acre[2], Joshuah Perkin[1], Megan Bean[3], Sarah Robertson[3], Ryan Smith[4] and Stephanie Parker[1] (1-Texas A&M University, 2-U.S. Geological Survey, 3-Texas Parks and Wildlife Department, 4-Texas Nature Conservancy)

The goal of this study was to assess the distribution and abundance of Conchos Pupfish at multiple spatial scales. The broad-scale distribution assessment included developing a species distribution model (SDM) across the range of the species in Mexico and the United States, while the fine-scale abundance model focused on population size at the three locations where the species persists in the United States. Results of the SDM illustrated high suitability at locations in the upper Rio Conchos in Mexico and the lower Devil's

River of Texas in the United States. Focal abundance estimates based on distance sampling at three locations on the Devil's River showed highest abundances in Dolan Creek near the USGS gage 08449100 (N = 2,251; 95% confidence intervals = 945-3,558), followed by the Devil's River at Pafford Crossing (N = 1,386; 826-1,947), and the Devil's River near Dolan Falls (N = 671; 301-1,042). We found Conchos Pupfish were most abundant in shallow areas with high floc and algal coverage, but slow water velocity. This research advances the field of conservation biology by demonstrating the application of distance sampling in an aquatic setting to develop ecological baselines and a status assessment for a rare and poorly studied species.

11:15 Multiple survey methods reveal greater abundance of endangered pupfish in restored habitats

Joshuah Perkin[1], Matthew Acre[2] and Megan Bean[3] (1-Texas A&M University, 2-U.S. Geological Survey,3-Texas Parks and Wildlife Department)

Freshwater organisms inhabiting arid ecosystems are imperiled by human alterations to water-limited landscapes. This is especially true among desert-dwelling cyprinodontid fishes, 90% of which are imperiled by habitat destruction within limited or shrinking ranges. Constructing habitats that mimic natural habitat form and function may provide a tool for species conservation, especially within freshwater protected areas. However, pupfish population assessments within degraded compared with restored habitats are infrequent, and few comparisons among survey methods exist. Density estimates were developed for Endangered Comanche Springs pupfish *Cyprinodon elegans* throughout altered and restored habitats in a freshwater protected area by using mark–recapture and N-mixture models fitted to data collected using minnow trap and visual count survey methods. This allowed comparison of habitats, survey methods, and statistical methods commonly used to generate population size estimates for imperiled pupfish. Population estimates varied across major habitat types and were largest among habitats constructed to mimic naturally occurring ciénegas. Estimates using visual counts were higher than estimates from minnow traps where water was deeper and where macroalgae cover was highest. N-mixture models generally estimated higher abundances than mark–recapture and were not limited by recapture ability. The results provide strong evidence that restored habitats house greater abundances of pupfish, but survey and statistical methods commonly used to detect these differences have trade-offs in performance according to the habitats surveyed. This work benefits the field of conservation biology by providing guidance for existing and emerging monitoring programmes assessing abundance-based fish responses to habitat improvements.

11:30 Use of Spray Marking as a Tool to Mark Least Chub (*Iotichthys phlegethontis*) for Mark-Recapture Studies

Jordan Holcomb[1], Keith Lawrence[1], Alan Ward[1], Jack Dudding[1] and Weston Pearce[1] (1-Utah Division of Wildlife Resources)

Knowing the number of individuals in a fish population can greatly enhance a manager's abilities to make informed decisions for fishes. Estimation of

population size is widely used for sportfish but somewhat less common in small, rare nongame fishes. The Least Chub *Iotichthys phlegethontis* is a small cyprinid (<65 mm total length) endemic to the Bonneville Basin. Historically, Least Chub were widespread in marshes and rivers across the Bonneville Basin but they have been widely extirpated and now only occur in a small number of isolated populations in Utah. The Utah Division of Wildlife Resources maintains experimental introduced populations for each wild population. Utah Division of Wildlife Resources annual monitoring protocols utilize collapsible mesh minnow traps to capture Least Chub at wild populations. Ratios of juveniles (< 35 mm total length) to adults (>35 mm total length) are obtained by measuring 100 fish per monitoring site. These ratios are paired with catch per unit effort measured by total number of fish per trap hour for each monitoring site to track populations through time. These metrics have not been formally evaluated to see how they translate to whole population level estimates.

We sought to identify a batch marking technique that did not require handling of every fish allowing for a mark-recapture study to eventually evaluate total population size of wild populations. This would facilitate comparison of juvenile:adult ratios and catch per unit effort data with population estimates through time. Spray marking is a method that consists of spraying fluorescent dye granules at high pressure to embed in the scales and skin of fish. Spray marking is already utilized in state of Utah hatcheries to batch mark fingerling salmonids and has been used successfully on other small desert fishes (Douglas et al. 2001, The SW Naturalist 46[2]:141-150).

One of the more robust experimental introduced Least Chub populations was selected to test spray marking as marking methodology. Spray marking equipment consisted of a gas powered air compressor with variable air pressure settings connected to a Porta-Blast (Porta-Blast, Singapore, China) paint sprayer. Spray marking dye granules were obtained from Fluomark (Fluomark, McCall, Idaho, USA). On the first marking occasion, we set 21 minnow traps for 1.75 hours and captured 1766 Least Chub (948 adults and 818 juveniles) and 100 fish were measured. Fish were held in 8 aerated buckets with frozen water bottles. We sprayed 100 fish with dry dye granules at 120 and 100 psi, respectively. Mortality was 100% and immediate at both pressures. Next, we sprayed about 80 fish at 100 psi with dye granules in water (wet dye) at 45% dye concentration and only juveniles experienced immediate mortality while adults survived. Fish were then visually sorted by adults and juveniles and all but 50 adults were sprayed at 100 psi with 45% wet dye concentration. The 50 adults not sprayed (control) and 50 spray marked adults were held in separate minnow traps placed in the refuge pond for 48 hours to evaluate post spray mortality and marking success. Mortality was 19.6% and 53.1% in control and spray marked groups, respectively. Mark retention was 98% and marks were evaluated with a uvBeast 365nm UV flash light (uvBeast, Portland, Oregon, USA), a different 365 nm black light flashlight, and 400 nm blue light flashlight with UV blocking glasses. A pop-up ice fishing hut used as a dark room. All lights fluoresced the marks and the uvBeast was the brightest.

On the first recapture (second marking session) we set 22 traps for 1.75 hours and captured 1075 Least Chub (447 adults 628 juveniles). Fish were held in 4 aerated buckets with frozen water bottles and sorted and counted into juvenile and adult cohorts and juveniles were released. Adults were evaluated for marks with the uvBeast flashlight and black light flashlight and 34 fish were previously marked. Due to higher than expected mortality in the control on the initial marking occasion, we sought to also use a larger enclosure to minimize potential mortality associated with the small volume of the minnow traps and evaluate if that had an impact on overall mortality. Larger enclosures (.25m2 x .75 m high) with PVC frames and 3.175 mm cloth mesh were used. Fifty fish were sprayed using the same settings as the first occasion, 50 fish were not sprayed, and the remaining fish were sprayed at 80 psi and 25% wet dye concentration. The 50 not sprayed fish, 50 sprayed at 100 psi 45% wet dye, and 50 fish sprayed at 80 psi 25% wet dye went into respective enclosures for 48 hours. Post spray marking mortality was 40, 65.9, and 81.2% in control, 100 psi 45% wet dye, and 80 psi 25% wet dye groups, respectively. Mark retention was 95.4 and 100% in the 100 and 80 psi treatments, respectively.

Given that the reduced spray pressure resulted in 100% marking success, it is possible that lower pressures and concentrations of dye could reduce mortality and still result in sufficient marking success. Handling stress should be minimized and even with many aerated buckets, we observed high mortality in unmarked controls. A subsample of fish could be evaluated for marks instead of handling every fish to further reduce handling. Spray marking proved to be very effective as a marking technique for Least Chub. However, mortality must be significantly lowered before spray marking can be viable for wild Least Chub populations.

11:45 **Statement of World Aquatic Scientific Societies on the Need to Take Urgent Action against Human-Caused Climate Change, Based on Scientific Evidence: Development and Overview.**

Scott Bonar (American Fisheries Society)

The world's aquatic resources are now under their greatest threat in human history and human-caused climate change is accelerating the degradation of aquatic ecosystems and the services they provide. 111 aquatic-science societies, including the Desert Fishes Council, representing over 80,000 scientists from all 7 continents authored a statement to the world's public and policymakers. The statement summarized key scientific findings highlighting the effect of climate change on freshwater and marine aquatic ecosystems, and the people who depend on them (essentially everyone). These findings provide evidence of what effects are currently happening and why world policymakers and all of humankind need to act jointly and launch concerted actions now if they wish to mitigate these impacts. The statement was released September, 2020. Overviews of the statement have been reported in both scientific and popular press worldwide and show how the power of scientific societies and their associated scientists can be harnessed to collaborate across regions to draw attention to large-scale issues.

12:00-13:00 **Lunch**

13:00-14:45 **Pre-recorded Presentations**

Pre-recorded Presentations can be viewed here

13:00 **Behavioral response of loach minnow, *Tiaroga cobitis*, to nonnative predators**

Edward Wild[1], Keith Gido[1] and Lindsey Bruckerhoff[2] (1-Kansas State University, 2-U.S. Geological Survey OK Cooperative Fish and Wildlife Research Unit)

Population declines of loach minnow, *Tiaroga cobitis*, throughout their range have been partially attributed to nonnative predation. Despite population declines, there are some systems where loach minnow coexist with nonnative predators, questioning the mechanisms that might allow coexistence of these species. Due to their endangered status, it is difficult to justify the removal of wild loach minnow to conduct predator-prey experiments that could result in mortality of individuals. As an alternative, we tested the behavioral response of captive reared loach minnow to the presence of smallmouth bass, *Micropterus dolomeu*i, or flathead catfish, *Pylodictus olivaris*, in complex outdoor experiment stream mesocosms. We predicted increased movement associated with foraging in the absence of predators and that loach minnow would avoid pools with predators present. Movements of both predators and prey were monitored continuously by PIT tagging all fish and placing submersible PIT antennas in the stream mesocosms. Both smallmouth bass and flathead catfish consumed loach minnow during the experiment. Loach minnow movement decreased after the addition of smallmouth bass trials but not following the addition of flathead catfish. Contrary to our prediction, loach minnow did not avoid pools with flathead catfish or smallmouth bass. Compared to a similar experiment with co-evolved predator and prey fishes, loach minnow were less responsive to nonnative predators, particularly flathead catfish. These results might help prioritize the management of nonnative predators that expand into loach minnow habitats.

13:15[CLH] **Fidelity, proximity, and climate determine tributary use of spawning flannelmouth sucker in a desert river**

Sophia M. Bonjour[1], Keith B. Gido[1], Mark C. McKinstry[2], Charles N. Cathcart[3] and Matthew R. Bogaard[1]. (1-Kansas State University, 2-Bureau of Reclamation, 3-Alaska Department of Fish and Game)

Migration of spawning flannelmouth suckers, *Catostomus latipinnis*, from mainstem rivers into tributaries has been documented throughout the Colorado River Basin. In the San Juan River basin, McElmo Creek serves as the only perennial tributary without dams or diversions within 10 km of its mouth and annually hosts thousands of spawning flannelmouth sucker. We used nine years of passive integrated transponder (PIT) and radio telemetry data to quantify 1) where spawning fish in this tributary were tagged in the winter, 2) inter-annual variation in the timing of arrival and duration of stay in the tributary and 3) the prevalence of tributary fidelity of migrating fish. Fish PIT tagged in the San Juan River closer to McElmo Creek in December 2020 were more

likely to spawn there the following March (50% of fish tagged 5-13 kilometers and 20% of fish tagged 35-42 km from the mouth of McElmo Creek). During wetter years (2017, 2019) fish moved into McElmo Creek earlier (median arrival 25 days earlier) and stayed longer (median residency time 44 vs 20 days). Fish PIT tagged in 2013 and 2014 had an apparent survival of 0.79 and detection probability of 0.67-0.99 from 2014 - 2020 indicating high fidelity and annual return to McElmo Creek. Recognizing patterns and variability in flannelmouth sucker tributary spawning is important for understanding the role of flannelmouth suckers in these systems and how changes in flow patterns may affect them.

13:30 **2021 Bonneville Basin Coordinator Update**

Drew Dittmer (Utah Division of Wildlife Resources)

1) Wetlands in Snake Valley serve as critical habitat for at least five of Utah's Species of Greatest Conservation Need (SGCN), including four species threatened by groundwater withdrawal. The Utah Geologic Survey has been leading efforts to monitor the area and this year released the following report:

Goodwin, P., Inkenbrandt, P., Menuz, D., Hurlow, H., and Dittmer, D., 2021, Snake Valley hydrologic monitoring—ten-year report: Utah Geological Survey Open-File Report 732, 36 p., 2 appendices, https://doi.org/10.34191/OFR-732.

2) A manuscript titled "A Successful Reintroduction of Columbia Spotted Frog, *Rana luteiventris*, Through Repatriation of Recently Hatched Larvae," is in press and will be available in 2022 in Ichthyology & Herpetology. It was authored by the following Utah Division of Wildlife Resources (UDWR) employees: Paul Thompson, Chante Lundskog, and D.E. Dittmer.

3) Manti Meadows is a wetland and Waterfowl Management Area (WMA) managed by the UDWR. Since 2018, Utah's Watershed Restoration Initiative has funded efforts to restore and improve habitat conditions at Manti Meadows. Prior to 2018, the entire area was dry but restoration efforts have successfully reestablished shallow, fishless aquatic habitat. Currently UDWR is developing plans to introduce a refuge population of Least Chub, *Lotichthys phlegenthontis*, in the WMA. Additionally, UDWR is planning to repatriate Columbia Spotted Frog as there are historic records of the species in the area.

4) Since 2020 the UDWR Native Aquatics section has been working closely with the Utah Natural Heritage Program to digitize species locality records into ArcGIS web maps. Presently we have developed web maps for Least Chub and Columbia Spotted Frog. These web maps serve as digital repositories of information that can be used to to inform species distribution models, habitat models, and aid in the revision of our Wildlife Action Plan SGCN list.

5) UDWR is continuing to formalize its efforts to manage and conserve Utah's native Mollusks. Some notable achievements include: 1) finalizing the Conservation Agreement and Strategy for springsnails; 2) conservation actions to benefit the Sub-globose Snake Pyrg, *Pyrgulopsis saxatilis*; and 3) significant

improvements in the distribution knowledge of Winged Floater, *Anodonta nuttaliana*, and Western Pearlshell, *Margaritifera falcata*.

13:45[CLH] **Evaluation of Antipredator Responses and Evolutionary Naïveté for Three Western Fish Species**

Cody M. Anderson[1], Brian D. Wisenden[1] and Craig A. Stockwell[1] (1-Department of Biological Sciences, North Dakota State University)

Many desert fishes that evolved in isolated aquatic communities with limited predation have been dramatically impacted by non-native predators. These observations are consistent with the evolutionary predator naïveté hypothesis. To explore this possibility, we evaluated antipredator behavioral responses of Shoshone pupfish, *Cyprinodon nevadensis shoshone*, Amargosa River pupfish, *C. n. amargosae*, and Red River pupfish, *C. rubrofluviatilis*. These pupfishes represent a species that evolved without natural predators (Shoshone pupfish), a species in a simple community of itself and one other small fish species (Amargosa River pupfish), and a species from a complex community with many other fish, including native predators (Red River pupfish). Antipredator behavior was evaluated by behavioral responses to conspecific alarm cues (chemicals released when epidermal tissue is damaged by a predator) in terms of change in vertical position in the water column and activity level before versus after delivery of alarm cue compared to behavioral response to water. Contrary to predictions of the predator naïveté hypothesis, all three species significantly reduced vertical position in response to conspecific alarm cue and showed no response to water (control). These findings are not consistent with the predator naïveté hypothesis, but are consistent with observations that various pupfish species can co-persist with non-native predators.

14:00 **Incorporating passive antenna detections with physical recaptures improves survival rate estimates for Razorback Suckers, *Xyrauchen texanus*, stocked in the Upper Colorado River Basin**

Koreen Zelasko[1], Kevin Bestgen[1] and Gary White[2] (1-Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, 2-Department of Fish, Wildlife, and Conservation Biology, Colorado State University)

Quantified demographic rates are useful for evaluating status and trajectory of an animal population. The most recent Recovery Goals (2002) for endangered Razorback sucker, *Xyrauchen texanus* (Abbott), family Catostomidae, require that two “genetically and demographically viable, self-sustaining” adult populations, each exceeding 5,800 individuals, exist in the Upper Colorado River Basin (UCRB) before downlisting or can occur. Between 1995 and 2017, nearly 400,000 Razorback Suckers were stocked into the UCRB to help achieve that target. In the absence of sustained, measurable recruitment, survival estimation is a valuable metric to assess status of the stocked population. From 1995 through 2006, physical mark-recapture data and analyses yielded low first-year survival, particularly for smaller fish stocked during summer months. Since that time, physical captures of Razorback

Suckers have increased, and the distribution and numbers of passive PIT-tag detection technologies (portable “flat plate” and “wagon wheel” antennas at congregation sites; fixed passive interrogation antenna arrays in tributaries, at fish ladders, and in diversion canals; and submersible ultrasonic receivers to detect radio tags associated with PIT tags) resulted in hundreds of thousands of Razorback sucker encounter records and documented movement between the UCRB and the San Juan River basin (SJRB) as well as first encounters of fish at large many years after stocking. We incorporated passive detection data alongside traditional, physical mark-recapture data to provide more up-to-date and robust survival rate estimates for hatchery-reared Razorback Suckers stocked into the UCRB. Here, an “encounter” is any record of a Razorback sucker after initial stocking. A “capture” is any encounter produced by physical sampling and handling after stocking. A “detection” is any encounter produced by the passive technologies mentioned above. We used the Barker model to incorporate detections with captures that were collected from nearly 1,300 river miles of the UCRB, SJRB, and associated river inflows to Lake Powell, 2003–2017. Of the 321,233 fish stocked in the UCRB, 93% were never seen again and 7% were later encountered. Of those encountered, 62% were physically captured over 15 years, while 30% were detected during only the last five years of the study. The remaining 8% were encountered by both means. The survival portion of the top-ranked model included effects of time since stocking, season of stocking, and total length at stocking. Survival rates were low in a fish’s first year and lowest for smaller fish stocked in summer, supporting earlier analyses. Mean first-year survival rates for 350-mm-TL fish stocked in spring, summer, and autumn were 0.57, 0.18, and 0.46, respectively, with low mean coefficients of variation of 6, 9, and 5%. Mean survival after the first year was 0.80. The survival estimates were higher than those from our previous analysis from 1995–2006, which included only captures. Capture probabilities from physical encounters were low during first sampling occasions (mean: 0.06, range: 0.01–0.18) and declined thereafter. Detection probabilities from passive encounters were higher for fish stocked into the Green River subbasin (mean: 0.03, range: <0.01–0.16) than the Colorado River subbasin (mean: 0.01, range <0.01–0.04). This study was the first to employ the Barker model to estimate survival rates of hatchery-reared Razorback Suckers and include detections as year-round resights, rather than as additional physical captures within discrete capture occasions. Incorporating cost-effective passive detections alongside physical captures yielded the most robust estimates available for hatchery-reared Razorback Suckers, which will aid evaluation of stocking practices and progress toward recovery.

14:15[CLH] **Efforts in the development of Trojan sex chromosome carrying Red Shiner (*Cyprinella lutrensis*) and Green Sunfish (*Lepomis cyanellus*) for the control of nuisance populations in the Southwest**

Chad Teal[1], Daniel Schill[2], D. Katharine Coykendall[3], Matthew Campbell[3], Susan Fogelson[4], Daniel Eardley[3], Thomas Delomas[3], Colby Roberts1, Melanie Culver[5], Kevin Fitzsimmons[6] and Scott Bonar[5] (1-University of Arizona, 2-Fisheries Management Solutions Inc, 3-Idaho Dept of Fish and Game, 4-Fishhead Labs, LLC, 5-U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, 6-Dept. of Environmental Science- University of Arizona)

Red Shiner *Cyprinella lutrensis* and Green Sunfish *Lepomis cyanellus* are considered highly invasive when introduced outside of their native range. Trojan sex chromosome eradication models have shown the release of YY males (or ZZ females) to be effective at suppressing and eradicating invasive populations of species across genera. Developing Trojan sex chromosome carrying individuals requires aquaculture protocols, knowledge about gonadal development, identification of sex determination systems, and sex reversal methods for the species of interest. We have developed aquaculture protocols for Red Shiner and Green Sunfish. Red Shiner's gonadal differentiation was observed between 45 days post hatch (dph) – 105 dph. Green Sunfish's gonadal differentiation was observed between 39 dph – 69 dph. We observed 100% feminization of Red Shiner fed 100 mg Estradiol-17β (E2) kg^(-1) of diet from 20 dph – 120 dph. We observed 100% feminization of Green Sunfish fed 100 mg E2 kg^(-1) of diet from 30 dph – 90 dph. Using restriction-site associated DNA sequencing we developed a single nucleotide polymorphic sex identification marker that is heterozygous in male Red Shiner. This sex identification marker was 95.74% (45/47) accurate at identifying phenotypic sex in unrelated Red Shiner individuals, thus providing evidence of a female-XX/male-XY sex determination system in this species. All developed and tested sex identification markers for Green Sunfish were unreliable as an identifier of phenotypic sex. It is possible that the sex determination system in Green Sunfish is polygenic and there maybe environmental effects on sexual differentiation in this species. Our results are useful for assessing the potential use of a Trojan sex chromosome eradication strategy to control nuisance populations of Red Shiner and Green Sunfish.

14:30[CLH] **Assessing a capture-translocation strategy to improve spawning migration connectivity of Razorback Suckers, *Xyrauchen texanus*, in the San Juan River**

Matthew Bogaard[1], Keith Gido[1], Mark McKinstry[2], Casey Pennock[3], Adam Barkalow[4], Benjamin J. Schleicher[5], Brian Hines[6], Katherine Creighton[6], Sophia Bonjour[1], Jerrod Bowman[7] and T. Kim Yazzie[7]. (1-Kansas State University, 2-Bureau of Reclamation, 3-Utah State University, 4-New Mexico Department of Game and Fish, 5-US Fish and Wildlife Service, 6-Utah Division of Wildlife Resources, 7-Navajo Nation Department of Fish and Wildlife)

In the southwestern United States, decades of water diversions, construction of large impoundments, and loss of floodplain habitats have all contributed to a highly fragmented riverine landscape. Additionally, barriers negatively impact population vital rates of riverine fishes that rely on connectivity between migratory routes to complete components of their life cycle, such as reproduction and recruitment. A capture-translocation strategy has been implemented for Razorback Suckers, *Xyrauchen texanus*, in the San Juan River to mitigate negative effects of barriers, while precluding nonnative species. Our goal was to use radio telemetry to assess movement behavior of Razorback Suckers following translocation above two barriers in the San Juan River. We deployed fixed remote radio receivers to determine residency time above each barrier and conducted mobile telemetry surveys to monitor

upstream movements following translocation. Although individuals are likely to return downstream of a barrier within a year of translocation, we expected most individuals remained upstream long enough to successfully spawn. After translocation above the Piute Farms Waterfall, (PFW) 80% of individuals remained upstream for 26 days in 2020 and 23 days in 2021. Movement dynamics differed following translocation above the Public Company of New Mexico (PNM) weir, where 80% of individuals remained upstream for 37 days in 2021. At each barrier, we observed upstream movements ranging from 2 to 262 km and detected distinct aggregations within the expected spawning season. While translocation efforts may seasonally reconnect migratory routes for a proportion of the population, continued management and mitigation will be needed to improve the reproductive potential of this imperiled species.

14:45-15:45 Interactive Poster Session II

15:45-16:00 Awards

End of Meeting

Posters

Posters can be viewed throughout the meeting here

PA indicates posters competing for the Student Poster Award

Wednesday

Assessing conservation potential of streams for Spikedace and Loach Minnow using species distribution modeling

Brian Hickerson[1], Evan Booher[2], Elizabeth Grube[1] and Anthony Robinson[1] (1-Arizona Game and Fish Department, 2-Washington Department of Fish and Wildlife)

Identifying, evaluating, and prioritizing freshwater systems for conservation is a persistent challenge for managers tasked with conservation and recovery of native fishes. We used historical records from the lower Colorado River basin aquatic gap dataset, the national hydrography dataset (NHD), and Random Forest modeling to predict probability of Spikedace and Loach Minnow occurrence throughout their range in the Gila River basin. Models for both species performed moderately well, with relatively high predicted probability of occurrence at streams with historical records. Predicted probability of occurrence was also relatively high in several streams without historical records of focal species, suggesting that there are unoccupied reaches throughout the Gila River Basin with similar environmental conditions to historically occupied reaches for both species. Unoccupied reaches with the highest predicted probability of occurrence may have a greater chance of supporting translocated populations of focal species. Our results can be used as a first step for locating reaches most likely to support translocated populations of Spikedace and Loach Minnow within their respective historical ranges. Our approach may be applicable to other species of conservation concern with available historic records in need of population replication.

Wednesday[PA]

Nonnative Virile Crayfish (*Faxonius virilis*) Distribution and Density in Secondary Channel and Island Backwaters of the San Juan River, NM, CO, and UT

Michaela Fishback[1], James Whitney[1], Blake Hansen[1] and Amber Bell[1] (1-Pittsburg State University)

The non-native Virile Crayfish (*Faxonius virilis*) has been observed throughout the Colorado River basin, where it has negative impacts on native fishes and macroinvertebrates. The San Juan River is a major tributary of the Colorado River where Virile Crayfish are present, although their distribution, abundance, and potential impacts in the San Juan River have yet to receive extensive study. The San Juan River hosts several imperiled fish species (e.g., Colorado Pikeminnow (*Ptychocheilus lucius*); Razorback Sucker (*Xyrauchen texanus*)) which may be impacted by Virile Crayfish, thus further information on this nonnative species is needed for effective conservation and management. The objective of our research was to quantify spatiotemporal variation in Virile Crayfish density in the San Juan River along an 89-river kilometer reach between Shiprock, New Mexico and Montezuma Creek, Utah. Within this reach we focused our sampling on secondary channel and island backwater habitats, as they are crucial nursery habitats for imperiled native

fishes. We seined 50 m sites within 20 backwater habitats (10 secondary channel and 10 island), with each site sampled four times from July 2021 through September 2021, for a total of 80 sites. All captured individuals were counted, had their length measured from the rostrum to the telson, and then were returned to their capture habitat. We calculated density (#/100m2) for each site and sample period by dividing number of individuals captured by sample area. We collected a total of 457 Virile Crayfish at 40/74 (54%) sites; we did not sample all 80 sites because high and low flows prevented sampling at some sites during certain sample trips. Mean density of Virile Crayfish was 2.25/100m2 and ranged from 0.00 to 26.90/100m2. Mean density in secondary channel backwaters was 2.95/100m2 and ranged from 0.00 to 26.90/100m2, whereas in island backwaters mean density was 1.42/100m2 and ranged from 0.00 to 18.24/100m2. We found that nonnative Virile Crayfish attain higher densities in secondary channel backwaters than in island backwaters, possibly due to secondary channels exhibiting lower water velocity and connectivity with the mainstem compared to island backwaters. The higher densities of Virile Crayfish in secondary channel backwaters could result in competition with and predation on the early life stages of imperiled fishes that prefer these habitats as nursery areas. For these reasons, further study concerning how nonnative Virile Crayfish are impacting native fishes in the San Juan River is warranted.

Wednesday

So Long Sucker: Comparing Growth Rates among Purebred Suckers and their Hybrids in a Laboratory Setting

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Flannelmouth Sucker (*Catostomus latipinnis*) and Razorback Sucker (*Xyrauchen texanus*) are two catostomids endemic to the Colorado River basin, and are known to hybridize with one another. Due to human altered river conditions (e.g., dams, water diversions, water withdrawals) and the introduction of nonnative species, many native fish populations within the Colorado River basin have declined. Razorback Sucker recruitment in the wild is low due to these stressors, and thus they have experienced largescale declines throughout the river. The scarcity of Razorback Sucker, and the rareness of conspecific mates, increases the probability of hybridization with the abundant Flannelmouth Suckers. Do hybrids have a competitive advantage over Razorback Sucker or Flannelmouth Suckers, and how might that affect the management and conservation of Razorback Suckers? We investigated the differences in growth rates between four progenies: Razorback Sucker, Flannelmouth Sucker, and their hybrids: Razormouth Sucker (RBS♀ x FMS♂), and Flannelback Sucker (FMS♀ x RBS♂), at two size classes: juveniles (< 130mm) and sub-adults (>130mm). Both juvenile and sub-adult hybrids grew faster than purebreds. For both size-classes combined, hybrid growth rates were 0.103 mm/day compared to 0.085 mm/day for Razorback Sucker and 0.058 mm/day for Flannelmouth Sucker. The presence of higher growth rates in hybrids suggests a life-history advantage exists in hybrids over purebred suckers, which could hinder the genetic integrity and recovery of the Razorback Sucker.

Wednesday[PA]	**Diel fluctuations in Comanche Springs Pupfish Abundances in San Solomon Springs, Balmorhea State Park** Lauren Yancy[1], Joshuah Perkin[1] and Matt Acre[2] (1-Texas A&M University, 2-USGS Columbia Environmental Research Center) The Comanche Springs Pupfish (*Cyprinodon elegans*) is a freshwater species only found in spring systems in the vicinity of Balmorhea, Texas in the Trans-Pecos region. The species was previously found in Comanche Springs in Fort Stockton, Texas until the springs ran dry because of groundwater depletion. The largest remaining population of Comanche Springs Pupfish occurs at Balmorhea State Park and is closely monitored and surveyed by the Texas Parks and Wildlife Department. The goal of this study was to assess diel behavior of the Comanche Springs Pupfish to test for diel variation consistent with the more widely studied Devils Hole Pupfish (*Cyprinodon diabolis*) that shows strong depth associations across gradients of light intensity. We hypothesized that Comanche Springs Pupfish abundance would be greater in shallow, concrete-bottom pool habitats during the day (when other fishes are absent) compared with night. To test this hypothesis, we conducted 9 repeated surveys (4 during the day; 5 at night) of pupfish abundance using a 1-m by 1-m quadrat to conduct visual counts along the shallow edge of San Solomon Pool. We then fit a generalized linear mixed model to predict pupfish abundance using space (distance from deep water) and time (day or night). We found significantly higher abundances of pupfish in the shallow water during the day compared with the night, supporting our initial hypothesis. Distance from deep water was not a statistically significant predictor of pupfish abundance. Our findings for Comanche Springs Pupfish show a reversed pattern of shallow water habitat use across the diel cycle compared with Devils Hole Pupfish, and therefore highlight variation in behaviors among pupfish species. The results of this study can be used by managers to identify ideal times to conduct visual-based population abundance counts that yield the most accurate results.
Thursday	**2021 Upper Colorado Area Report** David Speas (U.S. Bureau of Reclamation) Despite another year of extremely dry conditions and continuation of the COVID-19 pandemic, a number of exciting native fish conservation stories surfaced in the Upper Colorado River Basin during 2021, including: Palisade High School (Palisade, CO) students stocked 200 razorback sucker, *Xyrauchen texanus*, into the Colorado River, fish that they had reared themselves at their own hatchery; razorback sucker continued to spawn in Roubideau Creek, CO for the seventh year in a row, as did thousands of non-listed native suckers; after five years of planning, coordination, and construction, the San Juan Watershed Group and partners completed a fish passage at the Ranchmans-Terrell Irrigation Diversion on the Animas River (Flora Vista, NM); a new paper from San Juan River researchers showed that flow conditioning before stocking doubles razorback sucker survival; the Nature Conservancy and partners made progress toward securing base flows in the Price River, UT, for native fish conservation; the National Park Service

	conducted fish community surveys in four Capitol Reef NP streams; research by Utah State University continued on native fish use of complex habitat in the San Rafael River and the role of beaver in maintaining stream habitat complexity; construction began on a water control structure at the Stirrup floodplain wetland (middle Green River, UT) for use in rearing wild-spawned razorback sucker larvae and potentially production of bonytail, *Gila elegans*, in a wild setting; a first-of-its kind flow spike release was conducted at Flaming Gorge Dam (Green River, UT/CO) to disadvantage non-native smallmouth bass; research continued on native fish movement in the Blacks Fork River (Wyoming) and other tributaries to the Green River; downlisting of humpback chub, *Gila cypha*, from endangered to threatened status neared completion, and the Fish and Wildlife Service proposed downlisting for endangered razorback sucker; and more! Don't miss it.
Thursday	**Lower Colorado River Area Report** Ronald Rogers (BIO-WEST) The lower Colorado River Basin encompasses an area that spans from Lee's Ferry, Arizona, approximately 15 river miles below Glen Canyon Dam (Lake Powell), to the Gulf of California (Sea of Cortez), Mexico. Historically, the dynamic nature of river would have meandered across large flood plains, creating isolated pools, oxbow lakes, and backwater habitats, that were broken in small areas by when not bound by narrow canyons and high gradient reaches. This ecosystem was home to numerous species of fish, reptiles, plants, and invertebrates. However, in less than 100 years, a system of dams, diversions, levees, and canals has left this region as one of the most managed rivers in the world. Many scientists are currently working within the basin to better understand, conserve, and enhance endangered, threatened, and native fish populations. This report highlights some of the research, monitoring, and recovery efforts for fishes within the lower Colorado River Basin.
Thursday[PA]	**Trade-offs among life history traits and parasite intensity in the White Sands pupfish (*Cyprinodon tularosa*)** Justin Waraniak[1], David Rogowski[2] and Craig Stockwell[1] (1- Department of Biological Sciences North Dakota State University North Dakota State University, 2-Arizona Game and Fish Department) The White Sands pupfish (*Cyprinodon tularosa*) is a threatened species historically found in four desert spring and stream systems in the Tularosa Basin, New Mexico, USA. Of these, the Salt Creek and Malpais Spring populations are native whereas the Lost River and Mound Spring populations were established in the 1970's and are descended from the Salt Creek population. Previous work has shown evidence for local adaptation associated with high inter-system variation in flow, salinity, and trematode parasite densities. This study was designed to characterize life history traits within each of these systems to determine whether differences in environmental conditions and parasites have caused differentiation of life history strategies among *C. tularosa* populations. A total of 768 females were collected from the

four populations during the summers of 2000 and 2001. Scale-based age estimates, body size, body composition (dry weight, lipid content), reproductive tissue mass, and parasite loads were measured for each fish. Multivariate analyses of life history traits showed high variation within systems, but little variation that could effectively discriminate among systems. These results suggest that environmental differences have not led to noticeable differentiation in life history traits among the populations of the White Sands pupfish. This contrasts with the differences in body shape observed in these same systems in previous studies. There was no clear evidence for a direct trade-off between parasite intensity and reproductive effort, but rather, this trade-off appears to be mediated by fat stores and body size. Parasite infections and reproductive investments resulted in reductions of fat stores and the consequences of parasite infections were more severe for smaller fish.

Thursday[PA] **Measuring Activity Levels in Razorback Sucker *Xyrauchen texanus* and Flannelmouth Sucker *Catastomus latipinnis***

Robert Chadwick, David Rogowski and Crosby Hedden

The Razorback Sucker, *Xyrauchen texanus*, and the Flannelmouth Sucker, *Catastomus latipinnis*, are both native to the Colorado River basin. Razorback Suckers have been listed under the Endangered Species Act since 1991, and are still critically endangered, while Flannelmouth Suckers are a species of special concern in Arizona. Extensive effort is devoted to both recovery actions and monitoring for Razorback Suckers. Understanding activity levels, i.e. movement during different times of day, of this species may have important implications for stocking and monitoring. We are proposing to investigate diel activity levels of Flannelmouth and Razorback Suckers. Fish will be monitored with a camera taking photos every 15 seconds over the course of 72 hours. Understanding of Razorback and Flannelmouth Sucker diel activity may suggest optimal times of the day to stock Razorback Sucker which may decrease mortality of stocked fish and might be helpful for designing more effective sampling methods for both species and benefit the conservation of the Flannelmouth and Razorback sucker.

Thursday[PA] **Effects of thermal environment on reproductive physiology in Amargosa pupfish, *Cyprinodon nevadensis amargosae***

Maddie Housh[1] and Sean Lema[1] (1-California Polytechnic State University, San Luis Obispo)

Desert pupfishes of southwestern North America present an ideal system for examining how thermal experience shapes physiology. As a consequence of being confined to isolated aquatic habitats, many of which show extreme environmental fluctuations, pupfishes have evolved some of the broadest and most extreme thermal tolerances among freshwater fishes. Despite this, pupfish reproduction is thermally sensitive, becoming impaired many degrees below the thermal maximum. Physiologically, reproduction is regulated through hormone production via the hypothalamic-pituitary-gonadal (HPG) axis, and high temperature exposure has been found to reduce circulating

levels of estradiol, which is integral to processes such as egg development and mating behavior. Given current warming of inland aquatic ecosystems due to anthropogenic climate change, it is crucial to explore how thermal experience affects pupfish reproductive physiology, and whether thermal acclimation can impart physiological plasticity that benefits reproduction under future warming conditions. Here, we examined the effects of elevated temperatures on the reproductive physiology of Amargosa pupfish (*Cyprinodon nevadensis amargosae*) by maintaining adult fish for 44 days under three temperature conditions: stable 25°C, stable 35°C, or a regime of temperatures that fluctuated diurnally between ~25-35°C (mean: 30.5°C). Female pupfish at 35°C and under the fluctuating regime had lower gonadosomatic index (GSI) values compared to females at 25°C. Females at 35°C also had lower body condition (k) despite the absence of any difference in hepatosomatic index (HSI). Liver expression of genes involved in egg development, vitellogenin A (vtgA) and choriogenin L (cgL), were reduced in females at 35°C and fluctuating conditions compared to those at 25°C. Temperature did not, however, affect GSI or HSI in males. These findings suggest that oogenesis is more sensitive to elevated temperatures than spermatogenesis in pupfishes and demonstrate that oogenesis can be affected by elevated temperature even when increases occur in ecologically relevant fluctuating temperature regimes similar to those of stream and spring outflow channel pupfish habitats.