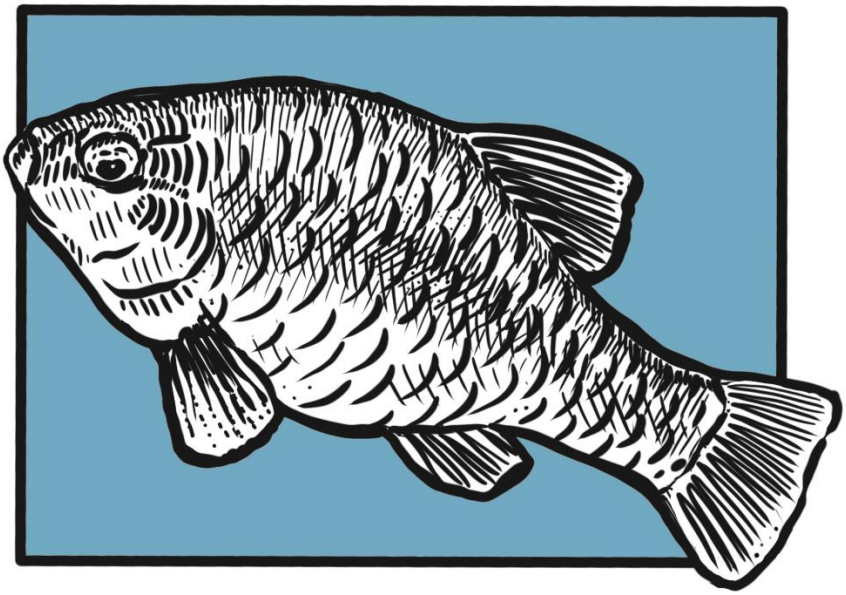
Desert Fishes Council 55th Annual Symposium, 2023
Bishop, CA, USA

LONG PROGRAM



Owens pupfish artwork by Rosa Cox

THANKS TO LOCAL HOST & MEETING ORGANIZERS
PHIL PISTER & MICHAEL BOGAN!

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MEETING SCHEDULE:

WEDNESDAY AFTERNOON, NOVEMBER 15 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

16:00-18:00: Registration

16:00-18:00: Presentation loading in person (if not emailed ahead of time)

THURSDAY MORNING, NOVEMBER 16 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

08:00-10:00: Registration

Opening ceremonies

09:00-09:15: Welcome – **Kevin Wilson**, President; **Michael Bogan**, Local Host

*Student Awards Session – **Ed Kluender**, moderator*

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

09:15-09:30: Genetic & genomic advances on the analysis of hybridization & introgression in the Yaqui catfish, *Ictalurus pricei* (Rutter, 1896) – **Alexsandre Gutiérrez-Barragán*, Alejandro Varela-Romero, Francisco Garcia-De Leon, Mariana Mateos, Carlos Alonso Ballesteros-Córdova, José Manuel Grijalva-Chon, John Carlos Garza & José Raul Romo-León**

The Yaqui catfish *Ictalurus pricei* is a native species of the northwestern Mexico and southwestern United States and is endangered due to loss of most of its historical recorded populations. Furthermore, hybridization with the exotic channel catfish *I. punctatus* threatens the few native remaining populations, increasing the risk of extinction. In the present work, mitochondrial Cytb and COXI and nuclear RAG1 and RAG2 genes were analyzed to detect hybridization evidence with channel catfish. Also, 23 individuals from Arroyo Cajón Bonito (Río Yaqui basin) were subjected to Whole Genome Sequencing (WGS) to detect evidence of introgression based on 1 million Single Nucleotide Polymorphisms (SNPs). Based on mitochondrial and two nuclear genes, hybridization was detected in Río Yaqui and Río Fuerte basins, as well as possible genetic introgression in the Río Tutuaca (Yaqui basin). Specimens sampled from the Río Mayo (following >20 years hiatus of Yaqui catfish collections), shown the presence of both Yaqui and channel catfish mitochondrial genes, indicating the presence of both species and/or their hybrids. Admixture results showed that 20 of 23 Arroyo Cajón Bonito individuals have 100% ancestry of Yaqui catfish, 17 of which are being kept alive in a stock for future reproduction. Of the remaining three individuals, the first was a pure channel catfish, the second was an F1 hybrid (50% ancestry of both species), and the third had 70% Yaqui and 30% channel catfish ancestries, indicating its status as a backcross. Thus, evidence of introgression at two localities of the Río Yaqui basin was detected using genes and WGS, demonstrating that hybrids are fertile and interbreed with the parental species, and thereby posing a major threat to the integrity of the Yaqui catfish. Further sampling and WGS analysis should be performed to better understand the negative impact of the introgression in the entire Yaqui catfish distribution, and to promote accurately informed management decisions and conservation plans between México and USA.

Contact – *alexsandre190195@gmail.com*

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

09:30-09:45: Assessment of predator naïveté for an insular fish species: the White Sands pupfish, *Cyprinodon tularosa* – **Molly Johnson*, Brian Wisenden & Craig Stockwell**

The predator naïveté hypothesis predicts that native prey that evolved with limited predation pressure will lack antipredator responses to non-native predators due to a lack of shared co-evolutionary history. Impacts of non-native predators on isolated desert fish populations have been attributed to predator naïveté. For example, Pahrump poolfish, *Empetrichthys latos*, were incapable of recognizing and responding to conspecific alarm cues, which may explain the high vulnerability of poolfish to invasive predators. Like the Pahrump poolfish, the White Sands pupfish, *Cyprinodon tularosa*, evolved in the absence of fish predators and have been isolated in the Tularosa Basin for approximately 2.5 million years. Testing *C. tularosa* to the predator naïveté hypothesis with conspecific alarm cue can shed light on their potential to detect and avoid invasive predators. In this study, we examined the behavioral responses of female *C. tularosa* to conspecific alarm cues in terms of fish activity and water column position. Pupfish reduced activity and moved to lower position in the water column in response to conspecific alarm cues. These antipredator behavioral responses are consistent with recent findings for several other pupfish species and suggest that *C. tularosa* have retained antipredator behaviors, despite a long period of isolation from fish predators.

Contact – *molly.i.johnson@ndsu.edu*

09:45-10:00: Conservation Genomics of Spikedace (*Meda fulgida*) – **Alex Cameron*, Megan Osborne & Thomas Turner**

Spikedace (*Meda fulgida*) is a small-bodied minnow endemic to the Gila River Basin (Arizona and New Mexico). Spikedace experienced geographic range contraction and declines in abundance in response to alterations of river flow and habitat, and coincident introduction of non-native species. To evaluate levels of genetic diversity, effective population size (Ne), and population structure we performed RAD-sequencing on 196 individuals from remaining wild populations and introduced populations. Genomic data consisted of 11,074 biallelic SNPs distributed across 25 chromosomes. Distinct lineages of Spikedace are present in Aravaipa Creek and the Upper Gila River. Aravaipa Creek retains the most genomic variation, suggesting long-term demographic stability compared with other wild populations. We found little evidence for natural selection contributing to the observed population structure. We recovered large effective population size estimates ($Ne > 500$) for wild populations in each lineage of Spikedace. However, there was considerable variability in Ne estimates among introduced populations, where two populations had low effective sizes ($Ne \leq 100$), but a third exhibited $Ne > 500$. Overall, these data highlight how demographic stochasticity contributes to genetic population structure among desert fishes.

Contact – *alcameron@unm.edu*

10:00-10:15: Odonate Predation on *Cyprinodon nevadensis shoshone* – **Bridger Scraper*, Craig Stockwell & Brian Wisenden**

Recent work in our lab showed that Pahrump poolfish *Empetrichthys latos* do not respond to conspecific alarm cues, perhaps due to predator naivete after long periods of isolation from predators. However, a pupfish species, Shoshone pupfish *Cyprinodon nevadensis shoshone* have retained antipredator responses to alarm cue despite thousands of years in allopatry from large fish predators. These recent findings suggest that antipredator behaviors may have been maintained for pupfish to respond to other classes of predators such as odonates. Although odonate predation on fish larvae and small-bodied fishes is likely, it has not been extensively evaluated. To explore this hypothesis, we set up 20 mesocosms, each with two male pupfish and four female pupfish. Treatments were randomly assigned within blocks and half of the tanks (n = 10) we added 30 dragonfly larvae to each treatment tank. The dragonfly densities were based on published surveys from various aquatic habitats at Ash Meadows National Wildlife Refuge. After 6 weeks, control tanks had 2.8 times more larvae than tanks that contained dragonfly larvae (266 vs. 95 per tank, respectively). Also, adult survival trended lower when housed with dragonfly nymphs. We conclude that dragonfly larval exert significant predation pressure on pupfish populations, especially on larval fish. These findings provide a possible mechanism for the retention of anti-predator behaviors in Shoshone pupfish, despite having evolved without predation pressure by fish.

Contact – *bridger.scraper@ndsu.edu*

10:15-10:30: **COFFEE BREAK**

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

10:30-10:45: Conservation genomics of endangered Death Valley pupfishes – **David Tian*, Nicolas Alexandre, Sean Lema, Bruce Turner, Olin Feuerbacher, Kevin Wilson, Michael Schwemm, Jennifer Gumm & Christopher Martin**

Small populations with limited geographic distributions are predicted to be threatened by inbreeding and lack of genetic diversity, both of which may negatively impact fitness and exacerbate population decline. Following the receding of pluvial lakes during the late Pleistocene, desert pupfishes in the Death Valley region became isolated in springs and creeks, limiting population sizes and connectivity. One of the most extreme examples is the Devils Hole pupfish (*Cyprinodon diabolis*), an iconic and critically endangered species with the smallest known habitat range of any vertebrate. Our previous research on this population found that levels of inbreeding were exceptionally high (FROH = 0.58) as a result of its demographic history. Over the past three decades, this endangered species has seen a significant decline in its population size, with two critical bottlenecks occurring in 2007 and 2013 when the population declined to 38 and 35 individuals, respectively. Our follow-up study assesses population structure, genetic diversity, structural variation, and past demographic history across desert pupfish species to understand how small, isolated populations cope with inbreeding. Here, we present two chromosome-scale de novo reference genomes of *C. diabolis* and *C. nevadensis mionectes*, and 150 resequenced genomes of Death Valley and Ash Meadows desert pupfishes. The development of these genetic resources will enable more accurate measurements of inbreeding and mutation load, comparisons of wild and captive populations of *C. diabolis*, and inference of genomic architecture for a lethal heart defect in some developing *C. diabolis* embryos.

Contact – *davidtian@berkeley.edu*

10:45-11:00: Limited genetic connectivity of aquatic invertebrate communities in Grand Canyon revealed using environmental DNA metabarcoding – **Jared Freedman*, Theodore Kennedy, Molly Burke & Dave Lytle**

The ability to disperse between habitat patches is a key life history trait that influences how aquatic invertebrates spread their genes, escape predation pressure, and seek out optimal habitats, with impacts on both the community and population scale. While the dispersal ability of every species is different, aquatic invertebrates with complex life histories face unique dispersal barriers such as stream network configuration, flow regime variation, and inhospitable terrestrial landscapes. Furthermore, anthropogenic alterations such as dam regulation and climate change have the potential to influence community-wide patterns of dispersal and genetic connectivity. In Grand Canyon, anthropogenetic habitat alterations have greatly reduced species diversity in aquatic invertebrate communities in the mainstem Colorado River, though little is known about the ability of invertebrates to disperse among tributary habitats. While dispersal is difficult to observe directly, gene flow can reveal dispersal patterns since individuals must move between populations for gene flow to occur. Following the isolation-by-distance (IBD) framework of Hutchison and Templeton (1999), the relationship between genetic and geographic distance can be used to classify gene flow across the study area, and therefore estimate the dispersal ability of each community member. Environmental DNA (eDNA) metabarcoding presents a promising method for this type of community-wide study of genetic connectivity and dispersal by enabling the simultaneous quantification of invertebrate community composition and the genetic diversity of the constituent species. To investigate gene flow and dispersal of invertebrates in Grand Canyon tributaries, we collected eDNA water samples from 22 perennial tributaries, as well as adjacent upstream mainstem Colorado River habitats, and performed metabarcoding sequencing on a short region of the aquatic invertebrate COI mitochondrial gene fragment. Applying strict denoising and filtering algorithms, we extracted exact sequence variants (ESVs; analogous to haplotypes) before clustering into operational taxonomic units (OTUs; analogous to species). For each OTU with sufficient diversity for population genetic analysis, we calculated pairwise Fst and pairwise river network distance and compared them using linear regression. We then classified population genetic structure of each OTU as low gene flow (low dispersal), medium gene flow (medium dispersal), or high gene flow (high dispersal). We identified 1,201 ESVs across 448 OTUs, with 148 OTUs comprised of multiple haplotypes. Of these 148 OTUs, 73 contained sufficient genetic variability to perform population genetic analyses, with 58 OTUs exhibiting low gene flow, 10 OTUs exhibiting medium gene flow, and 5 OTUs exhibiting high gene flow. This result suggests a widespread barrier to aquatic invertebrate dispersal that limits gene flow between tributary communities. The genetic isolation of many Grand Canyon invertebrates highlights the difficulties these invertebrates face in dispersing between viable habitat patches when separated by the dam-impacted Colorado River. Aquatic invertebrates form the base of the aquatic food web, so reduced gene flow creates fragmented and potentially vulnerable populations that can have detrimental upstream effects on fish and other consumers.

Contact – *freedmaj@oregonstate.edu*

11:00-11:15: Fish out of water: drying streams, steelhead (*Oncorhynchus mykiss*), & their invertebrate prey – **Jesse Fritz*, Matthew Orr & Dave Lytle**

More than half of global stream networks are non-perennial, and the frequency and duration of stream drying events are projected to increase globally due to climate change and human activities. By studying trophic interactions in non-perennial streams, we can better understand how these systems function and inform management strategies for their conservation in both natural and human-altered contexts. Recent research highlights the use of non-perennial streams by terrestrial and aquatic organisms, including spawning habitat by endangered steelhead (*Oncorhynchus mykiss*) and coho salmon (*Oncorhynchus kisutch*) of the Pacific Northwest. Whether these fish are simply surviving in these systems or benefiting from unknown advantages remains unclear. Our goal is to determine if differences in prey availability in perennial and non-perennial habitats are a factor influencing steelhead use of non-perennial streams. We collected diet samples of wild juvenile steelhead (n=100 individuals) and benthic invertebrate communities (n=24 samples) from both perennial and non-perennial sections of Thirtymile Creek, a high desert stream in Oregon, USA, from May through July 2022. We compared the biomass, abundance, and diversity of the steelheads' diets and the benthic invertebrate communities between the two habitats. Steelhead diets did not significantly differ between habitats. Further analyses using nonmetric multidimensional scaling (NMDS) of invertebrates collected from non-perennial and perennial sections will allow us to explore how different environmental variables in the two habitats influence steelhead diet and macroinvertebrate communities. Overall, our findings can inform conservation practices for steelhead in different stream habitats by exploring the dynamics of habitat-specific dietary patterns. Understanding how organisms subsist in non-perennial systems can help protect endangered species such as salmonids and preserve unique biodiversity in changing environments.

Contact – *fritzje@oregonstate.edu*

11:15-11:30: The conservation status of Nevada's native fishes: assessing risk & quantifying conservation threats – **Zachary Bess*, Sudeep Chandra, Zeb Hogan & Aaron Koning**

Nevada is the most arid state and hosts 45 extant native fish species. Ten of these species occur only in Nevada, confined to relatively small regions in the state. Despite the importance of these populations, a comprehensive evaluation of Nevada's native fishes has not been completed, and many of the populations remain relatively unstudied. For each of Nevada's 45 extant native fishes, we compiled existing data into detailed species profiles and then quantified the conservation statuses of these 45 species using a qualitative protocol previously used for quantifying the status of California native fish species. The qualitative protocol considered the effects of genetic risk, climate change, agriculture, feral horses and burros, cattle and livestock grazing, urban and rural development, angling and other recreation, hatchery stocking, mining and pollution, wildfire, and other potential threats. We compared score differences between game and non-game fishes, differences between taxonomic families, and differences between the state's three main basins (the Great Basin, Snake Basin, and Colorado Basin). Additionally, we compared these scores to existing assessments that were performed using the IUCN Red List Categories and Criteria. This assessment of Nevada's native fish diversity can inform the decision making of conservationists and agencies working to manage these populations against current and future threats.

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11:30-13:30: **LUNCH BREAK**

THURSDAY AFTERNOON, NOVEMBER 16 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

*General Session – **Pilar Rinker**, moderator*

13:30-13:45: Phylogenomic Analysis Confirms the Need for a Taxonomic Revision of the Pikeminnows (Teleostei: *Ptychocheilus*) – **Derek Houston**

Taxonomy is important for better understanding the natural world, classifying organisms for effective scientific communication, and for operational conservation of imperiled species. The pikeminnows belong to a genus (*Ptychocheilus*) comprising four species that are geographically distributed in western North America. Their taxonomic status has been called into question based on phylogenies wherein the genus is not monophyletic. However, a corresponding taxonomic change has not yet been made. We revisited this issue using DNA sequence data from ultraconserved genomic elements (UCEs). Our results support the hypothesis of a non-monophyletic (i.e., polyphyletic) genus *Ptychocheilus*. The Sacramento pikeminnow (*P. grandis*) appears to be a monotypic genus, and the desert dace (*E. acros*) more recently shared a common ancestor with the northern pikeminnow (*P. oregonensis*) and the Umpqua pikeminnow (*P. umpquae*) than did the Colorado pikeminnow (*P. lucius*). Thus, a taxonomic revision of the genus is needed. Following the Law of Priority in taxonomy, the northern pikeminnow should retain the genus name *Ptychocheilus*, as should the Umpqua pikeminnow, its sister species. The Colorado pikeminnow and Sacramento pikeminnow need to be assigned to new genera.

Contact – *derek.d.houston@gmail.com*

13:45-14:00: What are they doing down there? Further musings about the mysterious blind catfishes under San Antonio, Texas – **Dean Hendrickson**

Satan eurystomus (Widemouth Blindcat) and *Trogloanis pattersoni* (Toothless Blindcat) were finally proposed by US Fish & Wildlife (USFWS) for listing as Endangered on Aug. 22, 2023, with public comments accepted through October 23, 2023 (http://www.regulations.gov - search for rulemaking FWS-R2-ES-2023-0069). This proposal is likely to be controversial, given that the 2.6 million humans in the San Antonio metro area are mostly ignorant of the existence of these catfishes living a few hundred meters under their feet, but they are mostly very much aware that all of the water they consume comes from the aquifer in which the blindcats live. Mortality through entrainment in water wells is clearly a huge impact on both species. The listing proposal explores the very limited historical information about the species and threats to it, but compared to most every other species ever proposed for listing, these are far more difficult to study, and consequently very little is known about their basic biology. All wells are privately owned and almost no sampling of them has been allowed for decades. The resultant paucity of basic knowledge about the situation will clearly affect the decision-making process that will follow the comment period. This presentation will summarize the historical information used in the listing proposal, present diverse hypotheses about the life histories of both species and how they likely interact, explore how exploration of such hypotheses might shed further light on the decision-making process, and how the aquifer's much broader biodiversity could facilitate decision-making in ways beneficial to both the species and the humans living above them, if systematic biological sampling could be implemented in the future.

Contact – *deanhend@austin.utexas.edu*

14:00-14:15: Evaluation of the Green River Canal fish screen: Survival & physical assessment of Razorback Sucker using an innovative tagging method – **Cat Adams* & Kevin Bestgen**

Water diversions on rivers entrain substantial numbers of fish globally and are especially concerning when the species involved are rare and endangered. In the Upper Colorado River Basin, stationary Passive Integrated Transponder (PIT) tag antenna arrays detected entrainment of over a thousand native fish into the Green River Canal (GRC), Green River, UT between 2013-2018, including endangered Colorado Pikeminnow, Humpback Chub, Bonytail, and Razorback Sucker. In 2019, a fish weir and screen were installed at the canal entrance to reduce fish entrainment. This weir and screen structure was designed to return fish to the river via a return channel that can be accessed via flow through a bypass channel or over the screen, which reduced GRC entrainment by >99%. However, flows in the return channel, bypass channel, and over the screen are swift, turbulent and may cause mortality or physical damage. To investigate this, we released hatchery-reared Razorback Sucker (194 mm-450 mm TL) to assess their survival and condition before and after experimental releases through the bypass channel and over the screen; balloon tags facilitated timely post-release fish retrieval. Survival of fish recovered after passage through the bypass channel and over the screen was 100%. Razorback Sucker that traversed the bypass or the screen were only slightly more likely to sustain minor injuries than control fish. Moderate injuries on bypass and screen fish occurred at slightly higher rates than control fish but were rare overall; no severe injuries were noted. Also, smaller fish were more likely to sustain minor injuries than larger fish. High rates of Razorback Sucker GRC exclusion and survival post-passage, combined with low injury rates, indicated this design is effective, and may assist with fish conservation in the Green River and elsewhere.

Contact – *cat.adams@colostate.edu*

14:15-14:30: Lake Mead Fish Hatchery; A State Hatchery in Nevada Dedicated Solely to Rearing Native Fish – **Amos Rehm**

A brief history of the Lake Mead Fish Hatchery, from its origins as a trout hatchery through its transition into a native desert fish grow-out facility, highlighting challenges and creative solutions throughout this focal shift and its contribution towards recovery of endemic fish species.

Contact – *arehm@ndow.org*

14:30-14:45: Regrouping, resetting, & reinvigorating recovery of listed west Texas fishes: an update from the U.S. Fish & Wildlife Service on six species – **Maritza Mallek**

The Austin Ecological Services Field Office has U.S. Fish and Wildlife Service-wide lead responsibility for recovery of six 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*). The purpose of this talk is to introduce the new species lead (the author) and discuss ongoing and anticipated conservation efforts and agency assessments. The Service is currently developing status assessments (five-year reviews) for each of the six fishes. The previous set of five-year reviews for these species occurred 10 or more years ago, and there has been significant turnover in personnel assigned to these species during that interval. Therefore, an important component of the status assessments has been re-establishing relationships with public and private partners and compiling a coherent set of literature, data, and documentation regarding recovery efforts to date. This presentation will include an overview of our progress and a discussion of all major findings. Anticipated changes in U.S. Fish and Wildlife Service policy may create new opportunities to conserve these fishes, as well as other listed and at-risk species that are found in the same habitats. The talk will also discuss the most important next steps to pursue recovery, prevent extinction of these fishes, and reinvigorate partnerships with public and private entities.

Contact – *maritza_mallek@fws.gov*

14:45-15:00: **COFFEE BREAK**

15:00-15:15: Revisiting the Biogeography of the Owens Basin fishes – **Nicholas Buckmaster**

Biogeography requires a synthesis of both the geological and biological history in a region-creating a consensus narrative that proverbially describes ‘how things came to be.’ Interpretation of these disparate fields results in hypothesis that are periodically revised and revisited as new phylogenetic, paleontologic, and geologic information becomes available. This talk will review several recent genetic and geological studies centered on the paleo-Death Valley hydrologic system and focus on the Cypriniform fishes (Desert Speckled Dace, *Rhinichthys nevadensis*; Owens Sucker, *Catostomus fumeiventris*; and Owens Tui Chub, *Siphateles bicolor snyderi*) that inhabit the upper and lower Owens Basin. The geologic and phylogenetic data suggests recolonization of the entire proto-Owens River watershed from north and south following the Long Valley Caldera eruption. These fish were subsequently isolated within the Long Valley, Owens Valley, and Death Valley quaternary watersheds by both tectonism and glacial cycles.

Contact – *ngbuckmaster@gmail.com*

15:15-15:30: Ongoing restoration projects for the endangered Moapa dace, *Moapa coriacea*, & Virgin River chub, *Gila seminuda*, at the Moapa (Muddy) Warm Springs, Clark County, Nevada – **David Syzdek* & 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 1,933 Moapa dace in February 2023, and 1,888 Moapa dace in August 2023. Surprisingly, 23 young of year Virgin River chub were also detected by snorkel count in August 2023, showing the first documented reproduction of this species in the Warm Springs Natural Area since 1994.

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. This population persists but has been declining. In 2021, 90 Moapa dace were transferred to the Lake Mead Fish Hatchery for a NDOW fish propagation program and 18 progeny of these fish were released back into the wild in June 2023.

Contact – *david.syzdek@snwa.com*

15:30-15:45: Insights from 10 Years of operations at the Ash Meadows Fish Conservation Facility – **Jennifer Gumm*, Olin Feuerbacher, Daniel Villanueva, Ambre Chaudoin, Jeffrey Goldstein, Michael Schwemm, Kevin Wilson, John Wullschleger & Brandon Senger**

The Ash Meadows Fish Conservation Facility houses the only captive population of the Devils Hole pupfish (*Cyprinodon diabolis*). Recent population surveys estimate the population at approximately 450 individuals. This captive assurance population was established through the development of novel aquaculture methods and adaptive management of a refugia designed as an ecosystem mimic of the natural habitat. Herein, we summarize 10 years of operations at the Ash Meadows Fish Conservation Facility with emphasis on patterns in egg collections from the wild, egg viability, hatch rates, and survivorship in captivity. This retrospective highlights successes, challenges, and new opportunities that may ensure continued success in the conservation and recovery of the iconic Devils Hole pupfish.

Contact – *jennifer_gumm@fws.gov*

15:45-16:00: The distribution, status, & conservation of a narrow endemic, the Inyo Mountains salamander, *Batrachoseps campi* – **Christopher Norment*, Nicholas Van Gilder & Elizabeth Jockusch**

Between 2009 and 2023 we studied the distribution, ecology, and conservation genetics of the Inyo Mountains salamander, *Batrachoseps campi* (IMS). The IMS is endemic to the Inyo Mountains of California and one of only two extant plethodontid salamanders whose range is restricted to desert ecosystems. Survey efforts during this time resulted in the discovery of 5 new localities, increasing the documented localities to 24. We estimated that in the Inyo Mountains there are ± 15,200 m of IMS riparian habitat, the most common habitat for the species. IMS occurred across an elevation gradient from 523 to 2625 m, mostly ≤ 2 m from surface water. However, we found 9 IMS up to 1100 m from the nearest surface water, suggesting that populations may occur at other high elevation sites without permanent surface water. Riparian habitat supporting salamanders included a diverse mix of woody and herbaceous species. Some geographical variation in coloration occurred, with silver individuals common at 2 northwestern localities and very dark individuals predominating at 3 southern localities; individuals with intermediate amounts of dorsal silver were common elsewhere. Chytrid fungus, *Batrachochytrium dendrobatidis*, was absent from 36 IMS tested.

Genetic relationships among populations of IMS were analyzed using mitochondrial (n = 187 samples) and nuclear (double digest restriction-site associated DNA, n = 93 samples) data. Both datasets show 3 differentiated lineages, with higher genetic structure in the southern part of the range. A surprising amount of connectivity was noted across the main crest of the Inyo Mountains.

Long-term drought and intense flash flooding have impacted IMS habitat. Between 2010 and 2023 we observed decreased flow from 10 permanent water sources: 7 (29% of documented localities) support IMS. Although these declines generally appear small, continued drought could put small, localized populations at risk. Flash floods caused by convectional storms damaged riparian habitat in 46% of documented IMS localities, sometimes severely. However, we found little evidence for widespread IMS population decline across the species' range. Because all documented populations occur in federally-designated wilderness and many are difficult to reach, widespread direct human interference with the species is unlikely, as long as federal and state regulatory authority is maintained. However, climate models generally predict increased frequency and intensity of flash floods, which could further affect IMS habitat and populations. To provide better data for properly managing the IMS a standardized monitoring program should be implemented.

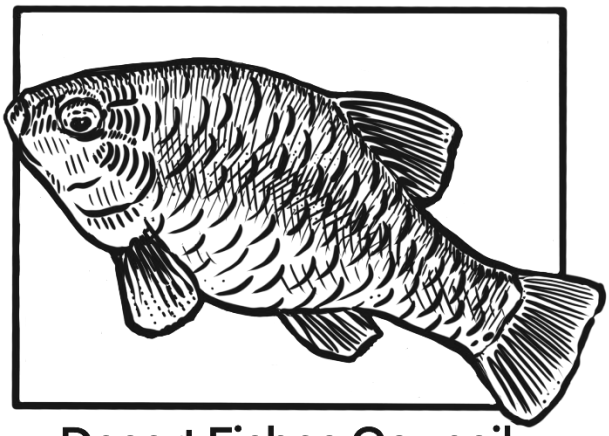
Contact – *cnorment@brockport.edu*

THURSDAY AFTERNOON & EVENING, NOVEMBER 16 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

16:00-18:00: Celebrating **Phil Pister** with stories & photos – join us for a celebration of Phil's life & legacy, & please share your stories during our open mic period as well

*18:00-20:00: Social at **Tri-County Fairgrounds**, Tallman Pavilion, open cash bar with dinner provided by Coachwhip Café food truck*

Pour a pupfish pint for Phil



Desert Fishes Council

2023

Owens pupfish artwork by Rosa Cox

FRIDAY MORNING, NOVEMBER 17 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

08:30-10:00: ***Poster Session with coffee & pastries*** –

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

1. The role of calcium carbonate in gross primary production in the Little Colorado River, AZ, & implications for Humpback Chub growth rates – **Phoebe Brown*, Eric Moody, Jeffery Muehlbauer, Bridget Deemer, Charles Yackulic, Jessica Corman & Ted Kennedy**

   The lower 13 km of the Little Colorado River (LCR) between the Atomizer Falls complex and the confluence with the mainstem of the Colorado River in Grand Canyon, AZ, is considered key habitat for threatened and endangered native fishes, most notably the Humpback Chub, *Gila cypha*. While Humpback Chub were historically present only in this lower reach of the LCR, studies of recent translocations above Atomizer Falls have revealed faster growth rates in translocated upper reach individuals. The upper reach differs from the lower reach in that it has reduced calcium carbonate (marl) precipitation rates due to the low pH of groundwater emerging from the springs that feed this reach. Marl precipitation reduces light availability, streambed stability, and availability of phosphorus. These factors can have bottom-up effects on the biomass of benthic invertebrates, which is considerably higher in upper, non-marl reaches. These combined effects may limit primary production in marl reaches in accordance with the differences of fish growth rates observed. Phosphorus availability can impact ecosystems as a limiting nutrient and is known to co-precipitate out of the water column during marl deposition. Thus, we hypothesized that lower bioavailable P in the lower compared to upper reach of the LCR could impact the food base and thus explain lower growth rates of Humpback Chub. An experiment revealed that P addition stimulated increased GPP in both marl and non-marl reaches. These data suggest that while reduced P availability in the lower reach likely contributes to low GPP in the lower LCR, the combined effects of low light availability, streambed instability, and reduced P availability in marl reaches together explain their low primary production. Ultimately, these bottom-up effects may control the growth rates of federally threatened Humpback Chub.

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2. Using metabarcoding to survey the biodiversity of intestinal parasites of fishes in Grand Canyon – **Isaac Schuman*, Claire Couch, Justin Sanders, Anna Jolles & David Lytle**

Parasites are undervalued components of a biological community, often grouped within the study of disease ecology in an ecosystem alongside its bacterial and viral pathogens. Outbreaks among host populations or zoonotic spillover are two situations where parasites are obvious. Yet the opposite scenario, where the parasite populations themselves are threatened, can go unnoticed. This project aims to characterize the intestinal parasite communities of three fish species in the Colorado River in Grand Canyon using 18s metabarcoding, as part of an effort to create a modern snapshot of this American landmark's ecology. Our goal is to describe the broad diversity of parasites in the river, and their geographic and host distributions. The fish host species of interest are native Flannelmouth Sucker, *Catostomus latipinnis*, Humpback Chub, *Gila cypha*, and introduced Rainbow Trout, *Oncorhynchus mykiss*.

Understanding the parasite community of Grand Canyon fish species is an important and timely aspect of ecological monitoring. Parasites drive host population dynamics, including through mechanisms such as direct mortality, manipulation of host behavior, and parasite avoidance behavior. Additionally, parasites with complex life cycles rely on multiple hosts at different trophic positions to complete their lifecycles, making them sensitive indicators for functional food chains. Finally, the Grand Canyon aquatic ecosystem is entering an unprecedented state of flux, as drought and water management challenges in the American Southwest reduce Colorado River flow to historic lows. The transition from a cold river defined by dam regulation to a warmer river with an unstable drought-defined flow regime occurs alongside new waves of invasive species and within the global context of climate change.

We hypothesize that a longitudinal gradient in parasite diversity will be evident moving downstream within the canyon, as well as areas of increased diversity near the mouths of relatively undisturbed perennial tributaries. Current work from the Lytle lab suggests that aquatic macroinvertebrate diversity is higher in tributaries than in the mainstem Colorado River, and a broad food base for fish will also support a broad variety of parasite life cycles. In contrast, the most ecologically damaged areas of the canyon such as those close to Glen Canyon Dam will show low parasite diversity, with generalist single host parasites making up a larger proportion of that diversity.

Feces were sampled from over 120x fish, most commonly *C. latipinnis*, longitudinally along 450 river-kilometers of the Colorado River in Grand Canyon. DNA was extracted from samples using Qiagen Blood and Tissue kits and sequenced using 18s primers to detect the presence of diverse parasite taxa. We obtained 36.6 million raw 18s reads across 115 fecal samples, with an average of 318,000 reads per sample.

Bioinformatic analysis of this sequencing data is currently ongoing, however, presenting the work is still relevant because of the use of novel methods in the system. The information from metabarcoding will complement traditional necropsies by more easily targeting microscopic parasites such as Microsporidia and Apicomplexa. It also allows high volumes of samples to be collected and processed in a minimally invasive manner, an important factor when working with threatened fish in desert rivers. The unique sensitivity of parasites to trophic disturbance, and their permeating effects on ecosystem dynamics, provide a unique and insightful method for assessing the impacts of anthropogenic changes on desert river communities.

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3. How beaver pond age affects aquatic invertebrates – **Jazmyn Rivera & Susan Washko**

   Beavers are ecological engineers, benefiting the aquatic ecosystems with their dams and ponds. The beaver ponds change over time; beaver ponds of different ages will have different characteristics. These differences will influence what types of aquatic invertebrates will inhabit these ponds. Understanding these different successional stages will help us understand more about the beavers' role in the ecosystem. We surveyed three newer beaver ponds and four older beaver ponds to assess the aquatic invertebrate community composition and taxa richness. The newer beaver ponds had an average of 18 taxa, whereas the older beaver ponds had an average of 28.25 taxa. The community composition between newer and older ponds was significantly different, due to some species that were unique or abundant for each pond age group. The habitat in the newer ponds is a type of middle ground between wetland and stream habitat. This could mean that few wetland and stream invertebrates can colonize there. The presence of trout in the newer ponds could also contribute to the low number of taxa. Learning more about the biodiversity associated with successional stages of beaver ponds can inform evaluation criteria for restoration using beaver and improve our understanding of beavers' role in the ecosystem.

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General Posters

4. Lower Colorado River Area Report – **Ron Rogers**

   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.

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5. Population genetic structure of the endemic fish *Gambusia marshi* from the Cuatro Ciénegas basin & its outflow in Coahuila, Mexico – **Jia Yan Xie, Kyung Seok Kim, Dylan Powell, Hector Espinosa-Pérez, Eric Moody* & Kevin Roe**

   The valley of Cuatro Ciénegas in Coahuila, Mexico, has the highest degree of local endemism of any habitat in North America. Despite the arid desert climate, the basin harbors an extensive system of permanent streams, wetlands, and spring-fed pools, and is divided into two sub-basins by the central Sierra de San Marcos y Pinos. Microsatellite loci were surveyed to infer the genetic diversity and population structure of *Gambusia marshi*, a poeciliid fish endemic to the Cuatro Ciénegas basin and the Río Salado de Nadadores in north-east Mexico. Bayesian clustering analysis revealed four genetic populations within *G. marshi* and a major east–west division corresponding to the Sierra de San Marcos y Pinos. Most sample sites exhibited high levels of genetic differentiation, although there is evidence for recent gene flow between some of these locations. The population of *G. marshi* in Poza Anteojo is extremely divergent and appears to represent a remnant of a different historical system. The *G. marshi* in Poza Anteojo should be considered an independent management unit. Documenting the number and distribution of distinct populations of *G. marshi* provides additional justification for protecting the Cuatro Ciénegas basin from additional water withdrawals and further homogenization via the construction of additional canals. By analyzing the population structure of a widespread species within a region containing many range-restricted and endemic species, these results shed new light on historical connections among aquatic ecosystems and raise awareness of the possibility that units of conservation concern may exist in other, more range-restricted taxa in the Cuatro Ciénegas basin and encourage the assessment of their conservation status.

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6. Cross-canyon connections? Conservation genomics of a desert-dwelling lungless salamander (*Batrachoseps campi*) – **Nicholas Van Gilder, Christopher Norment* & Elizabeth Jockusch**

   The Inyo Mountains salamander, *Batrachoseps campi*, is one of two plethodontid salamanders confined entirely to desert habitat. Though lungless salamanders must stay moist to respire, all known populations of this species occur within the Inyo Mountains of California, an arid range rising between the Owen's Valley to the west and the Saline Valley to the east. The salamanders occupy discrete areas of riparian habitat in steep-walled canyons separated by mostly inhospitable terrain. Previous genetic work on this species (Yanev and Wake, 1981, Herpetologica 37(1):16-28) suggested that these canyon populations are highly divergent from one another, with limited to no gene flow occurring between sites, and a strong overall north-south separation. Our study examines the population structure and genetic divergence of this species using contemporary molecular approaches and an expanded set of populations. Specifically, 93 samples of B. campi from 17 of 24 known populations were sequenced using a reduced-representation genomic approach (double digest restriction-site associated DNA sequencing, ddRAD), generating thousands of informative markers (single nucleotide polymorphisms, SNPs). Our population assignment analyses indicate the presence of at least three genetic clusters showing detectable admixture across the mountain range, and two of these clusters show connection over the crest of the mountains. Estimated proportions of admixture between clusters decreased with stricter filtering of SNPs, though all filtering approaches support at least three genetic groups. Additionally, we failed to find detectable genetic structure at the finest scale examined, a 425 m stretch of continuous riparian habitat. Measures of Wright's (1943) fixation index, FST, range from 0.033 to 0.189, with sites in the north generally less differentiated from one another than the sites in the central and southern portion of the range. Overall, measures of differentiation increase with distance between sites, but are generally less than half of the values calculated by Yanev and Wake (1981). With this genomic-scale data, we gain new insight into the connectivity of these canyon populations. While connectivity appears to be the strongest along riparian corridors within canyons, the genetic admixture seen in our results suggests that there has been historical gene flow between populations in sites not connected by obviously mesic habitats. The results of our work offer new perspectives and increased resolution of the evolutionary history and population dynamics of this species of conservation concern.

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7. What is the Nevada Cooperative Fish & Wildlife Research Unit? Graduate education, collaborative research, & technical assistance for conservation of Great Basin fish & wildlife – **Jeff Falke**

   The Nevada Cooperative Fish and Wildlife Research Unit (NVCFWRU) is part of a nationwide program administered by the U.S. Geological Survey (USGS) that began in 1935. These Units were created to foster college-level research and graduate student training in support of science-based management of fish and wildlife and their habitats. The mission of the Cooperative Research Unit program focuses on developing the conservation workforce of the future through applied graduate education, helping fulfill the training and technical assistance needs of the cooperators, and delivering actionable science to cooperating agencies and organizations. The unique model of the Cooperative Research Unit program increases productivity and capacity by allowing partners to benefit from each other's strengths, developing better management at every level of fish and wildlife conservation. The Nevada Unit was formed in 2021 via a Cooperative Agreement among the Nevada Department of Wildlife; the University of Nevada, Reno (UNR); the Wildlife Management Institute; the U.S. Fish and Wildlife Service; and USGS. This partnership is the key to the success of the Unit: each of the partners bears part of the cost but receives the whole of the benefit. The benefit comes as products: research published in peer-reviewed journals; students trained as entry-level professionals; and technical assistance provided by recognized experts. Based on the UNR campus, the program will focus on fisheries and wildlife research, ecology, and management, and will promote collaboration among the cooperating agencies. In addition, the program will support a focus on human dimensions and the importance of wildlife conservation to the public's overall quality of life. Unit scientists are USGS employees with faculty appointments at the host University. They conduct research, advise graduate students, and teach one graduate course annually. Other faculty cooperate in the program by conducting Unit-sponsored research, often carried out through the Research Work Order process, a funding mechanism authorized by Congress specifically for the Cooperative Units. The Great Basin and Nevada are facing unprecedented environmental change. Native plant communities and their associated fish and wildlife species are challenged by invasive weeds, increased fire frequency and intensity, water quantity and quality, and development associated with a growing human population. The new NCFWRU is positioned to complement ongoing work on Great Basin native fish conservation issues, across Nevada and the region, through graduate and post-doctoral research, education, and technical assistance.

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8. Long-term monitoring of a native fish in the Muddy River, Nevada – **Justin Handtke**

   The Virgin River Chub *Gila seminuda* persists in the Muddy River despite a complicated conservation status. The species is state listed as Sensitive and of Conservation Priority and is listed as federally endangered in the nearby Virgin River. In the Muddy River in Nevada, long-term monitoring and biannual sampling with hoop nets and minnow traps dating back to 2010 have provided a better understanding of the population dynamics of native fishes in the system. Recurrent monitoring of the fish populations in the Muddy River continues to be of importance following rotenone treatments from 2016-2019 for nonnative fish removal. Despite an apparent decline in Virgin River Chub relative abundance over time, increased CPUE of Virgin River Chub across multiple age-classes, a relatively high mean annual growth rate, and an overall increase in capture frequencies indicate the species may be rebounding in the Muddy River.

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9. 2023 update regarding Long Valley Speckled Dace populations – **Nicole Hatakeyama* & Nick Buckmaster**

   The speckled dace, *Rhinichthys osculus*, is a widely distributed temperate freshwater minnow, Cypriniformes, found throughout western North America. The Long Valley speckled dace (LVSD), *Rhinichthys nevadensis caldera*, is a subspecies of the desert speckled dace, *Rhinichthys nevadensis*, that historically inhabited streams and marshes within the Long Valley Caldera part of the Upper Owens River drainage. At present however, LVSD are limited to only three known locations: White Mountain Research Center (WMRC), O'Harrell Creek, and Whitmore Marsh. The WMRC is an artificial refuge pond outside of LVSD native range that was established in 2017 and hosts a stable population of over 1,000 fish. In 2022 and 2023, LVSD were translocated from WMRC to O'Harrell Creek to establish a new population of LVSD within their native range. A survey later in 2023 found a few young-of-year LVSD and the creek will continue to be monitored for successful establishment. Lastly, the primary wild population of LVSD exists at Whitmore Marsh, which is an alkali marsh that covers roughly 1 acre and has little open water habitat. Unfortunately, the source spring for the marsh was developed into a public swimming pool and discharges a lightly chlorinated stream adjacent to the source spring. Possibly due to chlorine exposure after the 2016 winter, the relatively stable LVSD population revealed no fish during surveys conducted in 2017, and trapping efforts in 2018, 2021, and 2022 yielded very few numbers. However, in September 2023, trapping efforts yielded over 200 healthy LVSD hopefully indicating successful repopulation of the marsh.

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10. Ten years of ecosystem monitoring in the Ash Meadows Fish Conservation Facility refuge tank – **Daniel Villanueva*, Olin Feuerbacher, Jennifer Gumm, Ambre Chaudoin, Jeffrey Goldstein, Kevin Wilson & Bryce Donaghue**

    The Ash Meadows Fish Conservation Facility (AMFCF) was constructed in 2013 to support the conservation and recovery of Devils Hole pupfish, Cyprinodon diabolis. The AMFCF houses a 100,000-gallon refuge tank that is a replica of the Devils Hole habitat that duplicates the Devils Hole pupfish natural ecosystem. Ten years of ecosystem monitoring have been conducted in the refuge tank. Monitoring efforts are ongoing with monthly algae surveys, invertebrate surveys, and weekly predaceous diving beetle, *Neoclypeodytes cinctellus*, trappings to study the health of this artificial ecosystem. Here, we analyze how aspects of the refuge tank community have changed over the years. We examined the percent coverage of algae species found in the shallow shelf of the refuge tank, invertebrate abundance, and population dynamics of *N. cinctellus*. *Spirogyra* sp. is a species of algae present in the refuge tank, and it's important for breeding behavior, egg survival, and larval fish survival. *Spirogyra* percent coverage has fluctuated over time but has remained present in the refuge tank and responds positively to management actions such as removing detritus and cyanobacteria. Amphipods, *Hyallela azteca*, are an important invertebrate food source for Devils Hole pupfish. A gut analysis of *C. diabolis* determined that *H. azteca* and the Devil's Hole warm spring riffle beetle, *Stenelmis calida calida*, combined, averaged 6% of the observed gut contents (Wilson and Blinn, 2007, Western North American Naturalist, 67(2):185 -198). A total of three amphipods was captured during monthly invertebrate surveys in 2020. The following year, a total of 807 amphipods were captured during monthly invertebrate surveys. We hypothesize that the decline in *N. cinctellus* may have led to an increase in amphipod abundance. *Neoclypeodytes cinctellus* trapping efforts began in March 2018, and as of August 2023, over 35,000 beetles have been removed from the refuge tank. In 2018, 8,659 beetles were trapped over 186 hours, resulting in a catch per unit effort (CPUE) of 47. In 2023, 14 beetles were trapped over 156 hours, bringing the CPUE to 0.090. The US Fish and Wildlife Service and agency cooperators continue to monitor the refuge tank.

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11. Texas desert fish art – **Harlan Bean* & Amanda Lord**

    I have been studying Pecos Pupfish and am taking an art class this year. I am making an art project about Pecos Pupfish and their habitat. My art project is about Pecos Pupfish, and I am painting one in its habitat. I am using acrylics on a 12x16 inch canvas. I will be using my art to teach others at my middle school about Pecos Pupfish.

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12. Digging in the dirt: Possible influence of soils & geology on the distribution of an endemic, desert-restricted salamander – **Christopher Norment* & Eli Polzer**

A variety of evolutionary and ecological factors likely have affected the distribution of the Inyo Mountains salamander (IMS), *Batrachoseps campi*, a species of management concern endemic to the arid Inyo Mountains of eastern California. For example, isolation of the Inyo Mountains due to mountain-building episodes about 15.6 and 2.8 Ma (Lee et al., 2009, Tectonics 28: TC1001, doi:10.1029/2008TC002295) likely led to diversification of B. campi from ancestral Batrachoseps lineages approximately 2.5 Ma. IMS are documented from 24 localities; 22 (91.6 %) of these have permanent surface water. However, 20 (80 %) of the 25 sites in the Inyo Mountains where we and our colleagues have unsuccessfully searched for IMS appear to have permanent surface water and riparian vegetation that should support the species. Although imperfect detection may be an issue with amphibian surveys (Schmidt and Pellet, 2010, pp. 467-479 in C. K. Dodd, ed., Amphibian Ecology and Conservation), IMS may not occur at many of these sites. Several possible reasons for the species' absence may include lack of colonization over evolutionary time, stochastic events such as severe flash floods, and an "extinction vortex" (Fagan and Holmes, 2006, Ecology Letters 9:51-60) caused by a combination of small population size, inbreeding depression, and habitat loss.

Two additional factors that could affect distribution of the IMS include geology and soils. These could interact to affect availability of suitable below-ground refuges; soil moisture, which is critical for the IMS because it must breathe through moist skin; and the presence of sufficient organic material to support an adequate prey base. Anecdotally, we have observed that otherwise suitable sites with permanent surface water may lack IMS if they occur in soils with high clay content or that are formed from decomposing granite. In this very preliminary analysis, we used GIS to examine the distribution of IMS relative to soil and rock/deposit types in the Inyo Mountains. Sites supporting IMS appear to have soils with significantly lower clay content and bulk density than sites where IMS have not been found. Although Thomson et al. (2016, California Amphibian and Reptile Species of Special Concern, Univ. Calif. Press) state that the IMS is "largely restricted to patches of riparian habitat associated with perennial springs and limestone fissures," it may occur in other rock/deposit types. Of the sites with IMS present, 71% of those were within areas of marine sedimentary and metasedimentary rocks, and 15% were within areas of granitic rocks. Conversely, only 32% of the sites where IMS have not been found were within areas of marine sedimentary and metasedimentary rocks, while 45% of the sites were within areas of granitic rocks. Although our conclusions are very tentative, they suggest that edaphic factors, and not just the presence of surface water and suitable vegetation, may be important in affecting the distribution of the IMS—and possibly other terrestrial species of management concern in Southwestern riparian ecosystems.

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13. Vertical profiles of temperature & dissolved oxygen in Pahranagat Chub refuge – **Montana Stevens**

Background.

The Pahranagat Roundtail Chub *Gila robusta jordani* (PRTC) is a federally listed Cyprinid that historically occupied approximately 30 km of the now disjunct White River located in the Pahranagat valley of Lincoln County, NV. Due to primarily agricultural development the native range of the PRTC is now reduced to about 3.5 km of natural stream and 2.5 km of an earthen drain; all located on private lands in the valley. During irrigation season (March – October) water is diverted away from the 2.5 km section of drain that eventually dries over the season, eliminating almost half the available habitat. Along with reduced habitat, the PRTC is under immense pressure from seasonal water withdrawals, causing variation in habitat flow and temperature. The native range is also highly inundated with non-natives including the common carp, convict cichlids, common poeciliids, and crayfish.

In response to the severely limited habitat range and quality, the United States Fish and Wildlife Service (USFWS) constructed a pond below Cottonwood Spring on the Pahranagat National Wildlife Refuge (PNWR) as a refugia for the PRTC. Multiple attempts to stock PRTC in the spring ended in mortality events that decimated the refuge population. USFWS suspects that variable geochemical and biological factors produced seasonally poor aquatic habitat for PRTC that could have contributed to the mortality events. Additionally, noted changes in winter water quality and clarity have coincided with fish mortality events. The previous attempts to stock PRTC into Cottonwood Spring that resulted in mortality occurred in 2011, 2016, & 2017. Following the final mortality event, the USFWS dedicated funding to a long term monitoring project of Cottonwood Spring.

Primary Project Goals

This project's overall goals focus on monitoring, understanding, and reporting on how the biological and geochemical behavior of Cottonwood Spring change over time. This will be used to understand the seasonally influenced water quality changes that might be linked to PRTC mortality. All the data collected will be used in developing a report to help guide the restoration of the spring to be more suitable for PRTC survival.

Presentation Focus

The focus of this presentation will primarily be over temperature and dissolved oxygen vertical profiles taken at Cottonwood Spring as well as other biotic and abiotic factors affecting water quality at the spring. The poster will show data collected over the course of 2023 and how those parameters along with pond quality have changed over time.

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14. Humpback Chub recruitment in light of changing environmental conditions – **Pilar Rinker* & Randy Van Haverbeke**

    The humpback chub, *Gila cypha*, population in Grand Canyon has been monitored using different protocols by several agencies beginning in the 1980s. In the early 2000s, the U.S. Fish and Wildlife Service (USFWS) began a monitoring project in the Grand Canyon that has evolved over time to monitor "aggregations" of humpback chub. An aggregation was defined as disjunct but reliably captured groups of humpback chub typically concentrated around springs and tributaries. Since 2010, USFWS monitoring methods have become relatively standardized and have tracked humpback chub abundances and relative abundances through time. Given recent environmental changes, humpback chub have expanded their range to include the entire western Grand Canyon and have been recorded among historic aggregation sites. In 2022, Lake Powell reached historic low elevations, warming the temperature of the river to its highest seen post-dam. This allowed the humpback chub to spawn and recruit in the mainstem at levels unseen since Glen Canyon Dam was built. This was evident as our 2022 data showed a sizeable cohort of age-0 chub and our 2023 data showed this cohort grew to the age-1 size class. The humpback chub population in Grand Canyon is as robust as it ever has been, but continually changing climate conditions may hinder their recovery as much as it has supported their expansion.

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*General Session – **Tyler Pilger**, moderator*

10:00-10:15: Seasonal movements & demographics of a critically endangered desert spring fish; the White River Spinedace – **Summer Burdick*, James Harter, Mark Beckstrand, Rachael Paul-Wilson, Brian Hayes, Collin Smith & Russell Perry**

Range and abundance of White River spinedace contracted over the 20th century from a known range that included at least seven springs in the White River Valley and part of the White River to only the Flag Springs complex in central Nevada. By 1991 and 1992 it was suspected that the species was limited to only 37 spinedace, nearing their maximum lifespan, that were captured in a 25 m long pool at the headwaters of north Flag Springs. Following removal of largemouth bass from the Flag Springs complex in Central Nevada and reintroduction of 20 spinedace to bass-free waters, reproduction ensued and the population rebounded. Emboldened by this success, a second reintroduction into Indian Springs was attempted in 2004 and 2005. This translocation failed to produce a reproductive population and it was suspected that lack of spawning habitat was the cause. To inform future reintroduction attempts, information is needed on spawning habitat use and demographic parameters for the species. We PIT tagged and released White River spinedace during four biannual events from November 2020 to June 2022. Fish were recaptured in minnow traps or detected on six passive PIT tag detection antennas placed throughout Flag Springs complex. Movement data were evaluated to understand seasonal habitat use. We used data on recaptured and redetected fish in a Barker mark-recapture model to estimate monthly survival rates between recapture events. Survival was greater between June and November than between November and June. The estimated recapture probability from these models was multiplied by the number of captured fish to estimate population size. We estimated there were from 322 to 874 White River spinedace in the Flag Springs complex. White River spinedace were active during spawning season but did not select habitat based on water temperature.

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10:30-10:45: Do conservation management actions improve native fish communities? – **Skyler Hedden*, Brandon Albrecht, Ron Rogers, Kevin Guadalupe, Rick Fridell, Melinda Bennion, Martin Schijf & Kody Callister**

Resource managers and agencies are tasked with conducting management actions to improve native communities or offset negative anthropogenic activities. But measuring the effectiveness of conservation actions is difficult due to temporal variations in fish communities, time lags, and lack of control sites to examine differences or changes in fish community structure and density. Thus, the effectiveness of conservation management actions often goes unmeasured and at times managers can be uncertain of their efforts. In the Virgin River, which flows across portions of Utah, Arizona, and Nevada, native fish management actions have differed substantially between the upper and lower portions of the river. In the upper Virgin River nonnative fish barriers have been constructed, rotenone applications have eradicated nonnative fish, native fish stocking plans have been employed, and pump back systems have been installed to keep stream temperatures within the desirable ranges of native fish. While in the lower Virgin River, efforts have largely been focused on collecting data towards long term datasets with relatively minimal management actions being performed. In this talk, native fish community structure and densities are compared between the upper and lower Virgin River to examine if any differences are observed between the two areas that have had substantial differences in conservation management actions. Fish community structure differed considerably between the two reaches, largely driven by the eradication of nonnative fish from the upper Virgin River. When only examining native fish community structure, differences were less apparent, with only two species driving differences. Our results suggest that conservation management actions do have positive impacts on native fish communities, but these actions may be more influential for certain species.

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10:45-11:00: Ontogenetic effects of flow variability in a high-desert stream – **Matthew Young*, Nicholas Buckmaster, Justin Clause, Veronica Violette & Steve Parmenter**

Flow variability is an important element of stream environments which provides myriad ecological benefits, including cuing fish migrations or reproduction, facilitating the establishment of seedlings and the recruitment of riparian vegetation, and mobilizing the streambed to maintain geomorphic features upon which aquatic biota depend. Reduced flow variability can negatively affect populations, communities, and ecological processes. The Owens River drains part of the eastward flank of California's Sierra Nevada, emerging into the arid Basin and Range hydrogeologic province. Competing demands for Owens River water has been a source of conflict for more than a century and has resulted in perennial desiccation of long reaches of the river. To benefit at-risk fish populations, a prescribed variable hydrograph is being reintroduced under court order. Using a combination of tools, we examine the effect of pre- and post-restoration flow variability on local ecosystems, including the non-native Brown Trout (*Salmo trutta*) and native Owens Sucker (*Catostomus fumeiventris*). Stable isotope analyses (δ13C, δ15N) of muscle tissue and eye lenses identified longitudinal and ontogenetic changes in food web structure and trophic support from autochthonous and allochthonous inputs. Otolith aging indicated marked differences in fish growth and development trajectories across control and impact reaches, suggesting flow-mediated variability in life histories. Our results demonstrate the immediate population and community level effects of flow restoration in the Owens River, with additional work needed to address inter-annual hydrologic variability and long-term restoration impacts.

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11:00-11:15: Genetic monitoring in Rio Grande Silvery Minnow using genotyping-in-thousands by sequencing – **Megan Osborne*, Guilherme Caeiro-Dias & Thomas Turner**

Human water use combined with a recent megadrought have reduced river and stream flow through the southwest United States. Reductions in snowmelt runoff and increased extent of drying collectively threaten the endangered Rio Grande Silvery Minnow (*Hybognathus amarus*). This species is subject to boom-and-bust population dynamics, under which large fluctuations in abundance are expected to lower estimates of effective population size and erode genetic diversity over time. Monitoring genetic effective population size has been widely advocated in conservation programs because it is an important predictor of adaptive potential. Until 2022 the trajectory of genetic diversity (including allelic richness, heterozygosity, and effective population size) in Rio Grande Silvery Minnow was measured annually using nine microsatellite loci and a mtDNA gene. In 2023, microsatellite markers were replaced by a Genotyping-in-Thousands by sequencing (Gt-seq) panel containing 285 loci distributed throughout the genome. We used the GT-seq panel to genotype samples from 1987, 1999-2012, 2015-2023; encompassing a period of almost four decades. The panel also includes a sex-specific marker, allowing us to track changes in the sex ratio in the wild population across the time-series. Population declines associated with drought resulted in increases in inbreeding metrics, reduced heterozygosity and smaller estimates of contemporary effective population size. We also recovered mitochondrial DNA sequences from NextRad data which revealed reductions in mitochondrial diversity associated with a multiyear population bottleneck that occurred from 2012-2014.

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11:15-11:30: Amargosa Toad, *Anaxyrus nelsoni* survey results & conservation activities within the Oasis Valley, Nye County, Nevada – **Kevin Guadalupe*, Brandon Senger, Ron Kegerries, Ron Rogers, Brandon Albrecht & Jef Jaeger**

To successfully manage the Amargosa Toad, *Anaxyrus nelsoni*, it is critical to understand population demographics, habitat, and distribution of the species. Nocturnal mark-recapture surveys for Amargosa Toad in the Oasis Valley were conducted annually starting in 1998, resulting in over 15,000 encounters. The use of passive integrated transponders (PIT tags) allowed long-term assessments of individual movements. Program MARK was used to calculate population and survival estimates. Surveys combined the efforts of state and federal agency personnel, university staff, volunteers, and residents of Beatty, NV. Local participation was critical in allowing access to privately owned land containing previously unknown toad distributions. Information collected to date supports the cooperative efforts of the Amargosa Toad Working Group tasked with implementing a Conservation Agreement Strategy. Findings indicate a large, persistent metapopulation of toads and a U.S. Fish and Wildlife Service review found that the Amargosa Toad was not warranted for federal listing. Following the listing decision, access to private lands increased in the upper Amargosa River drainage, resulting in the documented range of the Amargosa Toad being expanded, along with and other aquatic endemics with conservation opportunity.

Contact – *kguadalupe@ndow.org*

11:30-13:30: **LUNCH BREAK**

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

FRIDAY AFTERNOON, NOVEMBER 17 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

*General Session – **Skyler Hedden**, moderator*

13:30-13:45: 2023 Upper Colorado Area Report – **Dave Speas**

Water year 2023 in the Upper Colorado River Basin was characterized by above average snowpack conditions in most upper elevation catchments, which provided a much-needed respite from ongoing drought conditions. The 2023 Upper Colorado Area Report to the Desert Fishes Council will provide project updates and other highlights from across the basin, including: Operations at Flaming Gorge Dam to benefit endangered Razorback Sucker and Colorado Pikeminnow in the Green River; Colorado Pikeminnow broodstock collection efforts in the Green and Colorado rivers; Bipartisan Infrastructure Law funding awards for improvements at Ouray National Fish Hatchery (Randlett and Grand Valley units) and Wahweap State Fish Hatchery (Big Water, UT); infrastructure funding for expanded PIT monitoring capabilities in the Green and Colorado rivers; continued Razorback Sucker production and stocking by the Palisade High School Fish Hatchery in Palisade, CO and other outreach activities in the Grand Valley of the Colorado River; and Utah State University researchers describe the role of beaver dam analogs in restoration of the Price River, UT.

Contact – *dspeas@usbr.gov*

13:45-14:00: Pupfishes of Death Valley: Hurricane Hilary impacts to Salt Creek & Devils Hole – **Jeffrey Goldstein*, Ambre Chaudoin, Kevin Wilson, John Wullschleger, Olin Feuerbacher, Jennifer Gumm, Danny Villanueva, Mike Bower, Michael Schwemm, Brandon Senger & Bryce Donaghue**

Death Valley National Park manages conservation efforts for five species and subspecies of pupfishes (four in California and one in Nevada). On August 20th, 2023, Hurricane Hilary drenched Park Headquarters at Furnace Creek, California, with 2.2 inches (5.6 cm) of rain within 24 hours, compared to the usual annual average of 1.94 inches (4.9 cm). The National Weather Service radar indicated some parts of the park may have received around 5 inches (12.7 cm) of rain that day. As a result, the Park experienced significant flooding that destroyed roads and caused complete closure to the public for nearly two months. Flash floods drastically altered Salt Creek and habitat for its pupfish, *Cyprinodon salinus salinus*, and increased flows in the Amargosa River created a temporary lake within the basin of the prehistoric Lake Manly. Evidence from aerial imagery showed a possible reconnection of Salt Creek and Cottonball Marsh, hypothetically allowing brief geographic overlap of the typically isolated Cottonball Marsh pupfish, *Cyprinodon s. milleri*, and *C. s. salinus*. Saratoga Springs and the Amargosa River pupfish, *Cyprinodon nevadensis nevadensis* and *C. n. amargosae*, respectively, have not been assessed for flood impacts. Devils Hole, Nevada, received 3.66 inches (9.30 cm) over two days (August 20th–21st). Overland flow at Devils Hole did not reach flash flood levels, and the primary impact was a layer of fine sediments deposited over the shallow shelf. NPS staff and agency cooperators continue to monitor the endangered Devils Hole pupfish, *Cyprinodon diabolis*, which has experienced an overall increase in population size over the past several years.

Contact – *jeffrey_goldstein@nps.gov*

14:00-14:15: Turning up the heat: how pupfish reproduction is affected by warming temperature – **Sean Lema*, Maddie Housh & Kseniya Krayeva**

Reproduction in fishes is commonly sensitive to environmental temperature and increasing average temperatures or extreme 'heat wave' events associated with climate change have the potential to impact reproductive output. Even though pupfishes of the North American southwestern deserts have among the highest thermal limits for reproduction of any fishes, pupfish still show reduced reproductive performance at elevated temperatures. We have been examining the effects of warmer temperatures on reproduction in Amargosa Pupfish (*Cyprinodon nevadensis amargosae*) and other pupfish species under a variety of experimental temperature regimes. In fish as in other vertebrates, reproduction is regulated physiologically by the hypothalamic-pituitary-gonadal (HPG) hormone axis. Exposure of fish to atypically high or prolonged elevations in temperature can alter HPG hormone signaling with consequences for gametogenesis. Findings from several recent experimental studies with *Cyprinodon* pupfishes have demonstrated that egg development (oogenesis) in pupfish is considerably more sensitive to disruption by high temperatures than sperm production (spermatogenesis). Female pupfish experiencing elevated, but ecologically relevant, temperatures show reduced circulating levels of the estrogen hormone estradiol (E2). That lower E2 results in a downregulation of gene pathways essential to oogenesis, including significantly reduced gene expression of egg yolk (vitellogenin) and egg envelope (choriogenin) proteins in the liver. Ultimately, those effects of higher temperature result in diminished oogenesis and a reduced ovary mass. Females at elevated temperatures given supplemental E2 still respond by upregulating oogenesis gene pathways, implying that diminished oogenesis at higher temperatures is caused by the lower levels of E2. In contrast with females, the reproductive physiology of male pupfish is comparably insensitive to elevated temperature. Taken as a whole, these findings point to female pupfish being vulnerable to reproductive impairment when exposed to warmer temperatures and provide a foundation for understanding about how reproduction in wild pupfish populations will be affected by changing thermal conditions with climate change.

Contact – *slema@calpoly.edu*

14:15-14:30: New genetic tools give a detailed picture of hybridization & population structure of Flannelmouth Sucker – **Thomas Turner*, Thomas Dowling, Abby Wicks, Guilherme Caeiro-Dias, Alexander Cameron & Megan Osborne**

We adapted next-generation genetic screening tools to study hybridization and fine-scale population structure in Flannelmouth Sucker (*Catostomus latipinnis*) in two important Colorado River systems. We genotyped 1472 larvae distributed in two, 200-mile reaches in the Grand Canyon (GC) and San Juan River (SJR). We also genotyped 1085 adult fish sampled throughout the SJR mainstem and 300 adults that entered McElmo Creek, an intermittent tributary and an important spawning site for suckers. All sampled fish were identified as Flannelmouth Sucker based on morphology. Genetic analysis focused on hybridization status of individuals, and whether frequencies of hybrids were the same within and among river systems. Overall, 12% and 14% of larvae in the GC and SJR, respectively, had some evidence of introgression with Razorback Sucker (*Xyrauchen texanus*), with only marginal differences in frequencies across river systems. Introgressed larvae were randomly distributed in the GC, but not in the SJR. Larvae sampled downstream of McElmo Creek were more likely to be introgressed than larvae upstream. Adults in the SJR showed the same pattern, where adults sampled downstream of McElmo were more likely to be introgressed than upstream. We did not observe F1 or recently backcrossed hybrids in McElmo Creek, suggesting that hybridization with Razorback Sucker is probably occurring downstream. When all introgressed individuals were removed, reanalysis yielded two patterns of population structure. There was no obvious structure in the GC, but the SJR showed evidence of longitudinal differentiation up- and downstream, with hints of an unsampled spawning aggregation upstream.

Contact – *tsquare.turner@gmail.com*

14:30-14:45: Population genomics of the imperiled Peppered Chub (*Macrhybopsis tetranema*): new nuclear & mitochondrial data & prospects for long-term monitoring – **Guilherme Caeiro-Dias*, Megan Osborne & Thomas Turner**

Peppered Chub (*Macrhybopsis tetranema*) is part of the *Macrhybopsis aestivalis* complex, which comprises nine recognized species. Peppered Chub is extirpated from more than 94% of its historic range and is now restricted to a 218-kilometer reach of the South Canadian River between Ute Lake (New Mexico) and Lake Meredith (Texas). This species is a pelagic broadcast spawner, and survival and reproductive success are linked to river discharge and connectivity. We sequenced whole nuclear and mitochondrial genomes and these were used as references to map nextRAD (Nextera-tagmented reductively-amplified DNA) sequencing data. We identified SNP-containing loci (microhaplotypes) from 190 individuals sampled across six temporal collections and several localities in the South Canadian River. The nuclear microhaplotype dataset was used to re-assess genomic diversity, geographical and temporal differentiation, and genetic effective population size (Ne) between 2015 and 2020. Genome-wide diversity was moderate and virtually identical across the time-series. There was little genetic differentiation between years and between samples collected in New Mexico and Texas. Recent collections (2018 – 2020) show an order-of-magnitude reduction in Ne that coincides with an exceptional drought in 2019. Using the mitochondrial genome as a reference we were able to identify a 12S gene fragment of 573 base pairs in length in 78 individuals. We found moderate levels of mitochondrial diversity, including a unique haplotype in a single individual from Texas that was not detected in New Mexico samples. A single haplotype detected in three samples was more similar to Shoal Chub (*M. hyostoma*) mtDNA, denoting mitochondrial introgression from that species into Peppered Chub. Future work includes the assessment of whether mitochondrial introgression from Shoal Chub was accompanied by introgression of nuclear loci. Additional sampling has been completed and future work also includes the development of a GTseq panel for long-term genetic monitoring.

Contact – *gcaeirodias@unm.edu*

14:45-15:00: **COFFEE BREAK**

15:00-15:15: Catastrophic drying of a desert wetland: Sentenac Cienega, Anza-Borrego Desert State Park, California – **Kate S. Boersma*, Janelle Doi, Russell Barabe, Paulette Morales, Rainier Cardin, Shannon E. McNeil & Danny McCamish**

Desert wetlands are one of the most threatened ecosystems on earth, and their protection is a top conservation priority. In many arid regions, the ongoing effects of climate change, anthropogenic water use, and habitat loss make restoring wetlands to historical baselines unrealistic. Instead, scientists and resource managers are increasingly focusing resources on protecting existing biodiversity and preventing future habitat degradation and drying. Understanding how aquatic invertebrate communities shift with changing hydrology is an essential component of this approach. Sentenac Cienega is a desert wetland in Anza-Borrego Desert State Park, Southern California, USA, that has experienced catastrophic drying over the past two decades. Although the entire wetland once contained reliable surface water, currently the only remaining perennial habitat in the catchment is upstream of the wetland. In this study, we sampled aquatic invertebrates from perennial (upstream) and intermittent (downstream) portions of Sentenac Cienega and conducted a colonization experiment in mesocosms to record movement of invertebrates from perennial to intermittent reaches. We had hypothesized that the downstream intermittent reach and its adjacent mesocosms would contain a subset of the species found in the upstream perennial reach. Instead, we found that the communities downstream were almost entirely distinct from those found upstream, even though the reaches are < 2 km apart. Invertebrates that colonized the mesocosms along the intermittent reach below the Cienega included several unique species not found elsewhere in the catchment. These findings highlight the conservation value of both intermittent and perennial habitats of Sentenac Cienega, suggesting that the entire catchment should be included in conservation planning, not just the perennial habitat. Including degraded habitats in conservation efforts may conserve more species than protecting intact reference habitats alone.

Contact – *kateboersma@gmail.com*

15:15-15:30: Environmental DNA analysis does not detect the endangered Rio Concepcion topminnow, *Poeciliopsis jackschultzi* – **Alanna Fulkerson**, **Alejandro Varela Romero, Alexsandre Gutiérrez-Barragán, Doug Duncan &** **Mariana Mateos***

The Rio Concepción topminnow, *Poeciliopsis jackschultzi*; Conway, Mateos, Vrijenhoek 2019, is a microendemic (historically occupied ca. 30 km stretch) of the Rio De La Concepcion, Sonora, Mexico. This species is considered endangered by the IUCN Red List, and whether it is still extant is unknown. The major threats appear to be habitat loss/degradation and invasive species. Survey efforts are hampered by the inability to use external morphology to distinguish *P. jackschultzi* from its co-occurring congeners: the Gila topminnow, *Poeciliopsis occidentalis*; and asexual hybrids whose maternal progenitor is the Headwater topminnow, *Poeciliopsis monacha*. Environmental (e)DNA provides a promising and non-invasive alternative for biodiversity and ecosystem monitoring. Here, we present the results of a metabarcoding eDNA based method aimed at detection of teleosts. We collected and filtered in situ water samples from 8 sites, based on known localities and historical occurrence of *Poeciliopsis* species of interest. After DNA extraction, samples were subjected to Polymerase Chain Reaction (PCR) with the MiFish primer set, which targets a 163-185 bp region of the mitochondrial 12S rRNA gene of teleosts, and is diagnostic for our target taxa. PCR products were subjected to Illumina short-read sequencing. After filtering sequenced reads, we obtained ~238 million reads associated with 1668 unique features (also known as Amplified Sequence Variants), which were assigned to 64 taxa based on a combination of Blast searches and phylogenetic analyses. Unfortunately, we did not detect a single feature assigned to *P. jackschultzi*, suggesting that it was absent or at an abundance below our detection ability. Overall, the most frequent features were those assigned to the native cyprinids Longfin dace, *Agosia chrysogaster* (~66 million) and Sonoran Chub, *Gila ditaenia* (~43 million), followed by those assigned to *P. occidentalis* (> 8 million) and *P. monacha* (> 5 million). We also detected features assigned to the non-native fish, which are known or suspected to occur at or nearby the sampled sites. Among these, Green sunfish, *Lepomis cyanellus* (> 11 million), and Tilapia, *Oreochromis niloticus* (> 9 million) had high frequencies. Other non-native species such as Western mosquitofish, *Gambusia affinis* (> 1.3 million), Swordtail, *Xiphophorus* (< 1 million), Bullhead, *Ameiurus melas* (> 800,000), and Bluegill, *Lepomis macrochirus* (> 300,000) were also present but at lower frequencies. In conclusion, we have no evidence of occurrence of *P. jackschultzi* in the sampled sites. Ongoing work is examining more recent eDNA samples as well as additional localities.

Contact – *mmateos@tamu.edu*

15:30-15:45: Texas area report – **Megan Bean*, Maritza Mallek, Ryan Smith, Melissa Casarez, Sarah Robertson & Gabriela Tamez**

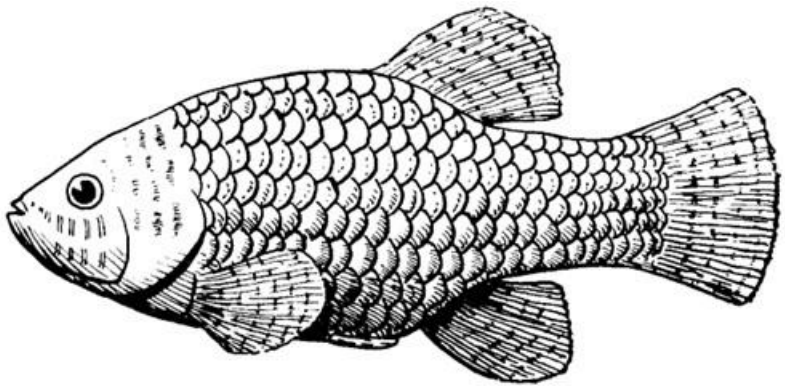
Conservation partners in the Chihuahuan Desert region in Texas have been working on projects including life history studies, habitat associations, setting up refuge populations, and habitat restoration projects. A National Fish and Wildlife Foundation funded project was completed at Diamond Y Preserve near Fort Stockton, Texas. The study mapped aquatic habitats, monitored aquatic organisms, and removed invasive riparian species. Fish assemblage monitoring projects and aquatic youth education outreach events were held on the Devils and Pecos Rivers. Grassland and habitat restoration projects continue in the Pecos River watershed and the Rio Grande Joint Venture developed grassland, riparian, and instream restoration monitoring protocols for the Chihuahuan Desert in Texas. The Alamito Creek Restoration Initiative partners installed beaver dam analogs along Alamito Creek and TPWD partnered with the San Antonio Zoo to set up a captive refuge population of Conchos Pupfish. Partners are hopeful that Conchos Pupfish can be restored to Alamito Creek near some of the habitat restoration projects using San Antonio Zoo propagated fish. Progress has been made setting up private lands locations of Pecos Pupfish with one site stocked in September 2023 with fish propagated by the Fort Worth Zoo and another private lands habitat pond creation is in the works. Additional collaborative projects with university and conservation partners include updating species distribution models and Texas' State Wildlife Action Plan.

Contact – *megan.g.bean@gmail.com*

15:45-16:15: Still scratching the surface: an update on film & storytelling projects in desert-fish country – **Jeremy Monroe* & David Herasimtschuk**

We will present updated imagery and previews from several ongoing film and photo projects in the Colorado River and Great Basins and share our outlook and plans for future work.

Contact – *jeremy@freshwatersillustrated.org*



FRIDAY AFTERNOON & EVENING, NOVEMBER 17

16:30-17:30 *Annual DFC business meeting & ExComm elections, Heritage Arts Building, Tri-County Fairgrounds (see meeting agenda on next page)*

18:00-21:00: *Social at Phil's favorite watering hole, **Mountain Rambler Brewery**, 186 S Main St, Bishop, CA 93514, with dinner provided by Rolling Chef 395 food truck*

DESERT FISHES COUNCIL 55TH ANNUAL – BUSINESS MEETING AGENDA
NOVEMBER 17, 16:30-17:30

I. Welcome & call to order – **Kevin Wilson**, President
    a. Discussion & approval of 2022 Business Meeting minutes
    b. President's report

II. Executive Committee Reports
    a. Immediate Past President – Megan Bean
    b. Treasurer, Executive Secretary – Stewart Reid
        i. Alternative signatory on financial accounts
    c. Membership Secretary – Melissa Trammell
    d. Member-at-Large – Lindsey Elkins
        i. 2023 Grants
        ii. Nominations & voting:
            1. President
            2. Program Secretary
            3. Membership Secretary
            4. Areas Coordinator
    e. Student awards – Krissy Wilson
    f. Areas Coordinator – Michael Schwemm
    g. Outreach Coordinator – Heidi Blasius
    h. Program Secretary – Chris Hoagstrom
        i. Naming The Poster Award for Phil Pister
    i. Proceedings Editor & Data Management, Webmaster – David Rogowski

III. Old Business
    a. 2024 Meeting – Kevin Wilson
    b. Call for additional old Business – Kevin Wilson

IV. New Business
    a. 2025 Meeting & collaboration with SIMAC (Mexican Ichthyology Society) – Dean Hendrickson
    b. Call for additional new business – Kevin Wilson

V. Adjourn

SATURDAY MORNING, NOVEMBER 18 – HERITAGE ARTS BUILDING, TRI-COUNTY FAIRGROUNDS

*General Session – **Susan Washko**, moderator*

08:15-09:00: Screening of "*Paya: The Water Story of the Paiute*" – Owens Valley Indian Water Commission

Paya: The Water Story of the Paiute tells the untold story of America's longest lived water war between the Owens Valley Paiute and the city of Los Angeles. Using in-depth interviews, 2-d animation, archival footage and photography, Paya documents the history of the Owens Valley Paiute who constructed and managed sixty square miles of intricate irrigation systems for millennia, long before Los Angeles diverted the Owens River through the Los Angeles Aqueduct, 220 miles across the Mojave Desert. After the Indian War of 1863, surviving Paiute returned to the valley from the Eastern Sierra and White Mountains to find their ancient waterworks taken over by white settlers. Over 150-years later, the Paiute continue the fight to save their waterworks, which are remnant in the Owens Valley landscape. Using archival maps from 1856, the filmmakers spent four years working with Paiute elders to locate and map their remnant irrigation systems using GIS technology, ultimately laying the foundation for a 'first use' water rights case now underway. Paya is currently being used by the Owens Valley Paiute and the Native American and academic communities nationally to mobilize tribes.

Running Time: 36:23 minutes with credits

Festivals: Hot Springs Documentary Film Festival, Red Nation Film Festival, Native Women In Film & Television Festival

Academic curricula: Columbia Law School, Vermont Law School, University of Arizona Indigenous Peoples Law & Policy Program, University of California, Los Angeles, University of California, Berkeley, University of Southern California, University of California, Davis, University of California, Santa Barbara

Awards: "Best Documentary Short" Red Nation Film Festival

The Owens Valley Indian Water Commission is distributing DVD copies of Paya: The Water Story of the Paiute. A DVD is $29.95 with a shipping and handling fee of $5.00 USD to domestic addresses. Please email teri@oviwc.com for express shipping options, international orders, and screening requests.

09:00-09:15: The microendemic origins of scale-eating in *Cyprinodon* pupfishes provides unexpected insights into rapid speciation, new vertebrate gene function, & the regulation of human cancer genes – **Christopher Martin**

Understanding the genetic basis of novel adaptations in new species is a fundamental question in biology that also provides an opportunity to uncover new genes and regulatory networks with potential clinical relevance. Highly conserved genetic regulatory pathways shared across diverse vertebrate species have been shaped by adaptive evolution to produce a tremendous diversity of phenotypes. This diversity can be harnessed to access the genetic underpinnings of human clinical and natural variation that is absent from model systems. Emerging non-model systems are known as 'evolutionary mutant' models and have proven to be a powerful complement to research on model systems. Fundamental investigation of the genetic basis of adaptive phenotypes can lead to better diagnosis, prevention, and treatment of human diseases.

Here I review a decade of my lab's work investigating the rapid evolutionary transition from a generalist algae-eating pupfish (*Cyprinodon variegatus*) to scale-eating (*C. desquamator*) and molluscivore (*C. brontotheroides*) specialists endemic to the desert-like subtropical hypersaline lakes of San Salvador Island in the Bahamas. We show that colonizing these niches occurred in stages, beginning with selection on standing genetic variation for feeding behavior, then aided by adaptive introgression from diverse sources, and ending with selection on de novo mutations in key craniofacial genes. We discovered that only 157 single-nucleotide polymorphisms (SNPs) and 87 deletions are fixed between these two specialists despite extensive phenotypic divergence in their craniofacial morphology, metabolism, and behavior. In many cases, only a single highly divergent SNP or structural variant is found in the regulatory, intronic, or (rarely) coding region of genes associated with these phenotypic axes. This provides a key advantage for identifying causal adaptive variants due to minimal genetic differentiation among highly divergent trophic ecotypes replicated across lake populations.

For example, using the pupfish evolutionary mutant system, we recently demonstrated a new role for galr2 in vertebrate craniofacial development. We confirmed the loss of a putative Sry transcription factor binding site in the upstream region of galr2 in scale-eating pupfish and found significant spatial differences in galr2 expression among species using in situ hybridization chain reaction (HCR). We then experimentally demonstrated a novel function for Galr2 in craniofacial development and jaw elongation by exposing embryos to drugs that inhibit Galr2 activity. Galr2-inhibition reduced Meckel's cartilage length and increased chondrocyte density in both trophic specialists but not in the generalist genetic background.

We also identified additional candidate adaptive variants in pupfish for human genes that also play a key role in cancer, including gpa33, prlh, and twist1. We are now using CRISPR-Cas9 genome editing to confirm a causal role for these variants. By combining candidate gene and variant discovery with functional genetics, we aim to demonstrate the flexibility and power of non-model systems to gain new insights into the developmental genetics of human diseases. Our findings also illustrate the growing utility of linking adaptive variation in non-model systems, such as desert fishes, with novel vertebrate gene functions.

Contact – *chmartin@unc.edu*

09:15-09:30: Effective or futile – mechanical removal of nonnative species – **David Rogowski**

Aquatic invasive species are an ever-increasing problem. Prevention is the best management policy for nonnative species. However, humans are a reactionary species and prevention is not funded nor enacted at levels that are adequate. As a society we spend billions to respond to fires but comparatively little to prevent those fires in the first place. Similarly, with aquatic invasive species, most effort has been responding to invasions instead of preventing invasions in the first place. In many cases upon detection of new aquatic invasive species the response of agencies has been mechanical removal, as it is one of the few tools in our toolbox. However, in a large river such as the Colorado River, is mechanical removal effective?

Contact – *darogow12@gmail.com*

09:30-09:45: Humpback chub (*Gila cypha*) monitoring & translocations in the Little Colorado River, Arizona – **Michael Pillow*, Pilar Rinker & David Ward**

The humpback chub (*Gila cypha*) is a large-bodied, federally protected Colorado River cyprinid with populations in Colorado, Utah, and the Grand Canyon in Arizona. The Little Colorado River (LCR) is a warm water, spring-fed, Colorado River tributary at the Grand Canyon that provides important spawning and rearing habitat for a large portion of this population each year. In 2000, the U.S. Fish and Wildlife Service began conducting a series of annual, two-pass, closed Chapman Petersen mark-recapture efforts in the spring and fall in the LCR to track abundances of humpback chub and other native fish. Since 2006, there has been a significant increase of adult humpback chub in the LCR. During spring 2022 the estimated abundance of humpback chub ≥150 mm in the lower 13.57 km of the LCR was 10,563 (SE = 727). Of these fish, it was estimated that 8,525 (SE = 665) were adults (≥200 mm). During fall 2022 the estimated abundance of humpback chub ≥150 mm in the lower 13.57 km of the LCR was 2,320 (SE = 367). Of these fish, it was estimated that 1,888 (SE = 321) were ≥200 mm. These numbers indicate that the spring spawning and fall abundances of humpback chub in the LCR have remained relatively stable since experiencing significant post-2006 increases. In addition, since 2003 the U.S. Fish and Wildlife Service has translocated 4,871 juvenile humpback chub from the lower reaches of the LCR to above Chute Falls, a travertine waterfall complex within the LCR that acts as a barrier to some upstream migration. By the time they are two years old, the majority (74.5%, n = 760) of translocated fish that remain above the falls are adults (≥200 mm), compared to only 12.6% (n = 539) of the captured but not translocated humpback chub. A warmer annual temperature profile and abundance of food above the falls are thought to contribute to the higher growth rates of these translocated fish compared to their non-translocated cohorts in the lower LCR.

Contact – *michael_pillow@fws.gov*

09:45-10:00: Invasive Northern Pike, *Esox lucius*, Telemetry in Utah Lake – **Wes Franklin*, Bryan Kesner & Paul Marsh**

Utah Lake is home to an endemic population of June Sucker, *Chasmistes liorus*. A decline in the June Sucker population led U.S. Fish and Wildlife Service to list the species as endangered in 1986. Extensive recovery efforts by the interagency group "June Sucker Recovery Implementation Program" (JSRIP), led to June Sucker being reclassified from endangered to threatened in 2021. Illegal introduction of Northern Pike, *Esox lucius*, into Utah Lake in early to mid-2000s may jeopardize June Sucker recovery. Presence of Northern Pike in Utah Lake was confirmed in sampling by Utah Division of Wildlife Resources (UDWR) in 2011. Because of the substantial threat Northern Pike pose to recovery, it was determined that research and monitoring for Northern Pike in Utah Lake should be initiated to a) identify Northern Pike spawning sites and aggregations; b) identify the best capture methods, and ultimately, control measures; and c) evaluate potential impact of Northern Pike on the June Sucker population. In 2021, a three-year research project was initiated by JSRIP in collaboration with Marsh & Associates and UDWR. This project implements a combination of acoustic and radio tracking, larval trapping, PIT tag monitoring, and observation to describe Northern Pike movement, habitat use, congregational behavior, and spawning behavior in Utah Lake. The presentation includes data and results from 2.5 years of project work. To date, 43 Northern Pike have been tagged in Utah Lake. Current results show locations where Northern Pike are contacted and caught most including Provo River, Hobble Creek, Lincoln Beach & the Utah Lake State Park jetties as well as the months in which Northern Pike are contacted most (March – May).

Contact – *wfranklin@nativefishlab.net*

10:00-10:15: Assessing ecosystem & population dynamics to determine the primary drivers of Devils Hole Pupfish population trends – **John Umek*, Kevin Wilson, Jeff Goldstein, Ambre Chaudoin & Mark Hausner**

The critically endangered Devils Hole pupfish (DHP), *Cyprinodon diabolis*, found only in Devils Hole, was in a steady decline in population size beginning in the mid 1990s. The population reached an all-time low of 35 observable fish in the spring of 2013. Since this all-time low the population has increased to 150-250 observable fish. However, the population remains well below historical levels of 400-600 individuals. Because the reasons for the steady decline and subsequent increase are not fully understood, the multi-agency management team established a Long-Term Ecosystem Monitoring Program (LTEMP) in 2011 to collect ecosystem level information on the ecosystem processes and population dynamics of Devils Hole and the DHP. In 2020, the Desert Research Institute (DRI) began a project to compile, organize, and document these data and make them accessible to researchers and resource managers. This project has two goals: (1) to compile the existing LTEMP data into a digitally ingestible format that can be easily accessed by researchers seeking to analyze the data; and (2) to perform data analysis to examine and quantify relationships between different drivers of habitat quality and metrics of the Devils Hole pupfish population. To accomplish this second goal we examine ecosystem and population dynamics through random forest modeling, a machine learning algorithm. The random forest technique can handle complex, multi-dimensional datasets and capture nonlinear relationships. By analyzing historical data, researchers and policymakers can better understand connections between different drivers of variability in the DHP population and make more informed decisions to minimize negative impacts and develop sustainable management practices. We use the random forest technique to examine the interactions between biotic and abiotic parameters measured in Devils Hole and the observed DHP population. Here we present the results of the analyses, identifying the most significant drivers of variability in the DHP population over the last 15 years.

Contact – *John.Umek@dri.edu*

10:15-10:30: Stratiomystery: Ability of aquatic Odontomyia (Diptera: Stratiomyidae) larvae to survive stream drying using dormancy – **Susan Washko* & Michael Bogan**

Aquatic solider fly larvae (Diptera: Stratiomyidae, subfamily Stratiomyinae) are known for their abilities to live in extreme environments. In the Sonoran Desert, Odontomyia larvae use dormancy to survive when temporary rock pools dry. Climate change is expected to make rock pool dry periods longer, which could test the limits of dormancy in aquatic solider fly larvae. To better understand the limitations of this strategy on larval survival and body condition, we conducted a series of laboratory-based microcosm experiments. We found that Odontomyia larvae can survive at least two extended dry periods (≥30 days) through dormancy. The presence of moisture in the substrate during dormancy is not necessary to survive and had no effect on survival or larval body mass in our experiments. Energy and bodily water loss likely limit survival in dormant stages. Although these results suggest Odontomyia are fairly resistant to drying, more data is needed on body mass, pupation, and reproductive success across hydroregimes. The more we understand about the survival limitations of rock pool aquatic invertebrates, the more successful conservation efforts will be for their unique aquatic biota.

Contact – *washko.susan@gmail.com*

10:30-10:45: Abandoned in the Mojave Desert: revised history of oviparous goodeids (Empetrichthyinae) – **Sonia Hernandez, Christopher Hoagstrom* & Wilfredo Matamoros**

Empetrichthyinae (poolfishes) is a subfamily endemic to the Mojave Desert, including *Crenichthys* and *Empetrichthys*. The biogeography of this group is enigmatic. Throughout most of the 20th Century, researchers debated its phylogenetic affiliation. In 1981, Parenti determined, using skeletal features, that the group belonged to Goodeidae (Cyprinodontiformes) and this finding later gained molecular support. However, this revealed a large geographical gap between Empetrichthyinae and its sister subfamily Goodeinae, which inhabits the Trans-Mexican Volcanic Belt. Hypotheses proposed to explain this disjunction included climate change (desertification), tectonic transport along the Pacific Coast, and immigration from the Great Basin into the Trans-Mexican Volcanic Belt, but no hypothesis was developed in detail. Our study of North American Cyprinodontiformes indicates families within this order diversified among drainages of the Gulf of Mexico. Goodeidae evidently separated from other Cyprinodontiformes via a marine-freshwater transition, likely into a Madrean River drainage that existed at the estimated time of origin (Middle Eocene-Early Oligocene), extending northwest from the western Gulf, along the front of the Sierra Madre Oriental, across southwestern North America. Late Eocene transfer of Madrean tributaries to what became the Oligocene Rio Grande provides a feasible route to the Great Basin, compatible with the estimated time of origin for Goodeidae. Subsequent divergence of Empetrichthyinae corresponds in time with breakup of this drainage, while also accounting for access of Goodeinae to the Trans-Mexican Volcanic Belt. Thereafter, volcanism and uplift of the Sierra Madre Occidental, desertification, river-drainage reorganization with faunal invasions, climatic cooling, and possibly (more recently) human settlement may have all contributed to creating the modern distributional gap between subfamilies.

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FIELD TRIPS

Saturday Nov 18

11:00-15:00: Field trip to Owens pupfish habitat restoration project at BLM Spring in Fish Slough, led by retired California Fish & Wildlife biologist Steve Parmenter & BLM biologist Evan Standifer – [*limit 20 attendees*]

Sunday Nov 19

08:00-13:00: Field trip to Owens pupfish conservation project at River Spring Lakes Ecological Refuge, led by project California Fish & Wildlife biologist Nick Buckmaster – [*limit 20 attendees*]