

Desert Fishes Council

Consejo de los Peces del Desierto



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

47th Annual Meeting

18-22 November 2015

Death Valley National Park, California, U.S.A.

Events will be held at Furnace Creek Visitors Center, unless otherwise noted

Wednesday 18 November 2015

16:00 - 21:00 *Registration* - Hosted by Phil Pister

16:00 - 21:00 Presentation loading

18:00 - 21:00 **Informal mixer at Corkscrew Saloon**

Thursday 19 November 2015

08:00 - 18:00 Registration and presentation loading

08:30 - 09:00 Opening Remarks (Phil Pister and Kathryn Boyer)

09:00 - 12:00 GENERAL SESSION - I (Clay Crowder, Moderator)

12:00 - 13:15 LUNCH

13:15 - 17:15 GENERAL SESSION - II (Koreen Zelasko, Moderator)

17:30 - 19:00 POSTER SESSION

19:00 - 19:30 A special reading from *Relicts of a Beautiful Sea*
(Christopher Norment)

19:00 - 21:00 Graduate Student-Professional Speed-Networking Workshop (Hosted by Marlis and Michael Douglas)

Friday 20 November 2015

08:30 - 10:15 SPECIAL SYMPOSIUM (Kathryn Boyer, Moderator)

10:15 - 12:00 GENERAL SESSION - III (Shawn Goodchild, Moderator)

12:00 - 13:30 LUNCH

13:30 - 17:15 GENERAL SESSION - IV (Alejandro Varela-Romero, Moderator)

17:15 - 18:15 BUSINESS MEETING

18:30 - 22:00 **BANQUET - Furnace Creek Date Grove**

Saturday 21 November 2015

08:30 - 12:00 GENERAL SESSION - V (Sierra Love Stowell, Moderator)

12:00 - 13:30 LUNCH

13:30 - 15:30 GENERAL SESSION - VI (Kristen Humphrey, Moderator)

Sunday 22 November 2015

08:00 - 15:00 FIELD TRIP

Desert Fishes Council

Consejo de los Peces del Desierto



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

Wednesday, November 18, 2015

16:00-21:00 Arrival, check-in and presentation loading at the Furnace Creek Visitors Center

Thursday, November 19, 2015

08:00-18:00 Registration and presentation loading

Note: Presenters should be prepared to load presentations before the start of each session

08:30-09:00 Opening Remarks

- Phil Pister, Desert Fishes Council Executive Secretary
- Kathryn Boyer, Desert Fishes Council President
- Devil's Hole Pupfish Video

*****PLEASE NOTE THE FOLLOWING ABSTRACTS HAVE NOT YET BEEN EDITED OR STANDARDIZED FOR FINAL PUBLICATION. PLEASE CONTACT AUTHOR(S) OR DFC PROCEEDINGS EDITOR FOR CLARIFICATION IF THERE ARE QUESTIONS ABOUT POSSIBLE ERRORS*****

09:00-12:00 General Session I: Clay Crowder, Moderator

09:00 DFCs publishing legacy: Transitioning into the digital age with new services for, and request for participation of, Council members

Hendrickson, Dean^{*1}, Pister, Edwin (Phil)². (1-University of Texas/R4000/PRC176, 2-Desert Fishes Council). DFCs mission includes rapid dissemination of information concerning activities of the Council and its members. For decades following founding of the Council in 1968, annual meetings combined with distribution of the meeting Proceedings to address this goal. Meetings have been consistently annual since 1970, but the way Proceedings have been handled has varied. The Council has never had paid staff and has always been dependent strictly on volunteer labor, with consequential variation in the rapidity and form of information dissemination. Through the 1980s paper copies of hand- or type-written records of meetings were reproduced and mailed annually to members. In 1992 I assumed editorship and began computer-based production of the Proceedings, providing text-based PDFs and mailed bound hard copies. Postal mailings to members ceased by about 2000 with distribution switching to email and downloading from the website, saving the Council many thousands of dollars in annual printing and mailing charges.

For a few years, bound hard copies were printed and shipped on request by an online printer for a small fee, but few were sold. Eventually all prior back issues were scanned to graphic-based pdfs and made available from the website and only digital copies were made available. DFC being an international group with many Mexican members and using savings from stopping printing and mailing, starting in XXXX, all abstracts were meticulously translated to Spanish. Highly qualified translators provided this service for far less than market value, but dissemination became far less rapid as a result. A decision was made in 2013 to discontinue translation after completion of the 2006 volume. Currently all Proceedings from 1968-2006 are published as pdfs on the website. PDF content, however, is not indexed on the web so their content is not easily discovered. A new form of publishing has just recently been tested that will make abstracts far more easily searchable via the web. In its early years, the Proceedings occasionally included full papers that followed up on content presented at meetings. Inquiries at meetings over the years occasionally suggested the DFC should publish a peer-reviewed journal. Early digital issues explored this, but the work load exceeded limitations of volunteer editors and only the 19XX volume has full papers. At many meetings it has also been suggested that DFC publish the digital files from meeting presentation. Volunteer time and expertise limitations have never been adequate. At its summer 2015 meeting the DFC Excomm agreed to explore new forms of online publication that are being made available as a result of the ongoing revolution in the world of scientific publication and exploration of fully open publication. A DFC channel was been established in <http://f1000.com/research>. F1000 (Faculty of 1000) is a well established, international group focusing on open publication and scientific information dissemination. This system allows for rapid and fully open and indexed publication of content by authors. By establishing a DFC channel there we have a place where anyone can quickly publish either their presentations given at meetings (not peer reviewed but requiring acceptance by DFC editors) or fully peer-reviewed contributions. F1000 will manage the peer review via an automated system that will be facilitated by the DFC membership signing up to serve as volunteer reviewers. The entire review process is totally open, with reviewers comments and authors responses openly published. All publications (including presentations) are assigned DOIs so they are easily found by web searches and are fully integrated into that global citation tracking system. This system then provides authors fully citable and tracked rapid publication and reviewers have verifiable records of their contribution as reviewers. Publication of presentations is completely free and takes no more than 5 minutes, but can only be done by the authors themselves who choose how they wish to license their content. Any wishing to publish a complete paper (peer reviewed) through the F1000 system will pay 50% of the publication fee (\$150 for short contributions). There is thus no time commitment for DFC volunteers so this looks to be a sustainable system, but success will be dependent on author and reviewer participation. Abstracts starting with those from the 2007 meeting will be made available (in English only) in easily searchable Google fusion table format. This is an experimental way of publishing abstracts that may change in future, but the work flow to get the content from the DFC abstract database into this system appears to be sustainable and there is great potential here to involve the membership in tagging and further normalizing the content to better integrate it into the semantic / linked web of the future.

09:15 Using Structured Decision Making to prioritize projects under a limited budget: A case study from New York

Barrett PhD, Paul ^{*1}, Robinson PhD, Kelly². (1-Structureddecisions.com, 2-Cornell University).

The State of New York (NY) has invested substantial time and resources to create an organized network responsible for managing the state's invasive species. Various entities were established as a result of the NY Invasive Species Task Force Report, including eight Partnerships for Regional Invasive Species Management (PRISMs), the NY Invasive Species Research Institute, the Cornell Cooperative Extension Invasive Species Program, the NY Invasive Species Clearinghouse, the NY Invasive Species Council, and the Invasive Species Advisory Committee. These groups currently work together with the Department of Environmental Conservation Invasive Species Coordination Unit, NYS Parks Invasive Species Coordination, and numerous other NGOs and community groups. Each of these entities is required to set invasive species priorities, elaborate strategic plans and provide recommendations to partner

organizations and volunteer networks. The groups needed to prioritize among feasible actions that make the best use of available resources. These actions should be science-based, sustainable, and environmentally ethical. During and subsequent to an April workshop, Structured Decision Making tools were used to develop a model to assist in prioritizing projects. The resulting model is transparent, standardized, and scalable, within the parameters above, to protect the environment, human health, and the economy by preventing or reducing significant negative impacts of non-native species. In light of the limited resources and conflicting mandates among the entities working to recover and manage desert fishes similar methods and models can be used to prioritize actions proposed to conserve these fishes and their habitats.

09:30 Environmental drivers of growth of an endangered desert fish in two contrasting environments

Dzul, Maria C.^{*1}, Yackulic, Charles B.¹. (1- USGS-Grand Canyon Monitoring and Research Center, 2- USGS-Grand Canyon Monitoring and Research Center).

For fish species where survival is closely linked to body size, growth rates can play an important role in population dynamics. Determining environmental drivers and estimating responses of growth in such species can inform decision-making about conservation and management of imperiled species. We present a Bayesian growth model that uses monthly means of environmental covariates to describe subadult growth of endangered humpback chub *Gila cypha* in two contrasting environments, the Colorado River (CR) in Grand Canyon and the lower Little Colorado River (LCR). While the thermal and hydrologic regimes in the LCR are mainly influenced by air temperatures and precipitation patterns, respectively, the thermal and hydrologic regimes of the CR are influenced primarily by operations and reservoir level of Glen Canyon Dam and are therefore more seasonally constant. We compared models with food availability, turbidity duration, hydropeaking (CR only), and temperature effects in a model selection framework. Results indicated environmental influences on growth differed in the two habitats. While warmer temperatures were associated with increased growth in both systems, the effect was much stronger in the CR than the LCR. Furthermore, turbidity positively affected growth in the CR, and food availability positively affected growth in the LCR. Overall, environmental covariates explained more variation in growth in the CR than the LCR. A better understanding of how environmental covariates affect growth in the CR and LCR may improve the predictive capability of humpback chub population models and help predict how chub vital rates will change if the southwestern U.S. warms and becomes more arid in future years due to climate change.

09:45 Flannelmouth Sucker distribution, movement and growth within the Colorado River, Arizona

Osterhoudt, Robin J.¹, Rogowski, David L.^{*1}. (1-Arizona Game and Fish Department).

The flannelmouth sucker, *Catostomus latipinnis*, is one of four remaining native fish species found within the Colorado River between Glen Canyon Dam, Arizona and Lake Mead, Nevada. Flannelmouth sucker undergo large migratory movements, but since the impoundment of Glen Canyon Dam, they are now restricted to a smaller closed-off regulated system. Alteration from historical Colorado River conditions has adversely impacted native fish fauna, and while much effort has been expended toward the endangered species (humpback chub, razorback sucker) little effort has been directed towards flannelmouth sucker. We investigated movement and growth of flannelmouth sucker from PIT (Passive Integrated Transponder) tag mark and recapture events using a dataset from long-term monitoring studies conducted by Arizona Game and Fish Department, U.S. Fish and Wildlife Service, and Grand Canyon Monitoring and Research Center (1991-2015). Flannelmouth occur throughout the Colorado River between Glen Canyon Dam and Lake Mead (~460 km) but tend to be more abundant in the lower reaches below the Little Colorado River (LCR; ~120 km below Glen Canyon Dam). The LCR is the largest and most influential tributary in this study area, and flannelmouth sucker are commonly found there, particularly during seasonal spawning. From a random subset of the total marked fish 40% of marked flannelmouth suckers were captured at least once within the LCR. For analyses fish were categorized as

subadult (150-349 mm) and adult ($\geq$ 350 mm). Movement and annual growth of flannelmouth suckers varied with size. Subadult fish moved relatively little (37.9 km/yr), while adult moved significantly greater distances (147 km/year). Subadult flannelmouth suckers grew an average of 85.6 mm per year, while adults grew an average of 58.8 mm per year. Future analyses will investigate growth, movement, and survival in relation to dam operations and environmental factors.

10:00 Approaches for re-establishing Bonytail, *Gila elegans*, populations within the Colorado River basin

Kegeries, Ron^{*1}, Albrecht, Brandon¹, McKinstry, Mark², Speas, Dave². (1-Bio-West, Inc., 2-U.S. Bureau of Reclamation).

Bonytail, *Gila elegans*, is one of four endangered fish species in both the upper and lower Colorado River basins. To date, there has been no measurable success in recovering, or developing stable populations of this fish species anywhere in the Colorado River basin outside of hatchery or predator-free, pond-type settings. Since 1996, nearly 250,000 Bonytail have been stocked into the upper Colorado River basin, mostly within the Green and Colorado rivers (approximately 90%). Despite these stocking efforts less than 10,000 (<4%) individuals have been captured or detected via various sampling methods. According to capture history data, only 34 individual Bonytail were at large for more than a year before being recaptured. The longest period between captures was 7 years: a single fish stocked into the Colorado River in 2007. Due to the poor survival and recruitment under the current stocking plan, the U.S. Bureau of Reclamation supported the development of different approaches for conserving and recovering Bonytail with emphasis on all life stages to promote recruitment. Biologists from the upper and lower Colorado River basins discussed research-based approaches that may be beneficial to increase survival and recruitment of the species. The two primary approaches included: 1) releasing Bonytail into complex off-channel wetlands within the Green River, and 2) releasing Bonytail into coves within Lake Powell that provide turbidity and cover near the Colorado inflow. The goal for each would be to establish populations that reproduce in areas that contain habitat necessary for rearing, growth, and potentially recruitment. Life-history strategies of Bonytail that provide advantages to improve survival and recruitment include prolific spawning, non-specificity of spawning substrates, and lentic spawning. Under each of these approaches stocked fish would be tracked, reproduction assessed, and recruitment measured through continued monitoring. These approaches are aimed at improving recovery potential, while generating ideas and cooperation among the cooperators who work with Bonytail.

10:15 Conditioning hatchery reared fish to recognize non-native predators

ONeill, Matthew¹, Stewart, William^{*1}, Finnegan, Andrea². (1-Arizona Game and Fish Department, 2-U.S. Bureau of Reclamation).

Predation by non-native fish may be the main mortality source for stocked bonytail (*Gila elegans*) and razorback sucker (*Xyrauchen texanus*) in the Lower Colorado River. Hatchery reared fish are naive to this risk and may not survive their first encounter with a predator. We used conspecific alarm pheromone to condition groups of predator-naïve prey fish to recognize a non-native fish predator. Prior to conditioning, the jaw muscle of a predator fish was incapacitated with botulinum toxin, preventing it from capturing prey fish during conditioning. Fish were conditioned by simultaneously adding a hindered predator and alarm pheromone into their tank. Predator recognition conditioning significantly improved survival of bonytail and razorback in 24 hour survival trials with largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), and mixed bass and catfish. Survival of conditioned fish averaged 20% higher than unconditioned fish. There was no change in mean prey fish size, suggesting that all prey fish were susceptible to predation and conditioning benefitted all prey fish sizes. This novel conditioning method improved survival without prey fish seeing or experiencing predation during the conditioning process, suggesting this methodology may be successful at training large groups of these endangered fish in hatchery production ponds.

10:30 An evaluation of the efficiency of minnow traps for estimating the abundance of minnows in desert spring systems

Scheerer, Paul¹, Peterson, James², Clements, Shaun¹. (1-Oregon Department of Fish and Wildlife, 2-U.S. Geological Survey, Oregon Cooperative Fish and Wildlife Research Unit).

It is important to accurately quantify population parameters for native desert fishes of special conservation concern. We evaluated the efficiency of baited minnow traps for estimating the abundance of two ESA listed species, Fosskett Speckled Dace *Rhinichthys osculus* ssp. and Borax Lake Chub, *Gila boraxobius*, in desert spring systems in southeastern Oregon. We estimated capture and recapture probabilities using the Huggins closed-capture estimator and compared the abundance estimates with the commonly used Lincoln-Petersen estimator. We evaluated alternate sample designs using simulation. Trap capture probabilities averaged 23% and 26% for Fosskett Speckled Dace and Borax Lake Chub, respectively, but differed substantially among sample locations, through time, and nonlinearly with fish length. Recapture probabilities for Fosskett speckled dace were, on average, 1.6 times greater than first capture probabilities, suggesting trap happy behavior. We found the Lincoln-Petersen estimator underestimated Fosskett Speckled Dace and Borax Lake Chub abundance by 48% and 20%, respectively comparing to the Huggins estimator. These biases were due to variability in capture and recapture probabilities. Simulation of fish monitoring that included the range of capture and recapture probabilities observed indicated that bias and error decreased with increasing capture occasions and that variability in these probabilities over time of +/-10% greatly reduced the ability to detect annual decreases in abundance using raw catch data. Failure to account for this variability in capture and recapture probabilities can lead to poor data quality and study inferences. Thus, we recommend employing sampling designs and estimators that can account for this variability.

10:45 Longitudinal and temporal patterns of food availability for endangered Humpback Chub, *Gila cypha*, in the Little Colorado River, Arizona

Muehlbauer, Jeffrey^{*1}, Kennedy, Theodore¹, Kortenhoeven, Eric¹, Smith, Joshua¹. (1-U.S. Geological Survey). The Little Colorado River (LCR) in northern Arizona provides spawning and rearing habitat for the largest population of endangered humpback chub, *Gila cypha*, in the Colorado River Basin. However, relatively little is known about the aquatic food web in this river, particularly the aquatic insect community that is presumed to compose the bulk of the drift-feeding chub's diet. Here, we present results from two years of spatially and temporally-intensive study on aquatic insects in the LCR. We found pronounced seasonal patterns of aquatic insect activity, peaking in mid-April and otherwise remaining fairly low throughout the remainder of the year. Additionally, light availability, as related to the contrasting influences of canyon orientation and bicarbonate buffering, appears to act as a strong spatial control on aquatic insect densities throughout the LCR. We close by describing the implications of this spatial and temporal variation in the aquatic foodbase for humpback chub population dynamics.

11:00 Interannual reproduction and recruitment dynamics of Flathead Chub, *Platygobio gracilis*, in Fountain Creek, Colorado, USA

Haworth, Matt^{*1}, Bestgen, Kevin¹. (1-Colorado State University, Dept of Fish, Wildlife, and Conservation Biology, Larval Fish Laboratory).

Stream ecosystems of the North American Great Plains are threatened by widespread flow regulation, alteration of thermal and sediment regimes, establishment of non-native biota, and habitat loss. These changes have driven the loss or decline of many fish species, including small-bodied pelagic-spawning cyprinids, a guild thought to be particularly susceptible to flow regulation. Thus, conservation of this guild requires an understanding of their specific life histories, particularly the relationships between reproduction, recruitment, and flow regime. We measured seasonal presence and abundance of egg, larval, and juvenile life stages of Flathead Chub, *Platygobio gracilis*, over two reproductive seasons in the southwestern portion of their range (Fountain Creek, Colorado, USA) to relate effects of hydrology and water temperature on reproduction and subsequent recruitment. Spawning was most affected by water temperature as initiation and peak of reproduction was consistent between study years despite different

seasonal flow conditions. Back-calculation of hatching dates from juvenile chub otoliths revealed survival and recruitment was most affected by high magnitude or frequent flow spikes caused by convective storm runoff. Downstream displacement or mortality of eggs and recently-hatched larvae by flow spikes caused reduced abundance of juveniles hatched just prior to or during these events. Our results demonstrate that investigations focused on a single early life stage are insufficient to evaluate factors limiting the persistence of Flathead Chub, and possibly other pelagic-spawning cyprinids, as stream flow and temperature conditions had varying effects on separate but interrelated early life stages. Life history investigations that encompass all early development stages will provide managers with information necessary to benefit both reproduction and recruitment of small-bodied pelagic-spawning cyprinids in regulated streams systems, and aid in the conservation and recovery of an imperiled guild of North American stream fishes.

11:15 Reproduction, abundance, and recruitment dynamics of young Colorado Pikeminnow, *Ptychocheilus lucius*, in the Green River Basin, Utah and Colorado, 1979-2012

Bestgen, Kevin R.^{*1}, Hill, Angela A.¹. (1-Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University).

We assessed long-term patterns of Colorado pikeminnow *Ptychocheilus Lucius* reproduction and age-0 recruitment in the Green and Yampa rivers of the upper Colorado River basin to better understand reasons for declining abundance of adults. Timing of reproduction in summer was positively related to date of peak spring runoff flow as well as water temperatures. Abundance of larvae produced from spawning areas was positively correlated with both spring peak and summer base flows (mean July-August flow) in the lower Yampa River and the lower Green River. In low flow years, few larvae were produced from spawning areas and transported to nursery habitat reaches in summer (e.g., 1994, 2002, 2007) so few age-0 pikeminnow were evident, especially in middle Green River backwaters in autumn. In most other years, production of larvae was thought sufficient to produce more age-0 fish but other factors controlled their survival and recruitment to autumn. Densities of age-0 Colorado pikeminnow in middle and lower Green River backwaters declined over the study period. Exact mechanisms controlling abundance of age-0 Colorado pikeminnow were not known, but moderate base flow levels were consistent with higher abundance in most years and lower abundance was noted in lower and higher base flow years. Growth of age-0 Colorado pikeminnow was positively related to length of the summer growing season and summer water temperature. Higher base flow levels were also associated with reduced autumn abundance of red shiner *Cyprinella lutrensis*, a potential competitor and predator on early life stages of native fishes. Although data patterns were messy, a result of high variability in pikeminnow abundance and environmental factors, a clear signal was that Green River base flows in summer and autumn need to be increased to favor survival of larger numbers of age-0 Colorado pikeminnow and bolster populations of adult life stages.

11:30 Cycles of boom and bust in coastal California intermittent streams

Bogan, Michael^{*1}, Leidy, Robert², Carlson, Stephanie¹. (1-Univ California Berkeley, Dept Environmental Science, Policy & Management, 2-Environmental Protection Agency, San Francisco, CA).

Intermittent streams in coastal California experience dramatic cycles of boom and bust across seasons and years. In wet winters these streams have many kilometers of flowing water, whereas in dry seasons or years only small, isolated pools remain. The communities inhabiting these remnant pools are rarely studied and their role in facilitating community recovery in adjacent reaches is unknown. We quantified community composition in remnant pools at one small and one large intermittent coastal stream in California: John West Fork (3 sq km) and Coyote Creek (240 sq km). After flow returned, we monitored community development in intermittent reaches adjacent to perennial pools. Both streams supported >150 invertebrate species in remnant pools. Coho salmon and steelhead inhabited pools at John West Fork, and 11 species of native fish and amphibians inhabited pools in Coyote Creek. Early in the wet season, communities in newly-flowing intermittent reaches were dominated by taxa with life stages resistant to drought (e.g. diapause). However, within several months taxa from perennial refuges had moved into adjacent intermittent reaches. Our results demonstrate the importance of perennial refuges in maintaining biodiversity in intermittent streams.

11:45 Upper Colorado Basin Area Report - 2015

Badame, Paul^{*1}. (1-Utah Division Wildlife Resources).

Activities continue in an effort to improve the status of many native fishes of the Upper Colorado River Basin. These activities are guided principally by four programs: the Upper Colorado River Endangered Fish Recovery Program, the San Juan River Basin Recovery Implementation Program, the Range-wide Conservation Agreement for the Colorado River Cutthroat Trout, *Oncorhynchus clarkii pleuriticus*, and the Range-wide Conservation Agreement and Strategy for the “Three Species” (roundtail chub, *Gila robusta*, bluehead sucker, *Catostomus discobolus*, and flannelmouth sucker, *C. latipinnis*). The two recovery programs, which collectively work towards the recovery of Colorado pikeminnow, *Ptychocheilus lucius*, razorback sucker, *Xyrauchen texanus*, bonytail, *G. elegans*, and humpback chub, *G. cypha*, use the protection of in-stream flow, habitat restoration, nonnative fish control, propagation, life history monitoring, and information and education to bring benefits to the four “big river fishes.” A species status assessment for razorback suckers has been initiated and the process to update humpback chub recovery goals has also started. Tasks to assist the species under Conservation Agreements included multiple remote sensing projects in tributaries throughout the basin; tamarisk control and watershed habitat restoration efforts are occurring on the San Rafael, Price, and White Rivers; distribution and density monitoring throughout their ranges; and renovation of trout streams and reintroduction of the Colorado River cutthroat trout continues in Colorado, Utah, and Wyoming.

12:00-13:15 Lunch

13:15-14:30 General Session II: Koreen Zelasko, Moderator

13:15 Lower Colorado River Area Report 2014-2015

Fitzpatrick, Lesley^{*1}. (1-Concerned Citizen).

The Lower Colorado River Area has many rivers and species with active programs for their conservation. From the Grand Canyon to the Virgin River, to the mainstem Colorado River to Mexico, the Gila/Salt/Verde and Bill Williams rivers there is something happening everywhere for native cold and warmwater fish. Programs across the area are cooperative efforts with Federal, State, Tribal, conservation agencies and private interests working together for native fish conservation. Projects reported on include: Conservation and Mitigation Program for Sportfish Stocking (AZ), Gila River Basin Native Fishes Conservation Program (AZ and NM), Glen Canyon Dam Adaptive Management Program (AZ), Lower Colorado River Multi-Species Conservation Program (AZ, CA, NV), Native Trout Conservation (AZ and NM), Six Species Conservation Agreement (AZ), Species Conservation Plans: Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub (NM), Recovery Plan for Gila Chub (new), Species listings under Endangered Species Act: Zuni bluehead sucker (E), proposed rule for headwater and roundtail chub (both AZ, NM), Virgin River Recovery Program, Muddy River Recovery Program, and Other Conservation as Reported.

13:30 A report on the renovation of Big Tank, El Coronado Ranch, Arizona with comments on Yaqui Catfish, *Ictalurus pricei*, collected from Big Tank during 2014-2015

Minckley, C.O.^{*1}, Ward, David², Lohrengel, Chris³. (1-Cuenca los Ojos, 2-USGS, Grand Canyon Monitoring and Research Center, 3-San Bernardino National Wildlife Refuge, USFWS, Douglas, Az).

Big Tank is located on the El Coronado Ranch in Cochise County, Arizona and is the site of a population of Yaqui catfish, *Ictalurus pricei*. Two introduced fishes, the green sunfish and black crappie were also present in the tank and were thought to be one of the factors in preventing the successful reproduction of Yaqui catfish. For that reason, it was decided to renovate the tank in 2015 to remove them. In April a large pump was used to remove water to a depth of two feet. The tank was then seined with a 120 ft. X 1/8 inch X 6 ft. seine, with a mud line. The fish collected and removed included 27 adult Yaqui catfish, 7 very large grass carp (20 kg), an estimated 1,000 green sunfish and black crappie, and thousands of

bullfrog tadpoles. Seining was stopped when the catch rate dropped markedly (<10 seine hauls). The Yaqui catfish were taken to San Bernardino NWR; grass carp were put into another pond; introduced fish and tadpoles were destroyed. The tank was then treated with full strength ammonia hydroxide to renovate it. It was refilled with water from the inflow of Turkey Creek after 24 hours. Ammonia levels were monitored for a month. Then, 90 days later, 13 Yaqui catfish and 1000 Yaqui chub were reintroduced into the refilled pond.

13:45 Roundtail Chub, *Gila robusta*, and the White River: A look at propagation in a natural oxbow.

Fiorelli, Michael D.^{*1}, Breen, Matthew J.¹. (1-Utah Division of Wildlife Resources).

The White River in Utah is critical habitat for Bluehead sucker, *Catostomus discobolus*, flannemouth sucker, *Catostomus latipinnis*, and roundtail chub, *Gila robusta*. These species have suffered reductions of their historic range in the upper Colorado River basin, and are listed as a Tier I Sensitive Species in Utah. Recent investigations in the White River have revealed strong populations of both bluehead and flannemouth sucker with population estimates of 598 flannemouth/mile (CI = 450 -746), and 282.52 bluehead/mile (CI = 221-392). However roundtail estimates have not been possible due to low recapture rates. In response to low recapture rates from electrofishing surveys, we initiated a netting protocol specifically targeting roundtail which also yielded low capture rates. It was determined that roundtail populations should potentially be bolstered in the White River as a result of low capture rates and limited evidence of recruitment during 2012 – 2014 fall seining surveys. In the spring of 2015 an off channel oxbow was formed on the White River presenting an excellent opportunity for roundtail propagation. This oxbow is 0.64 km long, with widths varying from 23 to 50 meters. Initial investigation of the oxbow in August found two disconnected pools. The downstream pool's maximum depth was 48 cm and was determined to be unfit for propagation. However, the upstream pool may provide the necessary requirements for roundtail propagation. This pool has an area of 0.18 acres with a maximum depth of 147 cm. A majority of measured depths in this pool were over 100 cm. The substrate is primarily silt/mud with very limited amounts of rock of any size class. This winter and fall we will deploy dissolved oxygen meters, and check on ice depths to determine if over winter survival is feasible. We will also deploy trail cameras in the spring to follow how the pool changes with spring runoff. It is our hope to use the data gathered between this fall and next spring to determine what modifications, if any, will be necessary to create suitable conditions for roundtail propagation in the White River.

14:00 Bonytail post-stocking monitoring in Lake Havasu

Humphrey, Kristen^{*1}, Kesner, Brian¹, Marsh, Paul¹. (1-Marsh & Associates, LLC).

The persistence of bonytail, *Gila elegans*, a federally endangered and functionally extirpated fish species, relies entirely on stocking programs. Since 2006, and for the next 41 years, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) will stock 4,000 bonytail per year greater than 300mm TL into Reach 3 of the lower Colorado River. In an effort to guide future stocking endeavors, we investigated short-term survival, habitat use, and movement of stocked bonytail through the use of acoustic telemetry and remote passive integrated transponder (PIT) scanning from spring 2013 to spring 2015 in the lower Colorado River basin between Davis and Parker dams. Sixty one study fish (306 – 349mm TL) were surgically implanted with acoustic tags and stocked into three general stocking locations Bill Williams River National Wildlife Refuge, Arizona, Blankenship Bend, Arizona, and Regional Park Moabi, California. Thirty one study fish were determined mortalities and 23 were permanently lost to the study within the ten weeks after release. Data from tracking and tag recoveries indicate that most mortalities were the result of predation by fish species. In addition, a large proportion of study fish were lost to the study, and data from SURs (submersible ultrasonic receivers) indicate that lost fish were removed from the water (e.g. avian predation). Contact rates of stocked bonytail through remote PIT scanning ranged from 5 – 68% of bonytail from each stocking event. Most contacts (73% or more) occurred within the first two weeks post stocking and contact rates steeply declined thereafter. Daily post-release survival was estimated from PIT scanning data using the Cormack-Jolly-Seber (CJS)

model within the Program MARK for two of the three release sites. Model averaged estimates of apparent survival ranged from 70.3 – 71.6% per day at Blankenship Bend and 93.2 – 93.9% per day at Regional Park Moabi. The probability of long term survival (over three months) for stocked bonytail under any stocking regime was estimated at less than one percent, although statistically significant differences in apparent survival among stocking locations warrant further investigation.

14:15 Insights into managing wetlands as nursery habitat for endangered Razorback Sucker, *Xyrauchen texanus*, after three years of success at Stewart Lake, middle Green River, Utah

Schelly, Robert^{*1}, Breen, Matthew¹. (1-Utah Division of Wildlife Resources).

Endangered Razorback Sucker, *Xyrauchen texanus*, have declined in the Colorado River Basin as impoundment-related flow alteration has reduced access to off-channel wetland habitats and nonnative species have proliferated. For decades, survival of wild-spawned razorback suckers to juvenile stages has been negligible, and populations have been maintained by stocking of hatchery-raised fish. Since 2013, however, the management of Stewart Lake, a gated wetland on the middle Green River near Jensen, Utah, has served as a promising model for the re-coupling of larval Razorback Suckers with productive off-channel wetland nursery habitat. In a cooperative multi-year effort by Federal and State agencies called the Larval Trigger Study Plan, light trapping is being used to detect the presence of larval razorback suckers in the river, triggering increased releases from Flaming Gorge Reservoir, temporally matching peak flows to the period of larval drift. In 2013 and 2014, after two and three months of entrainment, respectively, many hundreds of juvenile Razorback Suckers were returned to the Green River. After a mild winter and the earliest larval emergence on record, the 2015 cohort of Stewart Lake Razorback Suckers was smaller than expected, but a number of age-1 fish spawned in 2014 were recaptured throughout the 2015 season, confirming successful recruitment. Here we examine possible factors driving the inter-annual variation in Stewart Lake Razorback Sucker cohort size, with an eye towards fine-tuning our management strategy to maximize Razorback Sucker survival and further disadvantage nonnative fishes.

14:30 Conservation Agreements and Strategies: Utah's proactive approach to conserving native aquatic species

Wilson, Krissy^{*1}. (1-Utah Division Wildlife Resources).

In Utah, Conservation Agreements and Strategies have been an important conservation tool for the past 20 years. The primary goal of an Agreement is to proactively address the needs of species before they become imperiled and to expedite implementation of conservation measures as a collaborative and cooperative effort among resource agencies, Tribes, and NGOs to reduce and eliminate threats and prevent listing under the Endangered Species Act. Each Strategy is comprised of the same basic elements: determine historical distribution, document current distribution, assess threats to the species and their habitats, identify conservation actions to reduce or eliminate threats, implement conservation actions, and review and assess the effectiveness of the conservation actions. Strategies are in place for Virgin Spinedace, *Lepidomeda mollispinis*, Northern Leatherside Chub, *Lepidomeda copei*, Southern Leatherside Chub, *Lepidomeda aliciae*, Bonneville Cutthroat Trout, *Oncorhynchus clarkii utah*, Colorado River Cutthroat Trout, *Oncorhynchus clarkii pleuriticus*, Yellowstone Cutthroat Trout, *Oncorhynchus clarkii bouvieri*, Columbia spotted frog, *Rana luteiventris*, Least Chub, *Iotichthys phlegethontis*, Fat-whorled pondsnail, *Stagnicola bonnevillensis*, and the Three Fish Species, Roundtail, *Gila robusta*, Flannelmouth sucker, *Catostomus latipinnis*, and Bluehead sucker, *Catostomus discobolus*. Eight of the twelve Agreement species have been petitioned to list under the Endangered Species Act and all have been determined not warranted due to conservation actions and threat abatement identified and implemented through the Agreement processes.

14:45 Little bugs, big data, and Grand Canyon: light trapping by river rafters yields insights into Colorado River aquatic insect dynamics

Kennedy, Theodore^{*1}, Muehlbauer, Jeffrey¹, Yackulic, Charles¹, Lytle, David², Kortenhoeven, Eric¹, Metcalfe, Anya¹. (1-USGS, 2-Oregon State University).

Glen Canyon Dam has greatly altered the discharge and temperature regimes of the Colorado River in Grand Canyon, which may explain why only two aquatic insect taxa—midges and blackflies—are common in this river segment. In 2012, we initiated a citizen science project in collaboration with river rafters to quantify insect emergence for the 386 km Grand Canyon segment of the Colorado River. Rafters conducted standardized light trapping each night in camp, yielding an unprecedented emergence dataset (750+ samples each year). This dataset has elucidated insect emergence patterns related to dam operations, including pronounced decreases in midge emergence (catch per hour) coincident with abrupt increases in regulated discharge. Longitudinal patterns of emergence for midges were sinusoidal and appear related to the time of day when low versus high water associated with hydropeaking waves occurs in different reaches. Specifically, we observed higher and lower rates of insect emergence in locations of the Canyon where afternoon flows represented the daily minima and maxima, respectively. Because mating and egg-laying by aquatic insects often occurs in late afternoon/evening, these sinusoidal patterns in emergence may reflect differences in the quality of the egg-laying environment for aquatic insects. These results indicate that frequent hydropeaking may represent a bottleneck that limits aquatic insects by causing high mortality at the egg stage. Our findings suggest that aquatic insect assemblages might be enhanced through changes in flow management alone, even without more natural temperature regimes.

15:00 Annual Highlights from the Ash Meadows Fish Conservation Facility

Lee, Corey^{*1}, Feuerbacher, Olin¹, Barlics, Robert², Chaudoin, Ambre³, Oliver, Luke², Simons, Lee¹, Linares-Casenave, Javier¹. (1-U.S. Fish and Wildlife Service, 2-Great Basin Institute, 3-National Park Service).

Work at the Ash Meadows Fish Conservation Facility (AMFCF) has focused on establishing a backup population of the endangered Devils Hole pupfish (*Cyprinodon diabolis*), operating, maintaining and troubleshooting systems associated with keeping environmental conditions in the 100,000 gallon refuge tank, and strengthening partnerships. Devils Hole pupfish eggs as well as Devils Hole invertebrates and algae were recovered from Devils Hole and brought to the AMFCF for rearing and culturing. Plans have been developed and are being implemented to monitor multiple Refuge Tank environmental and ecological parameters as well as adult and early life history stages of Devils Hole pupfish. Water depth in the Refuge Tank shallow shelf is maintained at similar historical water levels in Devils Hole. Research using environmental DNA is underway to monitor successional changes in the Refuge Tank and to compare conditions with those at Devils Hole and other springs in Amargosa Valley. The USFWS Abernathy Fish Technology Center and UC Davis are using next generation sequencing to develop a genotyping tool to monitor and manage Devils Hole pupfish populations. Efforts to establish and maintain a second Devils Hole pupfish population in aquaria will continue in collaboration with co-managing Agency scientists.

15:15 Opportunities and challenges in the recovery of Desert Dace, *Eremichthys acros*

Gilmore, Todd^{*1}, Soldier Meadows Working Group¹, Soldier Meadows Working Group², Soldier Meadows Working Group³, Soldier Meadows Working Group⁴, Soldier Meadows Working Group⁴. (1-US Fish and Wildlife Service, 2-Bureau of Land Management, 3-U.S. Geological Survey, 4-Nevada Department of Wildlife, 5-Nevada Natural Heritage Program).

Desert dace, *Eremichthys acros*, are endemic to thermal spring systems in Soldier Meadow, Humboldt County, Nevada. Desert dace is the only member of the genus *Eremichthys* of the Cyprinidae family and has the highest temperature tolerance of any minnow in western North America. At the time of listing in 1985, desert dace was primarily known from private lands where the diversion of spring outflows into irrigation ditches for agricultural activities and nonnative fish were identified as the primary threats to the species. When the final recovery plan was published in 1997, a more substantial proportion of the species' range was on public lands managed by the Bureau of Land Management (BLM), where additional threats related to increased recreational use had been identified. Neither the listing rule nor the recovery plan specifically mentions threats from livestock, feral horses or burros, but these animals have

since become identified as a potential threat to the species and its habitat. A number of these threats are being addressed by BLM management actions including designation of the Black Rock Desert-High Rock Canyon-Emigrant Trails National Conservation Area, designation as an Area of Critical Environmental Concern, and additional planning documents. Other conservation and management actions that have been implemented to date include nonnative fish eradication efforts, fish barriers, and fencing around an occupied spring system. While there is still much to be accomplished, the Soldier Meadows Working Group (a group of federal and state partners charged with recovery of desert dace), are busy working to implement recovery actions to benefit desert dace.

15:30 Environmental DNA (eDNA) on a budget: Results from a novel single laboratory and limited dedicated equipment eDNA protocol

Holcomb, Kerry ^{*1}. (1-U.S. Fish and Wildlife Service).

Forensic technologies, namely environmental DNA (eDNA), offers the promise of cost effective tools capable of producing precise and repeatable data that describe 1) the occurrence of target species (either exotic species or species of conservation concern), 2) community biodiversity (ranging from viruses and single cell organisms to vertebrates), and 3) the relative abundance or density of a species. I present results from a novel protocol that delivers quality eDNA-driven monitoring of invasive species at much lower cost than earlier methodologies. Costs are mitigated by avoiding the use of dedicated laboratory spaces and by using only a limited amount of dedicated equipment. To monitor whether cost reduction measures impair the quality of results, stringent quality control and quality assurance measures were built into the protocol. These measures assess both method and process type I and II errors, relative to a null hypothesis of no target DNA present. During 2014 and 2015, a total of 31 presence/absence samples and 31 collection negative controls were collected and processed for red swamp crayfish, *Procambarus clarkii*, at Ash Meadows NWR (to benefit endangered Warm Springs pupfish, *Cyprinodon pectoralis nevadensis*) and for blue tilapia, *Oreochromis aureus*, plus red swamp crayfish at the Muddy River, Nevada (to benefit endangered Moapa dace, *Moapa coriacea*). In addition, each set of samples included a negative extraction blank, PCR negative blank, and a PCR positive control. Target DNA contamination was not detected in any of the 259 PCR sample or control assays or in any of the extraction nor PCR blank assays. False negatives were produced in 3 of 9 known positive samples (33.3%), while all positive controls produced expected results. The observation of no false positives (no process nor method type I errors) and limited false negative results (process and/or method type II errors) supports the idea that dedicated laboratory space and equipment are not obligatory to the production of valuable eDNA results. While likely not appropriate for applications requiring a probability of contamination near zero, this protocol provides a tool to effect conservation at meaningful spatial and taxonomic scales without exceeding budget limitations.

15:45 Wetland habitat associations of imperiled Pecos Pupfish, *Cyprinodon pecosensis*, in a brackish ciénega

Hoagstrom, Christopher ^{*1}, Caldwell, Colleen², Peterson, Damon². (1-Weber State University Department of Zoology, 2-New Mexico Cooperative Fish & Wildlife Research Unit).

Ciénegas of semi-desert grasslands are disappearing from the American Southwest, but were once common in the Pecos River valley. Pecos Pupfish, *Cyprinodon pecosensis*, was endemic to these wetlands, but now persists only in remnant habitats. Habitat fragmentation can create divergent morphotypes among isolated habitats, whereas habitat connectivity appears to allow gene flow, maintaining average morphotypes. We studied habitat association by Pecos pupfish in a connected, diverse brackish ciénega. The U.S. Fish and Wildlife Service National Wetlands Inventory Program mapped habitat types. Over two years, we monitored 52 locations representing six habitat types quarterly. Pupfish occurred in > 60% of collections from permanently watered locations and > 35% of collections from intermittent locations (when watered). It was the most abundant and widespread fish species, but in intermittent sites it had greater differential in frequency of occurrence and dominance (i.e. percent abundance) over other species. Dominance was also positively correlated with specific conductance.

Distribution of pupfish among available habitats was even in June, but biased toward vegetated habitats in December. Smaller pupfish (< 20 mm SL) predominated in shallow, salty, intermittent flats and deeper, fresher, permanent ponds with thick submergent vegetation. In contrast, larger pupfish (> 20 mm SL) predominated in shallow, fresher semi-permanent and seasonally flooded marshes. Pecos pupfish is a tolerant, generalist with a dynamic distribution when diverse habitats are available and variable. Habitat connectivity may not only increase gene flow, but also allow populations to maximize seasonal reproduction, recruitment, and survival.

16:00 Reproductive success of Bonytail in isolated off-channel habitats

Osborne, Megan^{*1}, Sanchez, Alyssa¹, Turner, Thomas F.¹. (1-University of New Mexico).

Bonytail is one of four species of large, long-lived, endemic fishes that were once abundant and broadly distributed throughout the Colorado River basin. Wild, naturally produced bonytail are now so rare that the species is considered functionally extirpated in the wild. Minckley et al. proposed using off-channel habitats to facilitate preservation of bonytail. In this program, native species would breed and their progeny would be allowed to grow in isolated, protected, off-channel ponds in the absence of non-native fishes. In 2014 and 2015 adult bonytail were stocked into three of the “Mohave backwaters” and allowed to reproduce naturally. Microsatellites were used to identify the parents of larvae and age-0 bonytail produced in these backwaters, and to assess the change in genetic variability between the parental and progeny generations. Reproductive success was high for both sires and dams in both backwaters and both sexes mated multiply. In 2014, variance in reproductive success (VRS) differed dramatically between backwaters and this result was remarkably consistent between sires and dams, and where VRS was high, genetic effective size was reduced. In 2015, VRS did not differ between backwaters and hence effective size was similar between them.

16:15 Pahrnagat Roundtail Chub: A cooperative recovery initiative approach

Harter, James^{*1}, Manville, Christiana¹, Rissler, Peter², Guadalupe, Kevin³. (1-Fish & Wildlife Service, 2-U.S. Geological Survey, 3-Nevada Department of Wildlife).

The Pahrnagat roundtail chub, *Gila robusta jordani*, is a federally endangered species whose native habitat resides entirely on private lands in Pahrnagat Valley, Lincoln County, Nevada. Major spring outflows in the valley were manipulated by the mid-1800s before biological inventories were conducted. The historical range of the species was believed to be around 19 miles though current distribution is limited to 2 miles of stream channel and 2 miles of a cement-lined ditch. Refuge populations are managed at the Southwestern Native Aquatic Resources and Recovery Center and Key Pittman Wildlife Management Area. In 2013, the Southern Nevada Fish and Wildlife Office received national funding to implement recovery activities for the Pahrnagat roundtail chub. Working with partners we have developed projects to stabilize a refuge site at the Key Pittman Wildlife Management Area, establish a second refuge site within Pahrnagat Valley at the Pahrnagat Valley National Wildlife Refuge, and improve cattle management on private lands along the last occupied stretch of the Pahrnagat River.

16:30 Ideology, imagination, and the conservation of aquatic ecosystems and species in the arid Southwest

Norment, Christopher^{*1}. (1-College at Brockport, SUNY).

Drought, population growth, development, and exotic species continue to threaten aquatic ecosystems and species in the arid Southwest. Threats to laws such as the federal Endangered Species Act and declines in public funding for natural resource management may exacerbate these environmental problems. Although scientific research offers better understanding of at-risk species and ecosystems, and suggests effective management strategies, data alone are insufficient. There are two reasons for this: 1) science, with its reductive approach and attention to detail, remains inaccessible to many people; 2) most people are “unmotivated reasoners,” who tend to deny evidence contradicting strongly held beliefs. Successful

defense of aquatic ecosystems and species in the arid Southwest thus requires not only good scientific information, but also strong communication skills, an understanding of the relationship between ideology and science, and political will. It also requires the knowledge that all actions result from acts of the imagination – be it scientific research, Las Vegas, the Ash Meadows Fish Conservation Facility, the extinction of the Tecopa pupfish (*Cyprinodon nevadensis calidae*), or the efforts of Jim Deacon and others to save the Pahrump poolfish (*Epiplatys latos latos*).

16:45 Razorback Sucker, *Xyrauchen texanus*, research and monitoring in the Colorado River inflow area of Lake Mead and the Lower Grand Canyon, Arizona and Nevada

Albrecht, Brandon^{*1}, Kegerries, Ron¹, Rogers, Ron¹, Gilbert, Eliza², Brandenburg, W. Howard², Barkalow, Adam L.², Platania, Steven P.², McKinstry, Mark³, Healy, Brian⁴, Stolberg, James⁵, Smith, Emily Omana⁴, Nelson, Clay⁴, Mohn, Harrison E.¹. (1-BIO-WEST, Inc., 2-American Southwest Ichthyological Researchers, 3-U.S. Bureau of Reclamation, Upper Colorado Region, 4- U.S. National Park Service; 5- Lower Colorado River Multi-Species Conservation Program).

For more than 20 years, Razorback Suckers were thought to be extirpated within the Grand Canyon. However, based on past studies and recent movements of sonic-tagged Razorback Suckers from Lake Mead into the lower Grand Canyon (LGC) section of the Colorado River, there are renewed questions regarding the presence of wild individuals and their relationship between the river and reservoir. This collaborative study includes efforts to continue research of Razorback Sucker (all life stages) within the Colorado River inflow of Lake Mead (CRI) combined with the inclusion of sonic telemetry, small-bodied fish community, and larval fish community sampling from Lava Falls downstream to Pearce Ferry, in the LGC (RM 180-280). The specific objectives outlined for these efforts included; (1) conducting larval and small-bodied fish community studies to quantitatively assess annual fish reproduction, spawning, and nursery areas in the LGC, (2) determining if Razorback Suckers are present in the study area and if they associate with specific habitats found within the LGC through the use of telemetry, and (3) identifying habitat associations, relative spawning and reproductive effort, and population trends of Razorback Sucker in the CRI. Specifically, this paper presents findings from the CRI portion of this multi-faceted study, particularly regarding natural recruitment observed within this population, with additional results from the LGC, as informed from small-bodied fish community sampling. Comparisons to historical data will be made, as appropriate. Finally, this research has also provided a means for fairly extensive documentation of young Humpback Chub *Gila cypha* throughout the riverine portions of the study area, as well as adult Razorback Sucker movement and habitat use within both a lentic and lotic environment.

17:00 Detection of Razorback Sucker, *Xyrauchen texanus*, reproduction in the Colorado River of the Lower Grand Canyon and where to go from here

Gilbert, Eliza I.^{*1}, Brandenburg, W. Howard¹, Barkalow, Adam L.¹, Platania, Stephen P.¹, Kegerries, Ron B.², Albrecht, Brandon C.², Rogers, Ron J.², McKinstry, Mark C.³, Healy, Brian⁴, Stolberg, James⁵, Smith, Emily Omana⁴, Nelson, Clay⁴, Mohn, Harrison E.¹ (1-American Southwest Ichthyological Researchers, 2-BIO-WEST, Inc, 3-Bureau of Reclamation, Upper Colorado Region, 4-National Park Service, 5-Lower Colorado River Multi-Species Conservation Program).

On 25 June 2014 the front page of the Grand Canyon News read, "Endangered Razorback Sucker makes a comeback" . Headlines of other publications read "They're Back! Endangered Fish Spawns in Grand Canyon" and "So long, sucker? Not yet: Endangered Razorback Sucker makes comeback". The excitement was due to the fact that adult Razorback Sucker, which had not been detected in the Grand Canyon since the 1990s, was captured in both 2012 and 2013. In 2014, as part of a collaborative research effort to document Razorback Sucker, larval surveys were undertaken to determine if reproduction by this species was occurring in the lower 100 river miles of the Colorado River in the Grand Canyon. In 2014 and 2015 larval Razorback Sucker was captured throughout the entire study area, (river miles 180-280, Lava Falls to Pearce Ferry). Data from 2015 indicated Razorback Sucker commenced spawning in February and persisted through early July. This is an earlier spawning date and a more protracted spawning period than documented in many other populations of Razorback Sucker. In 2015, as in 2014,

larvae were captured at the top of the study area indicating spawning adults were present above Lava Falls, the most upstream portion of the study area. Now that we have two years of data indicating Razorback Sucker in the Colorado River of the lower Grand Canyon are spawning, the questions to address grow rapidly. What is the distribution of spawning Razorback Sucker in the Grand Canyon? Are spawning fish residents of the river or immigrants from Lake Mead? What is the role of water temperature in cuing movement to spawning grounds and initiation of spawning? Are there physiological/ecological aspects of Razorback Sucker larvae, which limit their ability to recruit in the same environment that supports the common suckers, Bluehead Sucker, *Pantosteus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis*? Continued survey efforts and effective research to address these questions will assist managers in conserving this important population of Razorback Sucker.

17:15 Oregon / Northern California Area Report, November 2015

Scheerer, Paul^{*1}, Leal, Jimmy², Schreder, Marci³, Sidlauskas, Brian⁴, Meeuwig, Michael¹, Brandt, Troy, Smith, Terry⁶, Divine, Paul⁷. (1-Oregon Department of Fish and Wildlife, 2-Bureau of Land Management, 3-Lake County Watershed Council, 4-Oregon State University, 5-River Design Group, 6-US Forest Service, 7-California Department of Fish and Wildlife).

The northwestern extreme of the desert region includes several endorheic drainage subbasins in Oregon, northeastern California, and northwestern Nevada (Fort Rock, Chewaucan, Goose, Warner, Catlow, Alvord, Malheur Lakes, Coyote Lakes, and Quinn). This region supports remnant fish faunas that once inhabited extensive pluvial Pleistocene lakes. Oregon Department of Fish and Wildlife: 1) estimated Warner sucker, *Catostomus warnerensis*, abundance in the Twentymile Creek subbasin (Warner basin) and monitored movement of PIT tagged suckers to assess passage at a newly constructed, sucker-friendly fish ladder, 2) obtained a population estimate and evaluated habitat conditions for Foscett speckled dace, *Rhinichthys osculus* ssp., in Foscett and Dace Springs (in cooperation with BLM), 3) obtained a population estimate and evaluated habitat conditions for Borax Lake chub, *Gila boraxobius*, at Borax Lake in the Alvord basin, 4) conducted redband trout life history studies to estimate abundance in Blitzen River tributaries (Malheur Lake subbasin) and evaluate movement patterns, and 5) evaluated redband trout abundance estimate bias related to timing of surveys and in response to stream drying in Rock Creek (Catlow subbasin). Alan Mauer, reported that 1) the US Fish and Wildlife Service is in the process of drafting a proposal to reclassify the Borax Lake chub from endangered to threatened status under the Endangered Species Act, 2) The Fish and Wildlife Service, Bureau of Land Management and Oregon Department of Fish and Wildlife completed a "Cooperative Management Plan" for Foscett speckled dace, 3) the Fish and Wildlife Service is near completion of a draft 5-year review of the Foscett speckled dace, and 4) the USFWS anticipates in the near future a final decision on the proposal to remove the Modoc sucker from the list of threatened and endangered species (proposed February 13, 2014). Jimmy Leal, BLM, continued ongoing habitat restoration at Foscett Spring for Foscett speckled dace, including the thinning of aquatic vegetation from pools dug in 2013 and 2014 in the tule and cattail marshes. Jimmy Leal, BLM, Marci Schreder, Lake County Watershed Council, and Troy Brandt, River Design Group, partnered with the Robinson Ranch, the US Fish and Wildlife Service and ODFW to replace a passage structure for Warner suckers in the Twentymile Creek subbasin. BLM has secured additional funds (\$215K) for the next phase of the Honey Creek passage and screening project to benefit Warner suckers and redband trout (6 unscreened and unladdered diversions remain to be completed). Doug Markle, retired OSU professor, completed "A Guide to Freshwater Fishes of Oregon", which includes detailed information on the taxonomy and distribution of Oregon's desert fishes. Terry Smith, USFS, with assistance from Trevor Watson, ODFW, conducted population index surveys for Modoc suckers in Thomas Creek. The Lake County Watershed Council collaborated with the Fremont-Winema National Forest, Green Diamond Timber Resources, 70's Ranch, Anderson Engineering, Cascade Stream Solutions, US Fish and Wildlife Service and ODFW to provide fish passage and screening for native desert fishes in the Goose Lake, Chewaucan, and Silver Lake subbasins. Dr. Brian Sidlauskis (OSU), in collaboration with prior students, BLM, and ODFW, continued a study of species limits and population structure in speckled daces across the arid drainages of Oregon using phylogenetics, microsatellite

analysis, and morphometrics. They found a consistent morphological difference between three main lineages of Great Basin dace from springs and streams and that four desert springs (Stinking Lake, Barnyard, Hibbard and Rinehart) in the Malheur and Owyhee basins harbor a very divergent lineage of dace that likely represents an undescribed species, possibly a relict of a species that was once more widely distributed. Paul Divine reported that, California Department of Fish and Wildlife conducted drought monitoring on several streams and conducted fish rescues when necessary. This included temperature and flow monitoring and rescue assessments on several Goose Lake tributaries, two fish rescues on Cold Creek, relocating Goose Lake redband trout, Pit sculpin, and Goose Lake lamprey into Lassen Creek due to desiccation of Cold Creek, and temperature and flow monitoring and rescue assessments on four redband trout streams in the Southern Warner Mountains (Mill, East, Emerson, and Cedar creek). Preliminary results indicated high stream temperatures and reduced flows affected both quantity and quality of available fish habitat due to extreme drought conditions. Additional Authors: Douglas Markle, Oregon State University and Trevor Watson, Oregon Department of Fish and Wildlife

17:30-19:00 Poster Session

•Denotes author in consideration for poster award

Virgin Spinedace larvae and early juveniles-A descriptive account

Snyder, Darrel E.^{*1}, Seal, Sean C.¹, Bjork, C. Lynn¹. (1-Larval Fish Laboratory, Colorado State University). The Virgin Spinedace, *Lepidomeda mollispinis mollispinis* (Cyprinidae), is endemic to, and still persists in, the Virgin River Basin. As an imperiled resident of the Virgin River, the subspecies is protected by the states of Arizona, Nevada, and Utah and currently under renewed review for designation as threatened or endangered by the US Fish and Wildlife Service. It is one of just six fishes (all cypriniforms) native to the river and one of two therein belonging to a small group of cyprinids referred to as plagopterins (former tribe Plagopterini), most species of which are uniquely characterized by spinous modifications to the pelvic fin rays and the first principal and adjacent rudimentary rays of the dorsal fin. To document the morphological ontogeny of its previously undescribed larvae and facilitate researcher identification of collected specimens, the Virgin River Resource Management and Recovery Program (with funding by Washington County Water Conservancy District, UT) sponsored developmental study, illustration, and description of Virgin Spinedace larvae and early juveniles. Specimens for study and reference were reared, preserved, and provided in 2011 by Dexter National Fish Hatchery and Technology Center (NM; now the Southwestern Native Aquatic Resources & Recovery Center). As presented in this poster, most results were summarized in the standard species-account format of the Larval Fish Laboratory. Copies of the 2013 descriptive account may be viewed also at, or downloaded from, the Virgin River Program website (<http://www.virginriverprogram.org/wp-content/uploads/2011/08/Finalreport-Virginspinedacedescription-r.pdf>). Larvae and early juveniles of the Big Spring Spinedace, *L. m. pratensis*, a federally threatened resident of Meadow Valley Wash, NV, are likely very similar.

Fish-based index of biological integrity (IBI) for Ecological Assessment in the San Carlos and San Antonio Rivers located in the APFF Canon de Santa Elena, Chihuahua, Mexico

De La Maza, Mauricio^{*1}, Lozano-Vilano, Ma. de Lourdes², Contreras-Balderas, Armando J.¹, Garcia-Ramirez, Ma. Elena¹. (1- Pronatura Noreste, A. C., 2- Universidad Autonoma de Nuevo Leon. Laboratorio de Ictiologia).

The state of a river ecological health can be assessed through the analysis of its biological, physicochemical and habitat components, as well as the presence of invasive species. The Rio Grande (R  o Bravo) is crucial for the economic and social welfare of the extensive border region that exists between M  xico and the United States. Among the sites that have being identified as priority conservation areas by the Commission for Environmental Cooperation (CEC) are the San Antonio and San Carlos creeks, which are located within the limits of APFF Ca  n de Santa Elena in Mexico. Originally, our hypothesis for this study considered that both systems were in fair ecological conditions. In order to determine the ecological status of both creeks, we designed an Index of Biological Integrity (IBI) for fish, and determined baselines for the metrics used, as well as other ecological parameters. Our

results indicate 1) presence of moderate levels of fecal pollution probably coming from livestock and domestic waste; 2) creek sections with moderate to high eutrophication mainly from rural communities and agricultural runoff and irrigation returns; 3) presence of residual traces of heavy metals, which possibly originated from some of the abandoned mines in the region; 4) presence of 3 native species in both systems; and 5) invasion by the exotic species *Fundulus zebrinus*. Fish and water samples were taken from 10 sites in both creeks; an extra control site was sampled from a nearby Arroyo El Chapo. In order to construct the IBI we considered the three native species identified, as well as 3 “potential” and one exotic species for both sites. IBI scores for the various sites indicate different degrees of ecological impact. On a scale of 0 to 100, the Arroyo San Carlos scored 22, San Antonio 18, and their confluence 66; while nearby Arroyo El Chapo, located in the same hydrological sub-region scored 65. We recommend: 1) that livestock should be excluded from the riparian zones, 2) the treatment of waste water from small rural communities and 3) the construction of oxidation ponds to treat irrigation returns that cause eutrophication. Finally we recommend starting a restoration program, in order to restore habitat and species at specific sites, as well as a program for the control and/or eradication of exotic species.

Woundfin larvae and early juveniles-A descriptive account

Snyder, Darrel E.^{*1}, Charles, Jennifer A.¹, Bjork, C. Lynn¹. (1-Larval Fish Laboratory, Colorado State University). The Woundfin, *Plagopterus argentissimus* (Cyprinidae), is a federally endangered fish endemic to portions of the Lower Colorado River Basin. It historically inhabited the Virgin River, lower Gila River, and the Colorado River between (and probably below to Mexico), but currently remains only in the lower Virgin River (AZ, NV, UT). In the Virgin River, it is one of just six native fishes (all cypriniforms) and one of two belonging to a small group of cyprinids referred to as plagopterins (former tribe Plagopterini), most species of which are uniquely characterized by spinous modifications to the pelvic fin rays and the first principal and adjacent rudimentary rays of the dorsal fin. To document the morphological ontogeny of its previously undescribed larvae and facilitate researcher identification of collected specimens, the Virgin River Resource Management and Recovery Program (with funding by Washington County Water Conservancy District, UT) sponsored developmental study, illustration, and description of Woundfin larvae and early juveniles. Specimens for study and reference were reared, preserved, and provided in 2000, 2006, and 2009 by Dexter National Fish Hatchery and Technology Center (NM; now the Southwestern Native Aquatic Resources & Recovery Center). As presented in this poster, most results were summarized in the standard species-account format of the Larval Fish Laboratory. Copies of the 2011 descriptive account may be viewed also at, or downloaded from, the Virgin River Program website (<http://www.virginriverprogram.org/wp-content/uploads/2011/08/Final-WF-species-account.pdf>).

A Comparison of the Ichthyofauna in three natural protected areas of Nuevo León, Mexico

Lozano Vilano, Ma. de Lourdes^{*1}, Garcia Ramirez, Ma. Elena¹, Contreras-Lozano, Jorge A.², Contreras-Balderas, Armando J.¹. (1-Universidad Autonoma de Nuevo Leon. Laboratorio de Ictiología, 2-Laboratorio de Manejo de Vida Silvestre, Facultad de Medicina Veterinaria, Universidad Autónoma de Nuevo León).

The three Natural Protected Areas, the Monumento Natural Cerro de la Silla (Federal), create of 26 April 1991 for the president Carlos Salinas de Gortari, and Sierra de la Silla (State), the 24 of November 2000, the governor of Nuevo León, Fernando Canales Clarion, decree this Natural Protected Area, and Parque Nacional Cumbres de Monterrey (PNCM) (Federal), was create at November 24, 1939 by government decree of President Lázaro Cárdenas, was established for the conservation of flora and fauna; all of them are part of the physiographic province of the Sierra Madre Oriental. In this work, we report in total for the three areas: 28 species of fishes, in 21 genera and 11 families, according to zoogeographic origin 14 species are Nearctic, 12 Neotropical and one Palearctic and Ethiopian, according to ecological affinity 16 are primary, 9 secondary and 3 peripheral; and 9 species are non-native, spread exotic by invasion, translocation and introduction. Among the 19 species, 8 are in some category within the Norma Oficial Mexicana (NOM-059-SEMARNAT-2010)=NOM. In the Red List, IUCN (2011) only one appear as status Vulnerable *Etheostoma grahami* (Rio Grande darter). In the comparison of three areas, they share 21 species are 13 native fishes, 8 exotic or invasive: (*Dorosoma cepedianum* (sardina molleja), *Cyprinus carpio* (carpa común), *Notropis stramineus* (carpita arenera), *Scartomyzon congestus* (matalote gris),

Ictalurus punctatus (bagre común), *I. lupus* (bagre lobo), *Fundulus* sp (bagre común) and *Lepomis macrochirus* (mojarra oreja azul)), and 7 are in the NOM: Threatened *Cyprinella lutrensis* (Red shiner), *Cyprinella rutila* (Mexican red shiner), *Notropis amabilis* (Texas shiner), *Notropis jemezianus* (Rio Grande shiner) and *Etheostoma grahami*, (Rio Grande darter); as Endangered *Dionda melanops* (Spotted minnow) and as Special Concern *Ictalurus lupus* (Headwater catfish).

Determination of a site-level detection probability for the Inyo Mountains Slender Salamander, *Batrachoseps campi*

Norment, Christopher*¹, Bateman, John². (1-College at Brockport, SUNY, Department of Environmental Science and Biology, 2-SUNY College of Environmental Science and Forestry).

The Inyo Mountains slender salamander (IMSS), *Batrachoseps campi*, is one of only two desert salamanders in the world, with a distribution restricted to c. 20 pockets of riparian habitat on the eastern and western slopes of the arid Inyo Mountains, California. We used data collected over a 40-yr period and the program PRESENCE to calculate the site-level detection probability for the IMSS (the probability of detecting at least one IMSS during a single visit to a known locality). IMSS were detected on 65% of visits (n = 95); number of visits per site ranged from one to 12, with a maximum of 13 IMSS observed during a visit. High-quality patches, where relatively high numbers of IMSS were found on most visits, had water flows of c. > 10 l/min; poor-quality patches, in which few or no IMSS were detected on most visits, had intermittent flows of c. < 4 l/min. Overall detection probability was 0.6 ± 0.2 ; a minimum of three visits per site would be needed to detect IMSS in 90% of the occupied habitat patches. Although the IMSS currently is protected by isolation and a lack of development in its range, severe long-term drought could negatively affect its populations. Results of our study could be used to design a monitoring program to detect long-term changes in distribution of this unique salamander.

Experiences with Pahrump Poolfish, *Epiplatys latos*

Fairfield, Hal*¹. (1-Self, 2-USFWS - Ash Meadows).

Pahrump poolfish, *Epiplatys latos*, are the only remaining remnant of three killifish subspecies that were endemic to the desert biota in Pahrump Valley, Nye County, Nevada. Robert R. Miller first described these poolfish in 1948, just prior to the extinction of two of the subspecies due to habitat loss. The surviving poolfish were removed from their native habitat at Manse Ranch Spring in 1975 and only exists today at refuge sites outside Pahrump Valley. Our Pahrump poolfish are placed in the Goodeidae family and along with White River springfish of eastern Nevada represent the egg-laying members of an otherwise live-bearing group of small fishes found in south-central Mexico. The opportunity to maintain Pahrump poolfish in aquaria allowed observation with findings about the subspecies that include, male and female differentiation, a night mating preference, the presence of an ovipositor in females, and egg development with subsequent larval and juvenile observations. Elements of these findings are presented with a series of photographs and drawings to aid in understanding aspects of this interesting desert fish. It is hoped that this presentation will spark additional interest and further studies of this endangered desert fish.

Analyses on body shape diversification among the Pecos Pupfish, *Cyprinodon pecosensis*, populations in relation to interspecific interactions and environmental factors

Xu, Qianna*¹, Collyer, Michael L.¹. (1-Western Kentucky University).

During the 19th and 20th centuries, drastic anthropogenic alterations of the Pecos River (NM, USA) have greatly influenced the fish fauna within the drainage by fragmenting historically interconnected series of sinkholes and wetlands in the Bitter Lake National Wild Life Refuge (BLNWR). The Pecos pupfish (*Cyprinodon pecosensis*) might be the most impacted endemic small-bodied fish species. It was once abundant and relatively widespread; however, the large population has been disrupted and currently exists as distinct sub-populations persisting often in small numbers at a few isolated sites in New Mexico. Their habitats are severely fragmented that the connectivity among habitats can be extremely low. However, no research has been performed to consider the coordinated evolution of different species interacting in replicated communities. As part of a comprehensive multi-species evaluation, in this study, I analyze

preliminary data collected to examine body shape variation in *C. pecosensis* from multiple major sites within and around the BLNWR. Geometric morphometric methods were used to examine the morphological divergence among natural *C. pecosensis* populations including: (1) between sexes (i.e. sexual dimorphism) within isolated sub-populations; (2) between allopatric and sympatric populations in similar environments; and (3) associated with environmental variation, independent of species interactions. The preliminary data and results suggest that body shape variation of *C. pecosensis* is substantial and in part related to variation in communities.

Historical Biological Integrity Index (IBI_h) based on the fish from selected coastal river plains of the state of Chiapas, Mexico

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Chiapas is one of the states of the Mexican Republic with greater diversity, more than 200 species of fish are housed in this state. The IBI is used as a methods to assesst environmental health of a body of water and complementary to the monitoring, management and conservation programs. The hypothesis is that fish communities in the rivers have not had changes over time. The present study uses historical and current records of the ichthyofauna of the coastal plain of Chiapas to estimate the biological integrity of the sites, in order to address the problems associated with anthropogenic degradation of aquatic ecosystems. There were analyzed the available information of 5 sampling sites distributed on the coastal plain of Chiapas. 18 samples were analyzed to develop de IBI_h; the main parameters used were the number of native and non-native species, type of food, source, environmental group and tolerance for change of habitat. According to information obtained, the five sites show ecological deterioration of aquatic environments, changing the composition of the community of fish species in the rivers related with diversity and abundance. Non native species were found, indicating that the quality of rivers in terms of environment conservation, has not been altered in large proportions, however, the intervention of weather phenomena may be the cause of changes in the species composition, due to have been significantly modified the riverbeds. Therefore, it is proposed that management plans and conservation aquatic environments in this area should consider variables involved in the dynamics of rivers, such as the hydrological and hydrographic.

Spatial and temporal patterns of emergent aquatic insects of the San Juan River in Utah, USA from Bluff to Clay Hills

Kortenhoeven, Eric^{*1}, Muehlbauer, Jeffrey¹, Kennedy, Theodore¹, Metcalfe, Anya¹. (1-US Geological Survey - Grand Canyon Monitoring and Research Center).

The San Juan River in the Southwest USA is home to a diverse assemblage of both native and non-native fishes including the Federally endangered Colorado pikeminnow, *Ptychocheilus lucius*, and Federal candidate for threatened status roundtail chub, *Gila robusta*,. This study aims to understand the spatial and temporal patterns of emergent aquatic macroinvertebrates in the San Juan River as a proxy for the food base available to these fishes. Using a dataset of 72 light trap samples spanning approximately 90 miles of river collected from April to October 2014. We show that sensitive, large bodied, high energy content insect orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) groups decline in relative abundance with distance downstream from Sand Island to Clay Hills. EPT are high quality prey for fish and the EPT Index is an accepted method for assessing freshwater ecosystem health by the Environmental Protection Agency (EPA). These shifts in species dominance were correlated with a distinct geomorphic change in river habitat from a sinuous, multi-channel river with relatively high allochthonous input to a canyon bound, mostly bedrock habitat starting below the tributary Chinle Creek. Ideally this research will aid the San Juan River Basin Recovery and Implementation Program in understanding the quality, timing and distribution of food available to imperiled fishes in the San Juan River.

Seasonal variation in reproductive condition of the Pecos Bluntnose Shiner, *Notropis simus pecosensis*

Davenport, Stephen R. ^{*1}, Archdeacon, Thomas P.¹, Blocker, Sara D.², Henderson, Kjetil R.³. (1-United States Fish and Wildlife Service, New Mexico Fish and Wildlife Conservation Office, 2-Water Quality Division, Oklahoma Water Resources Board, Oklahoma City, 3-United States Fish and Wildlife Service, Carterville Fish and Wildlife Conservation Office).

Reproductive strategies vary among fishes, and information on reproductive characteristics is important for water managers to protect and recover imperiled species. We describe aspects of the reproductive ecology of Pecos Bluntnose Shiner, *Notropis simus pecosensis*. Gonadosomatic index, ovarian condition, and counts of mature ova were evaluated to determine the seasonal reproductive timing and duration of Pecos Bluntnose Shiner in the Pecos River, New Mexico. Monthly changes in gonadosomatic index, ovarian stage, and number of mature ova per female suggest Pecos Bluntnose Shiner have a reproductive season extending from April through September, with a peak occurring in June and July. In July, 93% (n = 44) of female Pecos Bluntnose Shiner were in reproductive condition, regardless of size. The highest number of mature ova counted (1,498) was observed in a 59.5 mm (standard length) female from June 2009. Peak spawning activity coincides with water releases from reservoirs with higher peaks and longer duration than natural rainfall events. Results of this study provide important insight on the reproductive biology of a threatened fish and may be useful in long-term conservation planning.

Cover and Substrate's Role in the Propagation of Devils Hole Pupfish, *Cyprinodon diabolis*

Burg, G. Chris^{*1}, Heuton, Matt², McKenna, Ken², PuenteDura, Georgina², Urbina, Natalia², Hillyard, Stanley, van Breukelen, Frank². (1-Nevada Department of Wildlife, School of Life Sciences University of Nevada Las Vegas, 2-School of Life Sciences University of Nevada Las Vegas, 3-School of Life Sciences and School of Dentistry, University of Nevada Las Vegas).

Following a 1976 water-rights victory in the US Supreme court, water levels in Devils Hole increased to cover the breeding ledge. The population of *Cyprinodon diabolis* subsequently increased with a maximal number of over 500 adults by the early 1990's. Beginning in 1996, the population declined markedly with a minimum number of 35 adults in 2013. A variety of reasons have been proposed for this decline, including observations of scuba divers counting the fish that mats of spirogyra, once covering much of the breeding ledge, had disappeared (Dr. Stanley Hillyard personal communication). This observation suggests cover provided by these mats might be an important factor for maintaining the population. We examined this possibility with captive breeding experiments using *C. diabolis* from a refuge population and *C. nevadensis mionectes* from a population that may have hybridized with the refuge fish. Our results demonstrated: 1. Egg deposition was much greater on carpet squares vs. yarn mops vs. an open mesh. We note the National Park Service has since used carpet squares as a means to collect eggs from Devils Hole for the Ash Meadows Fish Conservation Facility. 2. Survivorship of larvae in the presence of adults was similarly much greater with combinations of artificial plant and carpet squares. In the absence of cover, virtually all larvae were cannibalized 3. In the absence of adults, larval growth and survival was not affected by the presence or absence of cover. These results show cover is critical for reproduction and recruitment. We also note that the *C. diabolis* population estimate increased to 131 adults in the Fall 2015 census, in association with a recurrence of the spirogyra mats in Devils Hole.

Genetic contribution of native and introduced catostomids to larval drift in experimental and control streams of the Gunnison River basin in Colorado

Schwemm, Michael R. ^{*1}, Turner, Thomas F.², Thompson, Kevin³, Carson, Evan W.². (1-Southwestern Aquatic Resources and Recovery Center, 2- Biology and Museum of Southwestern Biology, University of New Mexico, 3-Colorado Department of Natural Resources).

Diagnostic microsatellite markers were used to characterize interspecific hybridization among native and non-native catostomids in two streams of the Gunnison River system. As part of an experimental study to evaluate the influence of non-native removal on hybridization, we conducted a baseline genetic assessment of catostomid larvae at two geographically proximate streams, Potter and Cottonwood creeks, one of which (Cottonwood) will be subject to removal of non-native suckers (via fish trap) and their

hybrids prior to spring spawning in 2016. Baseline admixture analyses revealed that streams differed in species composition and levels of interspecific hybridization. Genetic characterization showed that the prospective treatment stream (Cottonwood) was composed primarily of non-native white sucker (*Catostomus commersonii*), native flannemouth sucker (*Catostomus latipinnis*), and advanced backcrosses to flannemouth between these species. In contrast, larval drift in the proposed control stream contained primarily native flannemouth or native bluehead suckers (*Catostomus discobolus*), with relatively few hybrids (advanced backcrosses) between these species. These results provide a baseline of the level of hybridization among species prior to non-native removal, and additionally offer insight into the incidence of natural hybridization between flannemouth and bluehead suckers.

•Relationship of genetic diversity metrics to density in two imperiled Canadian River fishes, Arkansas River Shiner and Plains Minnow.

Sanchez, Alyssa V^{*1}, Osborne, Megan¹, Gilbert, Eliza². (1-University of New Mexico, 2-American Southwest Ichthyological Researchers).

Dewatering, fragmentation and associated habitat change of rivers in the Great Plains of North America have substantially altered stream fish communities over the past 50 years. Recent broad scale analysis demonstrated that these factors act together to cause declines, particularly in pelagic spawning species. Two members of this guild were the focus of this study, Arkansas River Shiner and Plains Minnow. We generated a genetic monitoring time series for Arkansas River Shiner spanning 6 years and collected baseline genetic data for Plains Minnow in the Canadian River. This data was used to assess temporal trends in genetic diversity and genetic effective population size. We also paired genetic effective size and abundance estimates (catch-per-unit-effort [CPUE]) to assess the relationship between these different metrics of population status. Genetic effective population size was small for Arkansas River Shiner but did not change significantly over the time series. For Plains Minnow metrics of genetic diversity were lower than elsewhere in its native range.

The response of Virgin River Chub, *Gila seminuda*, to flooding in the Muddy River (Clark County, Nevada, USA)

Rogers, Ron ^{*1}, Albrecht, Brandon¹, Kegerries, Ron¹, Mohn, Harrison¹, Syzdek, David². (1-BIO-WEST, Inc., 2-Southern Nevada Water Authority).

BIO-WEST Inc., in cooperation with the Southern Nevada Water Authority, documented a decline in the *Gila seminuda* relative abundance from 2007-2014 in the Muddy River (river kilometer 23.7-49.1). The decline in relative abundance was seemingly caused by an aging population combined with no detectable recruitment. Evidence to support an aging population in decline, includes significant decreases of catch per unit effort, a significant increase in mean total length, and an absence of size class distribution. However, floods in desert rivers can benefit the native fish community in several ways including creating new habitats for native species to occupy, reduce nonnative competitors, modify substrates to create spawning and foraging habitat, as well as other physical alterations to the river channel. In the September 2014 a large flood occurred in the Muddy River, followed by a spawning pulse of *G. seminuda* in 2015. Elevated numbers of small, wild *G. seminuda* and multiple size classes were detected during spring and fall 2015 long term monitoring efforts, suggesting that recruitment may be occurring in the Muddy River. This response has been observed in the native fish community in the neighboring Virgin River, and promising sign for the Muddy River *G. seminuda* population.

Study on effects of mining pollution in populations of native fish of the Bacanuchi and Sonora rivers

Varela-Romero, Alejandro^{*1}, Gámez-Alvarez, Agustin², Haros-Mendez, Celso¹. (1-DICTUS, Universidad de Sonora, 2-Departamento de Ingeniería Química y Metalurgia, Universidad de Sonora).

In official press release of August 2104, SEMARNAT) says the spill of 43,000 m³ acidified copper sulfate in Las Tinajas creek in the town of Cananea, Sonora on August 6, 2014, product of a failure in Las Tinajas reservoir. As a consequence this spill reached Bacanuchi and Sonora rivers and El Molinito dam near Hermosillo, and affected, in some degree, the native fauna that inhabit these natural habitats of the

Sonora River basin. The SEMARNAT to address promptly the damages caused by the copper sulfate spill in Sonora and Bacanuchi rivers, created the Fideicomiso Rio Sonora, in order to serve as a source of payment to carry out remedial measures, repair and / or compensation for damage to the environment and human health caused by the spill. The locals detect a fish mortality in Bacanuchi River. The fish impacted are longfin dace *Agosia n. sp.*, the Mexican stoneroller *Campostoma ornatum*, desert carp *Gila eremica*, Opata sucker *Catostomus wigginsi*, Gila topminnow *Poeciliopsis occidentalis*. The Opata sucker and Gila topminnow are currently considered as threatened under the protection Norma Oficial Mexican NOM-059. In this project we will evaluate the impact of the spill on the populations of native fish in the rivers and Sonora Bacanuchi using historical records of fish and the content of heavy metals in endangered species inhabiting the basin.

•Assessing thermal ecology of Colorado River catostomids through stable isotopes ($\delta^{18}\text{O}$)

Barkalow, Adam L. ^{*1,3}, Turner, Thomas F. ¹, Newsome, Seth D. ¹, McKinstry, Mark ². (1-University of New Mexico, Department of Biology, 2-U.S. Bureau of Reclamation, Upper Colorado Region, 3-American Southwest Ichthyological Researchers).

Knowledge of early life history strategies and ecological dynamics is invaluable for effectively managing and conserving common and endangered fish species. Isotopic analysis of otoliths from larval Colorado River catostomids could greatly facilitate understanding of thermally regulated growth rates, thermal preferences, and ontogenetic habitat use of these fishes. Isotope ratio mass spectrometry (IRMS) is a technique that reveals integral aspects of an individuals' life history that are often difficult or impossible to assess with traditional sampling methods. Analysis of $\delta^{18}\text{O}$ data from larval fish otoliths may permit detailed reconstruction of water temperatures experienced by fish during early developmental phases. Development and substantiation of techniques for $\delta^{18}\text{O}$ analysis of larval otoliths is an important and emerging area of ecological research. While techniques have been validated for adult fish, applications for larval fish have been limited. To investigate the thermal ecology and ontogenetic habitat use of Colorado River catostomid larvae, including the federally endangered Razorback Sucker *Xyrauchen texanus*, we propose a method for obtaining $\delta^{18}\text{O}$ from larval fish otoliths.

Nevada Area Report

Miskow, Eric ^{*1}, Simons, Lee ², Guadalupe, Kevin ³, Harter, James ², Gilmore, Todd ². (1-Nevada Natural Heritage Program, 2-U.S. Fish & Wildlife Service, 3-Nevada Department of Wildlife).

Nevada waters contain 16 endangered and six threatened species of fishes as well as numerous undescribed at-risk fish taxa. A summary, overview, and status of Nevada's desert fishes, including current research and management projects in the state, will be addressed. Information on selected areas includes: Restoration and monitoring efforts at Ash Meadows National Wildlife Refuge (AMNWR) continue on several systems, including eDNA results, suggesting that crayfish eradication at South Scruggs springs complex has been successful, which is home to the endangered Warm Springs Amargosa pupfish, *Cyprinodon nevadensis pectoralis*. A multi-agency plan to reestablish natural spring flows in the Five Springs area of the AMNWR is planned, benefitting the endangered Ash Meadows Amargosa pupfish, *Cyprinodon nevadensis mionectes*. Population monitoring has continued on refuge populations of the endangered Pahrump poolfish, *Empetrichthys latos latos*, at both Lake Harriet and Shoshone Ponds. Additionally, poolfish appear to have been re-established at the Corn Creek Desert National Wildlife Refuge as larval fish were observed after a successful rotenone project in 2014 to eliminate non-native species. In northern Nevada, collaborative agency and private landowner efforts created the Soldier Meadows working group focusing efforts to re-establish more natural spring outflows further protecting the threatened desert dace, *Eremichthys acros*. In Ruby Valley, Nevada Department of Wildlife have continued efforts and monitoring of the relict dace, *Relictus solitarius*, in the new transplant ponds created three years ago. Updates and statuses of the threatened Railroad Valley springfish, *Crenichthys nevadae*, and the suite of White River fishes, will also be discussed.

What's in the hump?

Ward, David Lance^{*1}, Ward, Mike², Morton-Starnes, Rylan¹. (1-U.S. Geological Survey, Grand Canyon Monitoring and Research Center, 2-ARUP Laboratories, University of Utah, Department of Pathology).

The function of the nuchal hump on adult humpback chub *Gila cypha* has been the subject of many fireside conversations. Hypotheses about the purpose of the hump range from it being a feature that confers hydrodynamic advantages in swift water to speculation about how the hump may have reduced predation vulnerability to toothless Colorado pikeminnow *Ptychocheilus lucius*. We compared the histology of the head region of captive reared specimens of humpback chub, bonytail *Gila elegans* and roundtail chub *Gila robusta* to evaluate if histological examination could give insight into the function of the hump. Tissues were sectioned, stained and photographed by a pathologist at the Associated Regional and University Pathologists laboratories in Salt Lake City. Although the reason for the evolution of the hump in humpback chub may never be resolved, the additional body depth created by the hump at adult sizes may help to limit predation. Analysis of anatomical gape and body depth relationships indicate juvenile humpback chub are not likely to be vulnerable to predation by adult chub once they reach 100 mm total length. Gape and body depth relationships also indicate vulnerability to introduced piscivores like rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta* or smallmouth bass *Micropterus dolomieu* are likely to continue until humpback chub reach more than 300 mm total length, even with a developed hump.

The use of dynamic multi season occupancy models in the conservation of desert fishes

Saenz, Jessica^{*1}, Peterson, James T. ². (1-Department of Fisheries and Wildlife, Oregon State University, 2-U.S. Geological Survey, Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University).

To conserve endemic desert fish species, managers must be able to identify at risk populations and understand the factors responsible for their decline. The identification of relations between fish population dynamics and their habitats can enable managers to identify the factors affecting at risk taxa and allow for the development of effective conservation strategies. Unfortunately, information on the vital rates of small bodied, short lived desert fish is often lacking and difficult to obtain with traditional capture-recapture techniques, particularly when sampling resources are severely limited. Dynamic occupancy modeling, a less information intensive approach, may help identify important factors affecting population processes and aid desert fish conservation and restoration efforts. We evaluated the potential efficacy of dynamic occupancy models to investigate habitat relationships and biological interactions between least chub, *Iotichthys phlegethontis*, and Utah chub, *Gila atraria*, fit to 11 years of annual monitoring data from aridland wetlands in the Snake Valley, Utah. Our results indicate that least chub and Utah chub patch dynamics in this system were influenced by patch-level characteristics (patch percent open water and average patch depth), grazing damage, population differences, and biotic interactions. The use of dynamic occupancy modeling in desert spring wetland complexes may provide a valuable tool for managers tasked with conserving at-risk desert fish species.

Lahontan Cutthroat Trout populations in Willow and Whitehorse Creeks

Banks, David T^{*1}, Ramirez, Benji S¹. (1-Oregon Department of Fish and Wildlife).

Lahontan Cutthroat Trout, *Oncorhynchus clarkii henshawi*, are listed as Threatened by the U. S. Fish and Wildlife Service. They occur in two watersheds within Oregon: McDermitt Creek and Willow-Whitehorse Creeks. In 2012 a wildfire burned 461,000 acres of sagebrush and riparian areas within these two watersheds. In 2015 sampling occurred in to generate population estimates within the Willow-Whitehorse Creek Drainage. These population estimates were compared to previous population estimates in 2005 and 2011 to determine if the fire affected LCT populations post-fire.

19:00-19:30 Special reading from *Relicts of a Beautiful Sea* by Christopher Norment

Relicts of a Beautiful Sea: Survival, Extinction, and Conservation in a Desert World is a meditation upon the wonder and tragedy of rare and endangered species. Set in the Death Valley region, the book tells the

stories of six rare desert species, all of which are restricted to aquatic habitats: four types of pupfishes, a toad, and a salamander. The book uses their stories to illustrate the beauty of evolution and ecology, and explore ethical and practical issues of conservation: just what are these species worth, why are they rare, and what would the cost of their extinctions be?

19:00-21:00 Graduate Student-Professional Speed-Networking Workshop
Hosted by Marlis Douglas and Michael Douglas

Friday, November 20, 2015

08:30-10:15 Special Symposium: *A Tribute to Jim Deacon and his Legacy of Conservation Science for Pupfish and Poolfish*: Kathryn Boyer, Moderator

†Denotes author under consideration for Carl Hubbs award

08:30 Battle Against Extinction: The Desert Fishes Council's dedication to an imperiled fauna, in tribute to UNLV scientist and pupfish advocate James Deacon.

Boyer, Kathryn^{*1}. (1-Oregon State University).

In the mid 60's aquatic ecosystems east of the Sierra Nevada and throughout the desert Southwest of North America were in peril of disappearing due to increased groundwater pumping and stream diversion. As the decade advanced, desert springs and streams were drying up, and the endemic fish fauna found nowhere else on earth was in peril of extinction. The Desert Fishes Council was formed in 1969 through the coordinated efforts of concerned scientists and managers desperate to act on behalf of the unique and imperiled fauna. The Council's flagship icon was and is the Devil's Hole Pupfish, *Cyprinodon diabolis* and its distant cousins. Instrumental in the conservation of this iconic species was Dr. Jim Deacon from the University of Nevada, Las Vegas. Jim's graduate students were studying the fauna and the habitat of Devils Hole, located within Ash Meadows of western Nevada. Die-hard desert rat biologists thus drafted themselves for a battle against extinction, scheduling the first meeting of the Desert Fishes Council in November 1969. This is the story about the Desert Fishes Council, and the vanishing species that triggered its rise, in tribute to Jim Deacon, and those who drafted themselves for combat.

08:45 Continuing the legacy of Dr. James "Jim" Deacon on the conservation and recovery of Devils Hole and its iconic pupfish

Wilson, Kevin P.^{*1}, Goldstein, Jeffrey A.¹, Chaudoin, Ambre L.¹, Wullschleger, John G.², Senger, Brandon L.³, Simons, Lee H.⁴. (1-Death Valley National Park, Pahrump Office, 2-National Park Service, Water Resources Division, Ft. Collins, 3-Nevada Department of Wildlife, Las Vegas Office, 4-U.S. Fish and Wildlife Service, Las Vegas Office).

Dr. James "Jim" Deacon developed numerous students into future impactful biologists and was instrumental in saving the Devils Hole Pupfish, *Cyprinodon diabolis* from extinction in the late 1960s and early 1970s. His testimony in 1976 resulted in a Supreme Court decision that provided protection for the Devils Hole ecosystem and surrounding spring systems by curtailing groundwater pumping near Devils Hole, which was part of Death Valley National Monument (now Death Valley National Park). In addition to his role in providing legal protection for the water within Devils Hole, Jim initiated the first life-history studies of Devils Hole pupfish. He also developed the method that is still used to count pupfish today, yielding a 43-year dataset. Dr. Deacon's contributions to the conservation of the Devils Hole pupfish and its unique habitat extended to consultation with the Devils Hole Recovery Team and managing agencies on population modeling, habitat restoration, and captive propagation. Although the pupfish population hit an all-time low of 35 in spring 2013, observable fish counts have increased in the past two years. Recent

counts for fall 2014 and spring 2015 were 107 and 80, respectively. Dive counts conducted in January and June 2015 as interim status checks averaged 124 and 100, respectively. Managing agencies continue recovery actions begun in 2013. These include the deployment of cover packets to mimic observed conditions from the early 1970s and 1980s, and the collection of pupfish eggs from Devils Hole for captive propagation at the Ash Meadows Fish Conservation Facility. The Devils Hole Long Term Ecosystem Monitoring Plan (LTEMP) builds on Dr. Deacon's legacy of research, obtaining information to better understand Devils Hole and factors that influence its pupfish population. We will provide an update on a predator-prey interaction study.

†09:00 The influence of temperature on reproductive success and oxidative metabolism in Desert Pupfish.

Jones, Alexander^{*1}, Lim, David¹, Hillyard Ph.D., Stanley¹, van Breukelen Ph.D., Frank¹. (1-University of Nevada-Las Vegas, School of Life Sciences).

The Devils Hole Pupfish, *Cyprinodon diabolis*, is restricted to only Devils Hole in Death Valley National Park. The main pool of Devils Hole almost never sees temperatures below 33 °C and is notoriously energy and oxygen limited, though temperatures fluctuate seasonally on the breeding shelf. We aimed to better understand the oxidative metabolism requirements of lab reared pupfish in eggs, larvae, and adults in Point of Rocks “refuge” fish derived from *C. diabolis* and in its close relative *C. nevadensis* mionectes. Fish reared at 33 °C often undergo long periods with little or no oxygen consumption, during which time body function does not appear to be depressed and ventilation rate is maintained. “Refuge” eggs closest to hatching consumed ~43% less oxygen at 33 °C than at 28 °C, though time to hatch decreased at the higher temperature. “Refuge” eggs did not show a significant increase in oxidative metabolism at any point during egg development at the higher temperature despite decreased time to hatch. These data suggest that anaerobic pathways may be important for pupfish that live in high temperature regimes in all life stages. Survival of eggs from parents acclimated to 33 °C was very low, indicating that these fish may not be well adapted to water temperatures typical of their natural habitat. Some pupfish species may not be as tolerant of high temperatures as previously assumed, which may have profound implications for the conservation of this group as global temperatures rise.

09:15 Using physical thresholds to quantify anthropogenic impacts on the Devils Hole Pupfish

Hausner, Mark B.^{*1}, Wilson, Kevin P.², Scoppettone, G. Gary³, Suárez, Francisco⁴, Tyler, Scott W.⁵. (1-Desert Research Institute, 2-U.S. National Park Service, 3-United States Geological Survey, 4-Pontificia Universidad Católica de Chile, 5-University of Nevada, Reno).

The endangered Devils Hole pupfish, *Cyprinodon diabolis*, has been severely impacted by human development “both directly and indirectly” over the past six decades. Beginning in the late 1960s, local and regional groundwater pumping in the Ash Meadows area lowered the water level in Devils Hole, reducing both the area and volume of the optimal spawning habitat in the ecosystem. More recently, climate change has impacted the air and water temperatures in the Amargosa Valley, leading to changes in both allochthonous carbon inputs and reproductive success. In this study, we use a computational fluid dynamic (CFD) model to examine the physical effects of both climate change and local groundwater levels on Devils Hole and combine those results with a conceptual ecological model to consider the impacts of those changes on annual recruitment of *C. diabolis*. The CFD model predicts water temperatures as a response to climate and water level, and the ecological model is used to determine the timing of tipping points that may encourage or suppress the annual recruitment of *C. diabolis*. Using those data and historical counts of *C. diabolis*, we define seasonal thresholds for water temperature and food availability to quantify the annual optimal recruitment window. The combination of interdisciplinary modelling approaches offers a novel method to quantify and compare the suitability of habitat under a range of management and climate scenarios. Climate change to date is shown to have negatively affected the duration of optimal recruitment conditions, and climate change projections indicate that this impact will continue. However, the influence of water level on the duration of the annual optimal recruitment

window is an order of magnitude greater than the influence of climate change – local and regional groundwater management will have a greater impact on the ecosystem than climate

09:30 Devils Hole retrospective: working with Jim Deacon to compare Devils Hole pupfish, *Cyprinodon diabolis*, populations and water levels

Andersen, Matthew E.^{*1}. (1-US Geological Survey).

As a graduate student at UNLV in the 1990s I was curious about desert fish ecology. This interest and being enrolled at this institution meant, of course, that I would be working with Jim Deacon. I had started on a different study at UNLV, but that project could not be completed. Jim was very helpful to me in opening up his extensive data sets and sharing ideas about what the data might mean helped me bring a study to fruition that compared historic Devils Hole population counts with the water level in Devils Hole and some historic events. It was a great chance to work with Jim, to advance my education, and to learn more about this fascinating, unique system. Working with Jim later in his career required me to be independent and resourceful, so graduate school was a very useful and valuable experience for me under his tutelage. I intend to briefly review my study (published in a journal article in 2001) and to discuss my experience studying under Jim Deacon.

09:45 Phenotypic differences between historic and refuge populations of Pahrump Poolfish.

Goodchild, Shawn C.^{*1}, Stockwell, Craig A.¹. (1-North Dakota State University).

The establishment of refuge populations as a hedge against extinction has been a common management technique for desert fishes. Such managed relocation has been debated for narrowly endemic aquatic species, and unintended rapid phenotypic divergence of the translocated population has been demonstrated in *ex situ* populations. Such divergence begs the question of whether these populations are suitable as potential source stock for reintroduction to the original habitat. One species that has undergone a complex history of translocations is the Pahrump Poolfish (*Empetrichthys latos latos*). Dr. James Deacon, along with a coalition of State, Federal, and other entities, removed Poolfish from Manse Spring prior to its desiccation, effectively saving the genus *Empetrichthys* from extinction. From its initial holding at the University of Nevada, Las Vegas, several refuges have been established in drastically different habitats. We investigated size and life history characteristics of two of the populations, the high latitude and elevation Shoshone Stock Pond and the low latitude and elevation Lake Harriet, to determine potential differences. We then compared these results with reported characteristics from the historic Manse Spring population. There were substantial differences among the three sites in life history, as well as in size and phenology. This phenotypic divergence has occurred within several decades and may reflect relict, plastic or evolutionary responses to environmental factors such as temperature and/or fish density. As such, more attention is needed to assess if phenotypic divergence of refuge populations may result in a phenotypic mismatch to prospective additional refuge habitats and/or reintroduction to their native habitat. Alternatively, these refuges could function as a novel ecosystem, and may be beneficial to provide resilient stock in light of large-scale habitat change, such as predicted from climate change or utilization in different refuge environments.

10:00 Jim Deacon: Reflections on a Life Well Spent

Williams, Jack^{*1}, Williams, Cindy¹. (1-Trout Unlimited).

Jim Deacon was passionate about desert fishes and the Desert Fishes Council. Jim received his Ph.D. from the University of Kansas in 1960 and joined the biological science faculty at the University of Nevada, Las Vegas that same year. His career would be marked by key victories in the war for survival of the Devils Hole pupfish, Ash Meadows, Pahrump Valley, the Virgin River, and the many other places where Jim and his students practiced fisheries science and conservation. Despite some impressive victories, Jim's concerns always were broad based and reflective of a larger struggle: how humans can live sustainably in the desert without destroying nature and themselves. Jim fought hard for these issues, long after he became confined to a wheelchair and long after his retirement as an Emeritus

Professor. He provided badly needed leadership at a time when society seemed more concerned with bright lights and fountains along the Las Vegas Strip than with ethics and sustainability. He was a force for biodiversity conservation and received the first annual E.O. Wilson Award for Outstanding Science in Biodiversity Conservation in 2012 from the Center for Biological Diversity. His passion for conservation spread through his family and resulted in many “family projects”, including two particularly prized publications with his grandsons on fish conservation. His family, his students, and his many colleagues continue to benefit from Jim’s leadership as we struggle to find better paths forward.

10:15-12:00 General Session III: Shawn Goodchild, Moderator

10:15 How old is the Devil's Hole pupfish?

Stockwell, Craig^{*1}, Reed, J. Michael². (1-North Dakota State University, 2-Tufts University).

The Devil's Hole pupfish *Cyprinodon diabolis* has reached iconic status amongst evolutionary and conservation biologists because of its rapid speciation and because of its vulnerability to extinction. We evaluate the widely held assumption that this species has persisted in small numbers (<600 individuals) for 10,000-20,000 years. We analyzed time series of count data, genetic estimates of time of isolation, and time to coalescence to evaluate persistence likelihood and isolation time for Devil's Hole pupfish. We conclude that mean time to extinction is 360-2900 years, with only a 2.1% probability of having persisted at least 10,000 years. Similarly, median time to coalescence ranged from 217 to 2530 years, but all approximations had wide credible intervals. Thus, pupfish most likely colonized Devil's Hole well after the Pleistocene Lakes receded.

10:30 Detecting phenotypic impacts of elevated temperature on Amargosa Pupfish: An integrative approach

Lema, Sean C^{*1}, Chow, Michelle I¹, Resner, Emily J¹, Westman, Alex A¹, Dittman, Andrew H², Hardy, Kristin M. (1-California Polytechnic State University, Department of Biological Sciences, 2-NOAA Fisheries, Northwest Fisheries Science Center).

Amargosa pupfish, *Cyprinodon nevadensis amargosae*, in Tecopa Bore “a small thermal spring in the Death Valley region” appear to have experienced a decline in body size (e.g., 48% decline in mass) related to an increase in habitat temperature that began in 2010. This decline in body size was accompanied by the loss of one or both of the paired pelvic fins in 34% of the population. Previous studies found that exposure to elevated temperatures during larval life inhibits pelvic fin development and implicated altered thyroid hormone (TH) physiology as a potential mechanism mediating these effects. Investigating whether changes in TH physiology might link to the phenotypic changes detected for *C. n. amargosae* in Tecopa Bore, we documented elevated mRNAs encoding deiodinase type 3 (*dio3*) as well as depressed mRNA levels for deiodinase type 2 (*dio2*) and TH receptor β (*tr\beta*) in the liver of wild pupfish from Tecopa Bore compared to a nearby allopatric population of conspecifics in the Amargosa River. Wild adult pupfish from these two populations acclimated in captivity to 24°C or 34°C continued to show population-level variation in liver *dio2* and *dio3* mRNA abundance, and also exhibited differences in how temperature influenced TH regulation of lactate dehydrogenase activity (i.e., an indicator of anaerobic metabolic capacity) and metabolism-associated gene expression. These findings indicate that TH regulation of metabolism is dependent on thermal experience. For pupfish occupying habitats with dissimilar thermal regimes, these complex interactions between temperature, TH physiology and metabolism could shift the dynamics of energy balance and growth to contribute to the observed differences in body size and morphology between populations of *C. n. amargosae*.

10:45 Geomorphic character of the Ash Meadows springs, channels, and wetlands-a guide to restoration (Ash Meadows National Wildlife Refuge)

Gourley, Chad^{*1}, Mortenson, Susan¹. (1-Otis Bay).

The Ash Meadows complex harbors many ecologically important wetland landscape features, many of which are composed of natural channel types. After assessing the geomorphic nature of the drainage

systems, we determined that dissimilar size drainages and spring systems create geomorphically different channel systems and wetland features within Ash Meadows. After assessing the Ash Meadows National Wildlife Refuge to determine the: 1) undisturbed condition; 2) natural range of variability; 3) hydrological processes; 4) sediment sources; and 5) geomorphic characteristics, ecological designers developed plans for restoration. This presentation recounts elements of the biophysical assessment that directed ecological restoration design and reviews. The assessment showed that many of the spring heads and upper outflow channels have small catchment basins and a small volume of sediment contribution. These areas are low energy systems and are stable over time. Farther downstream the systems gain catchment area and become more dynamic. Restoration designs should take into account increasing stream power and potential for disturbance in the downstream reaches of the systems. The first restoration construction was completed in 1997 on Kings Spring, and the spring pool and outflow channel ecosystem began to recover. Almost two decades later, lessons learned from this project serve as a guide for current and future desert spring restorations.

11:00 Efforts to establish a captive population of Devils Hole Pupfish

Feuerbacher, Olin G.¹, Lee, Corey W.¹, Weissenfluh, Darrick S.¹, Chaudoin, Ambre L.², Barlies II, Robert M.³, Simons, Lee H., Linares-Casenave, Javier.¹. (1-U.S. Fish and Wildlife Service, Ash Meadows Fish Conservation Facility, 2-National Park Service, 3-The Great Basin Institute, Ash Meadows Fish Conservation Facility). Recovery efforts for Devils Hole pupfish, *Cyprinodon diabolis*, at the Ash Meadows Fish Conservation Facility (AMFCF) have focused on establishing a captive population from eggs collected from Devils Hole. Eggs were recovered from Devils Hole using nylon spawning mops or carpeted tiles during November 2013 and January 2014. Mops and tiles were deployed 1-7 days on the shallow shelf and subsequently transported to AMFCF where they were inverted and agitated underwater to dislodge eggs and detritus. Recovered material was examined with microscopes to detect eggs. We recovered a total of 60 eggs and one larval pupfish from Devils Hole. Only 65% (n=39) of the eggs contained viable developing embryos. Hatching rate was 55% (n=33) and survival to adulthood was 88% (n=29). Rearing methods included treatment of recovered eggs with formalin, malachite green, and trimethoprim sulfamethoxazole, followed by incubation in acrylic hatching cones. Larvae were given probiotics upon first drinking, and fed a mix of infusoria, newly hatched *Artemia*, and commercial diets. As fish grew, they were transitioned to frozen and dry feeds. Adult fish (n=29) were moved in May-June 2014 into a 100,000-gallon refuge tank designed to emulate the Devils Hole environment. Attempts to collect eggs from Devils Hole resumed in 2015 and efforts are currently underway to breed these fish in aquaria before they are moved into the refuge tank to augment the existing population.

11:15 Relict Dace conservation in Ruby Valley, Nevada: Spring restoration, genetic status, and reintroduction efforts

Mortenson, Susan G.¹, Gourley, Chad R.¹, Petersen, Jeff D.², Shiozawa, Dennis K.³. (1-Otis Bay, 2-Nevada Department of Wildlife, 3-Brigham Young University). Relict dace, *Relictus solitarius*, are small minnows that evolved in isolated basins of northeastern Nevada. Following the recession of Pleistocene pluvial lakes they have been confined to desert springs and streams. This species is considered “Near Threatened” by NatureServe due to interactions with non-native species and habitat dewatering, and the US Fish and Wildlife Service (FWS) is currently evaluating *R. solitarius* for listing under the Endangered Species Act. Relict dace are the only known fish native to Ruby Valley, and their abundance has declined due to fisheries management practices, especially the introduction of largemouth bass (*Micropterus salmoides*), signal crayfish (*Pacifastacus leniusculus*), and speckled dace (*Rhinichthys osculus*). The FWS initiated a collaborative project with Nevada Department of Wildlife, Brigham Young University, and Otis Bay Ecological Consultants to: 1) examine the genetics of relict dace in and near the Ruby Valley National Wildlife Refuge (NWR) to determine where pure strains of relict dace (i.e., populations not hybridized with speckled dace) existed, 2) investigate habitat characteristics of spring pools in the Ruby Valley NWR, 3) design and implement plans to restore or create ponds isolated from introduced species, 4) translocate individuals from pure strain populations to

restored ponds, and 5) monitor translocated relict dace populations. Genetic analyses revealed that five of the sixteen springs in Ruby Valley contained pure relict dace. Hybridization of relict and speckled dace was documented at one spring beyond the F1 generation, indicating that viable offspring can result from interbreeding. Ponds in Ruby Valley NWR that could be physically isolated from introduced species were identified. In 2011 five new ponds were constructed and five existing ponds were restored to create shallow water habitat for the relict dace. Water control structures were designed and installed to prevent colonization of these ponds by introduced species, and chemical treatments were applied to remove introduced species from existing ponds. In 2012 and 2013 relict dace were captured from three ponds that contained pure relict dace, and these relict dace were reintroduced to three of the restored ponds. Surveys in 2014 revealed that all three ponds contained relict dace, and reproduction was documented in one of the ponds. Additional surveys are planned in October 2015. Relict dace may be reintroduced to two more ponds if absence of speckled dace is verified. These efforts will continue to ensure persistence of relict dace in Ruby Valley.

11:30 Development of a conservation program for the co-endemic Carbonera Pupfish, Largemouth Shiner, and Chihuahuan Dwarf Crayfish

Carson, Evan W.^{*1}, Banda-Villanueva, Iris², Lozano-Vilano, María de Lourdes³, Rodríguez-Almaráz, Gabino A.⁴, Sepúlveda-Hernández, Lissette A.², Cantú-Garza, Andrea, Padraza-Lara, Carlos⁵, De la Maza-Benignos, Mauricio². (1-Biology Department and Museum of Southwestern Biology, University of New Mexico, 2-Pronatura Noreste, A. C, 3-Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Colección de Ictiología, 4-Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Colección Carcinológica, 5-Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro).

Carbonera Pupfish *Cyprinodon fontinalis*, Largemouth Shiner *Cyprinella bocagrande*, and the recently rediscovered Chihuahuan Dwarf Crayfish *Cambarellus chihuahuae* are endemic to a group of five desert springs in Ejido Rancho Nuevo in Chihuahua, Mexico. Unsustainable development of water resources in the region resulted in drying of four of these habitats and decline of the remaining one, Ojo Solo. Through a Desert Fishes Council Conservation Award for conservation of Carbonera Pupfish, in fall 2013 we created a natural refuge at the nearby desert spring Ojo Caliente and in winter 2014 began introductions of the three species. All have become established at the refuge. Conservation of these species focuses primarily on monitoring of populations at Ojo Solo and Ojo Caliente. A captive propagation also was introduced to safeguard against extinction and to facilitate further study of these species. Our presentation considers the history and future of this multi-species conservation program.

†11:45 Reduced representation genomics reveals species level phylogeny of *Gila* spp. from the Colorado River Basin

Chafin, Tyler K.^{*1}, Douglas, Marlis R.¹, Douglas, Michael E.¹. (1-University of Arkansas).

The Colorado River Basin (CRB) is the most threatened riverine system in North America, due largely to persistent drought and anthropogenic modifications. Historically, its isolation and harsh environment have provided a theater for diversification for several unique groups of fishes, such that distinctive local adaptations arose over time to cope with these abrasive and erratic conditions. However, the effectiveness of these adaptations has been truncated by human habitat modifications, and by a prolific introduction of non-native competitors to a system with already depauperate levels of intraspecific diversity. Unique adaptations are most apparent within the *Gila* spp. (Cyprinidae) assemblage, manifested as multiple ecologically and morphologically distinct species, yet phylogenetic discordance and reticulation suggests a history of gene flow and blurred species boundaries. Here, using next-generation sequencing of reduced genomic samples (ddRAD), we present a phylogeny of Colorado River *Gila* informed by genomic insights, investigate historical interspecific introgression, and characterize species-level structure and admixture among the *Gila robusta* complex of the lower Colorado River Basin.

12:00-13:30 Lunch

13:30-16:30 General Session IV: Alejandro Varela-Romero, Moderator

†Denotes author under consideration for Carl Hubbs award

‡Denotes author under consideration for Robert Rush and Frances Hubbs Miller award

†13:30 Relationship between AFS standard fish sampling techniques and environmental DNA (eDNA) for characterizing fish relative abundance, biomass, and species composition in Arizona standing waters

Perez, Christina^{*1}, Bonar, Scott¹, Amberg, Jon², Rees, Chris², Ladell, Bridget², Edwards, Taylor, Stewart, William⁴, Gill, Curtis⁴. (1-University of Arizona, 2-U.S. Geological Survey Upper Midwest Environmental Sciences Center, 3-University of Arizona Genetics Core, 4-Arizona Game and Fish Department).

Recently, examination of deoxyribose nucleic acids in water samples (environmental DNA or eDNA) has shown promise for identifying fish species present in water bodies. In water, eDNA is the result of bodily secretions such as mucus, gametes, and feces. We are investigating whether eDNA can be effective for characterizing fish relative abundance, biomass, and species composition in large (>200 ha) and small (< 200 ha) Arizona lakes. Our primary objective in a large warm water reservoir and the small lakes was to compare fish relative abundance, biomass, and species composition measured through eDNA methods and established American Fisheries Society (AFS) standard sampling methods. The analysis for the large reservoir study site was a within impoundment comparison of sites and the analysis for the small lakes will include an across impoundment comparison of the 12 lakes. We found no relationship between relative abundance and biomass of fish and fish DNA copies in large standing waters. However, we did find a relationship between total fish count and total fish DNA copies to characterize whole lake fish species composition in large standing waters. Further evaluation of environmental DNA is necessary to identify its utility in standard fish monitoring. If proven a reliable technique the use of eDNA can be a cost effective and time saving tool for managers to obtain fisheries information from small or remote sites and large water bodies.

†13:45 Habitat conditions for the endangered Zuni Bluehead Sucker, *Catostomus discobolus yarrowi*, Zuni Mountains New Mexico: Continuous monitoring and hydrogeochemistry of springs

Frus, Rebecca^{*1}, Crossey, Laura¹, Bixby, Rebecca². (1-University of New Mexico, Earth and Planetary Sciences, 2-University of New Mexico, Department of Biology).

Spring fed ecosystems in arid environments have been identified as isolated islands that provide stable habitats for endemic species. The Zuni bluehead sucker (ZBS), *Catostomus discobolus yarrowi*, is the only endemic fish species still found in the Zuni River, tributary to the Little Colorado River. In 2014, the ZBS was federally listed as endangered as it has lost over 90% of its habitat range; populations have been reduced to 4 isolated spring fed sections of the Rio Nutria, New Mexico. This research focuses on three of the ZBS habitats to understand hydrogeochemical controls (major ion chemistry and stable isotopes, $\delta^{18}\text{O}$ and $\delta^2\text{D}$) on habitat suitability. In addition, multi-season continuous monitoring (CM) data (specific conductance (SC), water temperature, dissolved oxygen (DO)) are reported. Major ion chemistry was analyzed for water samples collected at each site and was compared to regional groundwater chemistry. Two of the habitat sites are determined to have major contributions of water supplied from the Permian San Andres/Glorieta (Psg) aquifer, while the third site has waters supplied from the Triassic Chinle Formation (TRc). In addition, all sites have contributions from local shallow alluvium aquifers (Qa) found in their respective creek beds. Geochemical mixing models show that the habitats are a mixture of these water sources TRc or Psg and Qa, with dry seasons having as much as 99% of the water supply from the spring waters (TRc or Psg). Stable isotopes of ground waters (TRc: $\delta^{18}\text{O} = -13.48$ to -12.14 and $\delta^2\text{D} = -94.83$ to -92.029 ‰; Psg: $\delta^{18}\text{O} = -11.84$ to -10.50 and $\delta^2\text{D} = -87.60$ to -83.37) indicates that the spring waters are recharged predominately through snow melt. The shallow alluvium waters (Qa: $\delta^{18}\text{O} = -12.829$ to -9.82 and $\delta^2\text{D} = -92.13$ to -76.07) can be recharged through both rain and snow events and undergo evaporation during warm seasons. CM of water temperatures show that TRc spring waters (5-13°C with peak in mid-September) have seasonal variability but temperatures are dampened and timing is different when compared to the Qa (2-18°C with a peak in mid-July). CM of SP shows that Qa waters are impacted by precipitation events (Qa: SP= 630 to 185 µS/cm) while TRc ground water has very slight response to precipitation events (TRc: SP=490 to 520 µS/cm). CM of Qa waters, with no spring inputs, have a mean DO=1.6 mg/l, while ZBS habitats with TRc waters having a mean DO=5.7 mg/l. These results indicate that spring waters input re-aerated waters to the ZBS habitat which helps to maintain tolerable DO levels. Without the perennial input from spring waters, habitats for the ZBS would either dry completely during warm seasons, or become stagnant anoxic water bodies unable to maintain ZBS. This research demonstrates the importance of maintaining groundwater resources for these essential aquifers. For the persistence of the species, encroaching development as well as impacts of a warming climate should be considered in natural resource management.

†14:00 Combined effects of invasive Mosquitofish and invasive Red Swamp Crayfish in small aquatic ecosystems

Fryxell, David^{*1}, Diluzio, Amber¹, Friedman, Maya¹, Menge, Nicklaus¹, Palkovacs, Eric¹. (1-UC Santa Cruz).

Invasive species are a threat to native biodiversity and can change important aspects of ecosystem function. Many ecosystems have been invaded by two or more non-native species, making it important to evaluate how interactions among invaders shape communities and ecosystem processes. Two common invaders in aquatic systems of the American Southwest are the western mosquitofish (*Gambusia affinis*) and the red swamp crayfish (*Procambarus clarkii*), both of which have been studied considerably in independence. Evidence from their nonnative range suggests these species may interact with one another, but what does this mean for their community- and ecosystem-level impacts in sympatry? Using experimental ponds, we tested for the community and ecosystem effects of crayfish and mosquitofish independently and together to understand their additive and interacting effects. As expected based on prior work, mosquitofish induced a strong pelagic trophic cascade by reducing the abundance of pelagic phytoplanktivores, and crayfish increased water conductivity and sedimentation, likely through

bioturbation associated with detrital processing. Interestingly, crayfish increased pelagic *Daphnia* abundance, perhaps by increasing their food resources or excluding them from the benthos. In sympatry, the species effects were almost exclusively additive with the exception of their effect on snail abundance; mosquitofish increased snail abundance, crayfish decreased snail abundance, but both species together had the lowest snail abundance of all treatments. Such interacting effects are difficult to predict without experimentation, but are important to our understanding of the impact of multiple sympatric invasives.

†14:15 An evaluation of sedatives for use in transport of native fishes

Tennant, Laura^{*1}, Ward, David¹. (1-USGS/Grand Canyon Monitoring and Research Center).

Sedated ornamental fish are commonly transported with minimal water in plastic bags filled with oxygen, but these same methods are rarely used for transportation of threatened or endangered fishes for conservation purposes. We evaluated the effectiveness of three common sedatives for use in holding native fish when minimal water weight is desirable, such as for transportation. Juvenile (70-90 mm) bonytail, *Gila elegans*, were subjected to three sedatives, AQUACALM (metomidate hydrochloride), TRICAINE-S (tricaine methanesulfonate or MS-222), and AQUI-S 20E (eugenol). Fish were exposed to 0.0, 2.5, 3.0, 3.5, and 4.0 mg/L of AQUACALM; 0.0, 55.0, 60.0, 65.0, and 70.0 mg/L of TRICAINE-S; and 0.0, 1.0, 2.0, and 3.0 mg/L of AQUI-S 20E. Fish were placed in plastic bags filled with 1L of water and oxygen, at both low (n=5) and high densities (n=20). For each dose and density, we conducted three replicates, at 4-hour intervals until a 12-hour time period was reached. Of the three sedatives, AQUACALM was found to be highly variable in both induction and recovery times with high mortality rates. The optimum dose of TRICAINE-S for this application was 70.0 mg/L for both low and high densities of fish, although low mortality (5%) occurred in the high density treatment. AQUI-S 20E appears to be the best sedative we tested for holding small to large numbers of bonytail using these methods. A concentration of 1.0 mg/L exhibited good stress reducing capability, satisfactory induction and recovery times, and no mortalities at either low or high densities. Only one fish died in all of the control trials where no sedatives were used. This was unexpected and indicates holding fish using these methods without sedatives may be equally effective.

†14:30 Comparing snorkelling and eDNA sampling techniques for monitoring presence and abundance of endangered Zuni Bluehead Sucker, *Catostomus discobolus yarrowi*, and Navajo Nation genetic subunit Bluehead Sucker, *Catostomus discobolus*, in Southwestern streams

Ulibarri, Roy^{*1}, Bonar Dr., Scott², Rees Dr., Chris³, Jackson, Craig³, Mata, Melissa⁴, Selby, Glenn⁵, Cole, Jeff⁵. (1-University of Arizona, 2-USGS Arizona Cooperative Fish and Wildlife Research Unit, 3-the USGS-Upper Midwest Environmental Sciences Center, 4-United States Fish and Wildlife Service, 5-Navajo Nation Fish and Wildlife).

Advances in technology have allowed development of DNA based methods to detect and monitor aquatic species. This new method of species monitoring in aquatic environments is referred to as environmental DNA (eDNA), and has typically been used to detect invasive species in aquatic environments through water samples. This study focuses on comparing eDNA methodology to a traditional fish sampling technique (snorkel surveys) to allow researchers and managers to compare fish abundance estimates to eDNA concentrations from water samples. Our study site included three streams on the Navajo Nation in northern Arizona and northern New Mexico containing Navajo Nation genetic subunit of the Bluehead Sucker *Catostomus discobolus* and the Zuni Bluehead Sucker *Catostomus discobolus yarrowi*. To sample, we first divided entire wetted area of streams into 100 m consecutive reaches. We systematically selected 10 of those reaches for snorkel surveys. Water samples were taken every ten meters within the 100 m reach. Samples were collected at the downstream starting point of each reach, and continued upstream 5-8 meters ahead of the snorkeler. All water samples were sent to the USGS-Upper Midwest Environmental Sciences Center in Lacrosse, Wisconsin for eDNA processing. We were able to positively detect both species with eDNA sampling techniques in two out of three streams, and snorkeling in all three streams. We found relationship between number of fish observed in each stream and positive detections, however, this relationship was not strong. Snorkel surveys detected fish in all streams even when numbers were low, eDNA samples only had seven to ten percent positive detection when fish numbers were higher. We

found no environmental characteristics (i.e., water velocity, substrate size, over-head cover, water depth, instream cover and mesohabitat conditions (i.e., pool, run riffle)) to be significant predictors for positive eDNA detection. According to results of this study, traditional fish sampling techniques are still recommended over eDNA techniques when working with rare species on small streams.

†14:45 Movement of introduced Flathead Catfish, *Pylodictis olivaris*, in the upper Gila River basin, New Mexico, and potential impacts on native fishes

Hedden, Skyler^{*1}, Gido, Keith¹. (1-Kansas State University).

Understanding movement behavior of nonnative fish predators can help identify potential impacts these organisms are having on native species. We used radio telemetry to observe nonnative flathead catfish, *Pylodictis olivaris*, at hourly, daily, and seasonal scales from May 2014 to June 2015 in the upper Gila River basin, New Mexico. Movements varied among individuals with a majority moving 80 m. Managers can use this information to understand potential overlap with native species, target future removal efforts in areas where these fish are concentrated, and avoid stocking native fishes in reaches where flathead catfish tend to aggregate.

†15:00 Comparative analysis of eukaryotic community assemblages in Devils Hole and its constructed analog

Paulson, Elizabeth (Abbey)^{*1}, Martin, Andrew¹. (1-University of Colorado - Boulder).

A small opening into a massive aquifer in western Nevada, known as Devils Hole, provides the sole natural habitat for the federally endangered Devils Hole pupfish (*Cyprinodon diabolis*). In the midst of a dramatic population decline, a replica habitat has been constructed to grow and house a backup population of this enigmatic desert fish. The replica pool was designed to precisely mimic both the abiotic environment and biotic community found in Devils Hole. We used environmental DNA surveys to characterize the eukaryotic communities found in the two systems, across all micro- and macrobiota, to assess similarities in species assemblages and discern possible drivers of community divergence. Although alpha diversity did not differ significantly as of June 2015, the two systems currently comprise different community compositions overall, as well as within algal mat, benthic sediment, and water column habitats. These discrepancies in community composition may be due to the absence of ecologically important nutrient-cycling taxa in the constructed pool, or differences in environmental variables such as temperature, insolation, and dissolved oxygen.

†15:15 Retrospective food web analysis of the Gila River: Do native and non-native interactions intensify during drought?

Reese, Rosalee^{*1}, Turner, Thomas F.¹, Propst, David¹, Gido, Keith². (1-University of New Mexico, 2-Kansas State University).

The relatively pristine Upper Gila River in New Mexico is a stronghold for endemic native fishes despite the presence of nonnative fishes. In other, more severely human-impacted tributaries in the Colorado River basin, nonnative fishes are a major factor in native species extirpation. Our goal is to test whether negative effects of nonnatives on natives are compounded during challenging hydrologic conditions (i.e., drought). Stable isotope analysis (SIA) allows for estimation of trophic position and trophic niche width. Fish specimens were selected from natural history collections to represent a time series that encompasses wet and dry years, as well as varying non-native abundances. We estimated $\delta^{15}\text{N}$ isotopic niche spaceTM by plotting $\delta^{13}\text{C}$ vs. $\delta^{15}\text{N}$ for native and nonnative fishes and statistically compared breadth and overlap in niches among species. Our prediction is that during drought periods, isotopic niches of nonnatives and natives will overlap, indicating competition, but that in wet periods, isotopic niches will diverge significantly as an indicator of resource partitioning. SIA of museum specimens offers the potential to test key hypotheses about the impact of non-native species on an endemic fauna, and provide understanding of the environmental context that non-native species negatively impact native fishes. Such understanding

is important now more than ever for conservation of the Gila River, where climate change and pending water diversion could lead to further decline of native fish abundance and eventual extirpation.

‡15:30 PIT and VIE tagging effects on a small-bodied fish, *Cyprinodon tularosa*

Peterson, Damon^{*1}, Trantham, Tulley¹, Simpson, Randi¹, Caldwell, Colleen C.¹. (1-New Mexico State University, U.S. Geological Survey, New Mexico Cooperative Fish and Wildlife Research Unit).

Body size has commonly been used as the primary predictor of suitable candidates for individual tagging; however few studies have focused on the impacts of tagging on small bodied adult fish. To address the hypothesis that body size predicts the probability of survival among tagged, small-bodied fish we quantified survival, tag retention, and growth in a southwestern pupfish, *Cyprinodon tularosa*. We used two tagging methods: (1) 8.5-mm PIT tags and (2) VIE and calculated tagging related mortality, tag retention, and growth over a 75d period for four different size classes (TL): 15-29mm/0.1-0.6g, 30-39mm/0.4-1.2g, 40-49mm/1.0-2.2g, and 50-59mm/2.3-4.2g. Fish mass was a good predictor of the probability of survival across all PIT-tagged animals ($P=0.016$) where animals were 62 times more likely to survive tagging as mass increased by 1 gram. The smallest size class (15-29mm TL) experienced the greatest rate of mortality (72%). VIE related mortality was marginally significantly different from the control group ($P=0.076$). The growth rate of all tagged animals was similar to the control group. Our data indicated that White Sands pupfish can be effectively tagged using 8-mm PIT tags with minimal tag loss or mortality at sizes ≥ 37 mm.

‡15:45 Identifying a potentially cryptic species of *Gila* in Sonora, Mexico

Ballesteros-Cordova, Carlos A.^{*1}, Varela-Romero, Alejandro¹, Ruiz-Campos, Gorgonio², Findley, Lloyd³, Grijalva-Chon, José M.¹, Gutiérrez-Millán, Luis E.¹. (1-DICTUS / Universidad de Sonora, 2-Lab. de Vertebrados /

Universidad Autónoma de Baja California, 3-Centro de Investigación en Alimentación y Desarrollo Guaymas).

The Desert Chub, *Gila eremica* DeMarais, 1991, is an endemic species in Sonora State in Northwest Mexico. It has been collected in and was described from the Sonora and Matape river basins, with a single record (perhaps dubious) from the Moctezuma River in the upper Yaqui River basin. Recently, two new populations of *G. cf. eremica* were discovered in large spring-fed pools (tinajas) in two subtropical canyons of the Arroyo El Tigre sub-basin, which intermittently drains the eastern flank of the ruggedly volcanic Sierra El Agua range within the Matape River basin, near the towns of San Carlos and Guaymas, Sonora. These new populations are distantly isolated from populations of *Gila eremica* in the Sonora and Matape drainages. Using several biological criteria, the taxonomic identities of these two new populations were evaluated against known populations of *Gila eremica* and other selected species of *Gila*. Based on box-truss protocol, 33 morphometric and six meristic characters were compared in 219 specimens from several populations *Gila* in Sonora, including all known populations of *Gila eremica*. Both meristics and standardized measures were analyzed by means of a discriminant function analysis (DFA). Tree diagrams based on squared Mahalanobis distances, as well as scatterplots of centroids, showed the newly discovered populations of *G. cf. eremica* from the Arroyo El Tigre sub-basin to be morphologically divergent with respect to known populations of *Gila eremica*, as well as the other species analyzed (*G. purpurea*, *G. ditaenia*, *G. minacae*). Analyses showed that 14 morphological and two meristic characters differentiate *G. cf. eremica* from nominal *Gila eremica*. Phylogenetic analysis (Maximum Likelihood) using mitochondrial gene *Cyt-b* of *G. cf. eremica*, and including sequences of all reported species of the genus, detected distinct geographical clades within the *Gila eremica* species-complex, with a clade for populations from the Sonora River basin (Sonora and San Miguel rivers sub-basins), and a clade for populations from the Matape River basin (Matape River sub-basin and Arroyo El Tigre sub-basin) showing close relationship of *G. cf. eremica* (Arroyo El Tigre sub-basin) with populations of *G. eremica* (Matape River sub-basin) as its sister clade. Populations of *G. cf. eremica* (Arroyo El Tigre sub-basin) showed a putative ancestor with respect to populations of *G. eremica* from the Matape River basin.

†16:00 Conservation implications of deformity and reproductive variance in the hatchery stock of Greenback Cutthroat Trout

Love Stowell, Sierra M^{*1}, Kennedy, Chris M², Monroe, Evan G¹, Martin, Andrew P¹. (1-University of Colorado, 2-US Fish & Wildlife Service).

Hatchery propagation is a valuable tool for fish conservation. Rare or declining populations can be supplemented with hatchery-raised individuals to maintain both population size and genetic diversity. However, hatchery propagation can also exacerbate the genetic issues of small populations: initiating a hatchery broodstock imposes a genetic bottleneck and adaptation to hatchery conditions happens within as little as two generations, leading to a stock with decreased genetic diversity and fitness that will introduce maladaptive alleles if used for supplementation. A hatchery broodstock of greenback cutthroat trout (*Oncorhynchus clarkii* unnamed subspecies) was initiated in 2008 when 67 fish from the single remnant wild population were brought into the hatchery. Of those 67, 42 were spawned in 2010 to make the first generation of greenbacks maintained in the hatchery system. This broodstock has declined rapidly from 8,010 eyed eggs in 2010 to 1,757 fry in 2011, 784 fish in 2012, and 173 fish in 2015. Deformities such as missing eyes, reduced opercula, and extra "chins" were common (65% of females, 70% of males) and correlated with smaller body size (length, 11mm shorter, $p=1.17 \times 10^{-6}$; mass, 40 g smaller, $p=3.3 \times 10^{-9}$); bilateral asymmetry using 20 landmarks was also significant. The rapid decline of the stock and the frequency of deformities are both high compared to other hatchery stocks of salmonids and are indicative of inbreeding depression. In the past, individuals were spawned 1 female : 1 male or 1 female : 2 males and then all eggs, fertilized or not, were pooled together. To assess variation in gamete production and fertilization success, we conducted 112 controlled crosses with 55 females and 91 males (spawned 1:1 or 1:2) and maintained each family group individually. Females had a wide range of fecundity (71-1572 eggs), egg mass (1.3-6.5mg), and lipid provisioning. Fertilization success measured by percent of eggs that developed eyes varied from 0 to 78% with a strong combinatorial effect (i.e. the same female could have or low fertilization success depending on the identity of the father). The variation in individual reproductive success has important implications for the genetic diversity of the stock as such variation lowers the effective number of breeds in the population. We are following the fate of the families through hatching and growth and testing for a relationship between the genetic relatedness of the parents and the fitness of the offspring. These data are being used to inform sustainable reintroduction efforts of greenback cutthroat trout into their native range and are illustrative for the management of small fish populations in other systems.

†16:15 Phylogenomics and introgression in the evolutionary history of *Catostomus*

Bangs, Max R.^{*1}, Douglas, Marlis R.¹, Douglas, Michael E.¹. (1-University of Arkansas).

Species boundaries have long been thought to be semipermeable (i.e., the ability of some genomic regions to introgress more readily than others), but have only recently been examined thanks to methodologies that can now discern historic introgression from its consort, incomplete lineage sorting. Yet despite this, confusion is still rampant, especially in non-model organisms. For one, historic introgression in *Catostomus* is poorly documented despite the fact that contemporary hybridization is widely acknowledged. This has become the subject of recent debate due to incongruence between morphological and mitochondrial phylogenies, with some authors attributing historic introgression without formal testing. To resolve this debate we applied double digest restriction-site associated DNA sequencing (ddRAD) to develop a molecular phylogeny for a species-subset, to include several in the subgenus *Pantosteus*. A series of D-statistics were applied to examine proposed introgression events. Results highlight the porous nature of species boundaries in catostomid fishes, in that several introgression events were identified. A well-supported molecular phylogeny was also generated, even in the presence of introgression, using >100,000 parsimoniously informative SNPs. Results help interpret several proposed taxonomic revisions, to include the elevation of Bonneville Bluehead Sucker (*C. (P.) virescens*), Little Colorado River Sucker (*C. cf. crassicauda*), and Zuni Bluehead Sucker (*C. (P.) discobolus yarrowi*).

†16:30 Phylogeography of Speckled Dace, *Rhinichthys osculus*

Mussmann, Steven^{*1}, Douglas, Marlis R¹, Douglas, Michael E¹. (1-University of Arkansas).

The ubiquitous distribution of Speckled Dace (*Rhinichthys osculus*) throughout all major drainage basins of the western United States is a direct result of an ever changing landscape. Geologic processes have simultaneously shaped the landscape and distribution of fish fauna over the past 20 million years, resulting in narrow endemism of several subspecies. This broad distribution could thus serve as a template from which phylogeographic hypotheses could be derived for aquatic organisms more restricted in abundance and/ or distribution. Such a template could also serve to develop a perspective on relationships of drainages, basins, and the biota therein. We begin this task by employing next generation sequencing techniques to construct a range-wide phylogeny of Speckled Dace. Double digest restriction associated DNA (ddRAD) sequencing recovered approximately 15,000 loci for this purpose. Phylogenomic analysis of 200 samples collected from 100 dace populations and 50 sub-basins recovered eleven clades representing major drainages of Western North America. Most clades, such those representing the Colorado River Basin, show concordance with modern drainage systems. However, others show remnants of Pleistocene connections, such as the Snake River clade.

†16:45 Use of ultrasonic imaging to evaluate egg maturation of Humpback Chub, *Gila cypha*, in Grand Canyon

Brizendine, Morgan E.^{*1}, Ward, David L.², Bonar, Scott A.¹, Matter, William J.³. (1-University of Arizona, Arizona Cooperative Fish and Wildlife Research Unit, 2-U.S. Geological Survey, Grand Canyon Monitoring and Research Center, 3-University of Arizona, School of Natural Resources and the Environment).

Humpback chub *Gila cypha* are endangered cyprinids endemic to the Colorado River drainage and are adapted to live in fast currents of warm, turbid water. Although nine known aggregations of humpback chub currently exist in the main stem Colorado River in Grand Canyon, little is known about their reproduction. We hypothesized that Colorado River water temperatures below Glen Canyon Dam are too low due to hypolimnetic dam releases for female humpback chub to develop mature eggs for spawning. Ultrasonic imaging is a non-lethal method that has been used to determine sex and maturity of a variety of freshwater, anadromous, and marine fishes. However, these studies typically use captive fish and not wild fish in the field. Our goal was to develop ultrasonic imaging to identify gamete development and to evaluate gamete maturity in female humpback chub in the Grand Canyon. We developed a standardized protocol for ultrasonically scanning humpback chub in the field and compared egg development in female fish from the main stem Colorado River, Little Colorado River, Havasu Creek, and Shinumo Creek. We documented egg development as expected in the Little Colorado River and to an extent in the main stem Colorado River and Havasu Creek.

†17:00 Interacting effects of developmental temperature and source population on the phenotype of *Gambusia marshi*

Moody, Eric K.^{*1}, Corman, Jessica R.¹, Espinosa-Perez, Hector², Ramos, Jorge¹, Sabo, John L.¹, Elser, James J. (1-Arizona State University, 2-UNAM).

The robust gambusia, *Gambusia marshi*, is native to the Río Salado basin in Coahuila, Mexico. This species inhabits a wide variety of habitats including rivers, thermal springs, and evaporative wetlands. In his description of *G. marshi*, W.L. Minckley suggested that phenotypic variation in fish among these habits may represent a species complex rather than a single variable species. We aim to investigate the source of phenotypic variation in *G. marshi*, focusing specifically on fish inhabiting springs in the Cuatro Ciénegas basin. Among eight springs, we found that adult female body size is negatively correlated with temperature, and that fish from warmer springs differ in their elemental composition and excretion ratios. We conducted a geometric morphometric analysis on specimens from two cool and two warm springs, and found a significant interacting effect of temperature and sex on fish morphology. We then reared F1 fish from two populations, La Becerra (mean temp = 32 C) and Los Hundidos (mean temp = 25 C), at both temperatures in the laboratory. Within each population, 25 day-old fish were smaller when reared at 33 C than at 25 C. However, fish from La Becerra were smaller at birth than fish from Los Hundidos, and

this difference persisted in 25 day-old F1 fish. Further, we found significant interacting effects of source population and developmental temperature on consumption, respiration, and excretion N:P of 25-day old fish. Our results suggest that while genetic differences between populations may affect the phenotype of *G. marshi*, thermal differences among springs also cause phenotypic plasticity.

17:15-18:15 Business Meeting

18:30-22:00 Banquet- Furnace Creek Date Grove

Saturday, November 21, 2015

08:30-12:00 General Session V: Sierra Love Stowell, Moderator

08:30 Eradication of invasive Red Swamp Crayfish, *Procambarus clarkii*, from a Mojave Desert Spring Complex

Andress, Robert¹, Fairfield, Hal², Weissenfluh, Darrick³, Simons, Lee H⁴, Simons, Laurie S.⁵, Bagozzi, Annji². (1-Gradient, LLC, Salt Lake City, Utah, 2-Ash Meadows National Wildlife Refuge, Nye County, Nevada, 3-Klamath Fish and Wildlife Office, Klamath Falls, Oregon, 4-Southern Nevada Fish and Wildlife Office, Las Vegas, Nevada, 5-Desert National Wildlife Refuge Complex, Las Vegas, Nevada).

Red swamp crayfish, *Procambarus clarkii*, is one of the most widely introduced and invasive of all crayfish, and has infested many areas in southern Nevada, including four of the six springs in the Warm Springs Complex, Ash Meadows National Wildlife Refuge. The Warm Springs Complex consists of six low-discharge spring systems with individual flows ranging from 1.13×10^{-4} to 1.98×10^{-4} cubic centimeters per second. Water temperatures range from 28 to 34 degrees Celsius. Four aquatic invertebrates and the endangered Warm Springs pupfish, *Cyprinodon nevadensis pectoralis*, are endemic to this Complex; the pupfish was in decline as efforts to eradicate crayfish began in 2008. The smallest of the springs infested with crayfish, School Spring, was diverted and desiccated from April through May 2008. Based on this success, three springheads at North and South Indian springs were diverted and springbrooks desiccated over a period of 21 months, including two cycles of hot summer weather. South Scruggs was the largest and most complex spring system to be cleared of crayfish, involving diversion of three springheads, desiccation for 26 months, including two summer cycles, and aggressive removal of organic debris and substrate in springhead areas. These efforts involved intensive trapping of crayfish pre- and post- eradication, salvage and repatriation of native fish and invertebrates from the springs undergoing rehabilitation, fencing to prevent crayfish movements, and extended monitoring of invertebrates and vegetation impacted by the project and especially for any surviving crayfish. To our knowledge, this 7-year effort represents the first successful eradication of this crayfish from an entire spring complex. Temporary desiccation, combined with a sound plan for containment and capture of surviving target pests, may be a successful strategy for control of aquatic invasive species in other ecosystems.

08:45 Can incentives help overcome landowner concerns about conserving endangered species on their land? A rancher case study applied to fisheries conservation and management

Svancara, Colleen^{*1}, Lien, Aaron¹, Vanasco, Wendy¹, Bonar, Scott¹, Ruyle, George¹, Lopez-Hoffman, Laura. (1-University of Arizona).

Payments for ecosystem services (PES) programs may encourage private landowners to conserve threatened and endangered species on their land. Harboring threatened or endangered species on private land may put landowners at risk of regulation or losing power to make decisions for their operation

because of implications from the Endangered Species Act (ESA). However, private landowners are vitally important to endangered species conservation because of their large capacity to conserve and maintain habitat. Because landowners are apprehensive about the effects of the ESA on how they manage, PES programs that ask them to promote habitat for an endangered species likely have to be uniquely designed to address their concerns about additional regulatory burden. We used three methods to assess the interest of ranchers in southern Arizona and southwestern New Mexico in participating in PES programs for threatened and endangered speciesâ€™ conservation, and to determine what specific considerations need to be included in the design of such a program. We extend conclusions from our study to applications in managing and conserving fish populations on private lands. Participants in our study were generally interested in hypothetical PES programs for threatened and endangered speciesâ€™ conservation. Results demonstrate that funding source for the program was important, programs must result in a net benefit to landowners, and regulatory assurances must be provided to landowners and their neighbors. These results are useful during preliminary stages of designing a PES program in the region of study, recognizing that further investigation into landowner preferences will be needed. Our approach is also a model for how other regions can evaluate stakeholder preferences before the initiating PES program design, including for threatened or endangered fishes on private land in the Southwestern, USA.

09:00 Drought and wildfire compromise genetic diversity and recovery in Gila Trout

Turner, Thomas F. ^{*1}, Osborne, Megan J. ¹, Pilger, Tyler J. ¹, Propst, David L. ¹, Brooks, James E. ¹, Wilson, Wade D. (1-University of New Mexico, Museum of Southwestern Biology, 2-USFWS - Southwestern Native Aquatic Resources and Recovery Center).

Gila trout, *Oncorhynchus gilae*, maintains a tenuous presence in the Upper Gila River basin. Beginning in 2011, a series of catastrophic wildfires negatively impacted nearly all remaining populations, with local effects ranging from reduced abundance to extirpation. We assessed genetic responses by assessing variation in 13 microsatellite loci and a gene critical for immune function (MHC). We show that, in addition to severe demographic losses, levels of genetic diversity changed radically over a 10-year period of extensive drought preceding the wildfires. Two distinct lineages (Spruce and Whiskey), both with behavioral characteristics that complicate large-scale hatchery rearing, experienced extensive losses of heterozygosity and allelic diversity at all loci, including MHC. Diversity did not change in lineages more amenable to hatchery rearing (Main Diamond, South Diamond). Marker-assisted crosses will likely be necessary to restore diversity and viability to the Spruce lineage. Restoration of genetic connectivity across multiple lineages in complex watersheds could also ameliorate negative demographic and genetic effects of drought, but could be complicated by climate change. Catastrophic fires and extensive drought will increase in frequency and geographic scale in coming decades, and we expect similar losses of diversity in other native trout populations. Gila trout serves as a case study in efforts to preserve other inland trout species.

09:15 Every bug is sacred: Management of highly diversified *Abedus* populations

Lytle, David ^{*1}, Hartfield-Kirk, Emily ¹. (1-Oregon State University).

Giant water bugs in the genus *Abedus* are found in streams and rivers throughout the deserts of southern Arizona, southern California, and Mexico. They serve an ecological role as top predator in many fishless streams, and can also be predators on fish and anurans. We present new data from whole genome sequencing (2bRAD) of *Abedus herberti* that suggests populations are highly isolated from one another across the landscape, and might better be considered a species flock of unique lineages rather than a homogenous single species. These data are congruent with previous mtDNA and microsatellite studies that pointed to high levels of among-population divergence. High genetic divergence among populations also explains the rich diversity of behavior (flood escape behavior) and morphology (extreme variation in body size) that is observed across *Abedus* populations. These patterns present unique challenges for the management of desert streams. First, the high degree of endemism suggests that translocating individuals among drainages, and even within drainages, could be problematic. Second, loss of populations, as has been documented in several Arizona streams, likely represents the loss of unique evolutionary heritage.

09:30 Spawning ecology and captive husbandry of endangered Moapa Dace

Ruggirello, Jack E.¹, Bonar, Scott A.^{*2}, Feuerbacher, Olin G.³, Simons, Lee³, Powers, Chelsea¹. (1-University of Arizona, 2-U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, 3-U.S. Fish and Wildlife Service).

Moapa Dace *Moapa coriacea* is a critically endangered cyprinid endemic to the Warm Springs area of Clark County, Nevada. Prior to this work, Moapa Dace had never been successfully held in captivity for any length of time, or propagated in captivity. To develop a protocol for rearing and propagation, 40 fish were collected in February 2013, and an additional group of 30 fish were collected in January 2014. We were able to successfully transport and rear Moapa Dace employing slow acclimation and aggressive prophylactic treatment; feeding adults with a combination of live and frozen invertebrates and commercially available pelleted foods; and providing an artificial stream environment to them. To spawn Moapa Dace, we applied 15 different treatments, including introduction of different types of cover and different sized substrates; manipulations of photoperiod, water chemistry, and temperature; application of hormone baths and injections, and manipulation of water flow. We were finally able to propagate Moapa Dace in two different artificial streams using a water flow modification treatment provided over three months. This treatment differed from all others in that it employed a submersible pump at the bottom - in addition to the surface flow - to deliver a lateral flow of water along the gravel substrate into a cobble bed. The conditions we used to successfully rear and propagate Moapa dace (artificial stream environment, provided cover; 30-32°C stream temperatures; water depths of 32-49 cm, and adequate flow directed along the bottom into cobble substrate) were similar to conditions where we saw Moapa Dace spawn in the wild using underwater videography. Our study suggests proper conditions in which to rear and propagate Moapa Dace are specific, spawning cues are subtle, and propagation can be difficult. Furthermore, alteration of flow, temperature, substrate and other conditions found in natural streams may affect conditions needed for successful spawning in the wild.

09:45 Relationship between stream and lake ecotypes of Warner Suckers

DeHaan, Patrick^{*1}, Von Bargen, Jennifer¹, Scheerer, Paul². (1-USFWS, Abernathy Fish Technology Center, 2-ODFW, Native Fish Investigations Program).

The Warner sucker, *Catostomus warnerensis*, is endemic to the Warner Valley, an endorheic subbasin of the Great Basin in southeastern Oregon. Two distinct ecotypes of Warner suckers exist; stream-type fish that are found in tributaries to the Warner Lakes and lake-type fish that are found in Hart and Crump Lakes. Lake-type fish attain larger sizes and presumably have increased fecundity, but risk increased predation, reduced access to spawning habitat, and periodic loss of habitat due to lake desiccation. Stream-type individuals inhabit a more stable environment with reduced risk of predation, however, they have a decreased forage base and stream habitat in the Warner basin has been extensively fragmented. Although it is presumed that lake-type individuals originate in the streams, information regarding the relationship between the two ecotypes is limited. Our objective was to use genetic assignment data to examine the relationship between the two ecotypes. We collected Warner suckers from four tributary populations and genotyped them at 16 microsatellite loci to develop a baseline dataset. Leave-one-out tests of our baseline dataset indicated a high likelihood that individuals from the lakes would be assigned to their correct population of origin. Between 2006 and 2012, we collected over 300 individuals from Hart and Crump lakes for genetic assignments and these fish were also genotyped at 16 microsatellite loci. Nearly all of the individuals collected from Crump Lake were assigned to Deep Creek, a tributary to Crump Lake. Individuals collected from Hart Lake were assigned to both Deep Creek and Honey Creek (a Hart Lake tributary), suggesting that fish were moving between the two lakes. These data provide important information regarding which tributary populations are important to Warner suckers in the lakes and will help to prioritize management actions such as increasing connectivity between lake and stream populations.

10:00 2015 Bonneville Basin Area Report

Mellon, Cassie D.^{*1}. (1-Bureau of Land Management).

The 2015 Bonneville Basin Area Report will provide an overview of activities and accomplishments for native aquatic species in the Bonneville Basin. This will include an update on June sucker, *Chasmistes liorus*, least chub, *Notichthys phlegethontis*, northern leatherside, *Lepidomeda copei*, and southern leatherside, *Lepidomeda aliciae*. Activities for Bonneville cutthroat trout, *Oncorhynchus clarkii* utah, will highlight reintroduction into tributaries of the Bear River. Utah Division of Wildlife Resources (UDWR) biologists and Utah State University (USU) are working to address limiting factors in the Weber River for a potentially unique species of bluehead sucker, *Catostomus discobolus*, in the Weber and Bear River drainages. These will also primarily be in partnership with Bonneville cutthroat restoration and reintroduction.

10:15 Using microchemistry to determine natal origin of Razorback Sucker in the San Juan River

Clark Barkalow, Stephani L.^{*1}, Platania, Steven P.¹, Kennedy, Jennifer L.¹. (1-American Southwest Ichthyological Researchers).

Although Razorback Sucker, *Xyrauchen texanus*, reproduce in the San Juan River, there is no evidence of recruitment of naturally produced fish to the adult population. Untagged Razorback Sucker are detected annually in the San Juan River; however, it is unknown whether they originated in the river or are hatchery produced fish that lack PIT tags. A non-lethal method for determining natal origin is necessary to assess recruitment of Razorback Sucker in the San Juan River. Elemental (Sr/Ca and Ba/Ca) and isotopic (⁸⁷Sr/⁸⁶Sr) microchemical analyses of fin rays and otoliths were used to determine if recruitment is occurring in wild Razorback Sucker populations in the San Juan River and to ascertain natal origin of untagged fish. Isotopic and elemental analyses revealed significant differences between hatcheries and the San Juan River allowing determination of natal origin for untagged Razorback Sucker. An important finding of this study was the identification of a naturally produced Razorback Sucker (224 mm TL) which represents recruitment to a larger size class than had been previously been documented in the San Juan River. Comparison of isotopic signatures of otoliths, fin rays, and water from the same source revealed that fin ray isotopic signatures were better correlated with water than were otolith isotopic signatures. Analysis of fin ray microchemistry is a useful, non-lethal tool for assessment of recruitment of Razorback Sucker in the San Juan River, and has applications for management and conservation of other endangered species.

10:30 Misconceptions on the use of rotenone in Arizona: It is still a feasible fish removal tool

Carter, Julie Meka^{*1}. (1-Arizona Game and Fish Department).

The ability to use piscicides in Arizona has gone through a laborious and complicated process to modify the planning and application approach. State legislation was introduced during three legislative sessions that would have limited the use of piscicides, particularly rotenone, in fisheries management. When the first bills were introduced in 2011, a subsequent moratorium on piscicide applications was issued. A Blue Ribbon Panel evaluated the potential impacts of rotenone to human health, the environment, and livestock, and a report was developed with multiple recommendations on the future of rotenone applications in Arizona. The recommendations were accepted, a rotenone policy was adopted, and a new process for treatments was developed. Still, similar legislation was again introduced in 2012 and 2013 and the bill was signed into law (A.R.S. 17 Â§ 481). Three rotenone projects with multiple applications have been successfully implemented since 2012, and multiple mechanical removal efforts are underway with successful results thus far. The new planning and approval processes, in addition to compliance with state and federal Environmental Protection Agency and project label regulations, has made the implementation of rotenone projects seem cumbersome at times, particularly to partners. However, the new process has increased the transparency, diligence, oversight, and the amount of public outreach per project, as well as the scrutiny of each project concept and the associated political environment to ensure successful treatments. Collectively, the ability to use multiple fish removal tools within Arizona maintains our ability to be creative and flexible, yet effective when eliminating or reducing the abundance of a target

fish species.

10:45 Recovery and delisting of the Modoc Sucker - a positive story

Reid, Stewart B.^{*1}. (1-Western Fishes).

The Modoc Sucker, *Catostomus microps*, occupies small streams in the upper Pit River drainage of northern California and southern Oregon (including Goose Lake Basin) and was federally listed in 1985. Principal threats to the species included its limited distribution, habitat degradation, non-native predators, and possible hybridization with the more abundant Sacramento Sucker. Recovery of the species has included addressing specific threats, resolving perceived threats through research, surveying for additional populations, introductions to suitable secure habitat and community outreach. Private landowner cooperation has been and continues to be essential for securing access to populations, carrying out conservation actions and developing non-confrontational attitudes toward the Modoc Sucker and its recovery efforts. At this time the distribution of Modoc Sucker is broader than at the time of listing, habitat conditions have improved, non-native species have been controlled, hybridization has been investigated with modern genetic methods not available at the time of listing and determined to not represent a threat, and landowner attitudes are generally supportive of conservation efforts. Getting there has involved collaboration between all parties, development of personal relationships and plenty of on-the-ground effort. The Modoc Sucker has also demonstrated its resilience over 30 years of climatic variation. In early 2015 U.S. Fish and Wildlife proposed the Modoc Sucker for delisting, and the final determination is in preparation after successful public review.

11:00 Razorback Sucker research and monitoring in Lake Mead, Nevada and Arizona.

Mohn, Harrison^{*1}, Albrecht, Brandon¹, Rogers, Ronald¹, Kegerries, Ron¹. (1-BIO-WEST, Inc.).

The natural recruitment, movement patterns, and habitat use of adult Razorback Sucker, *Xyrauchen texanus*, in Lake Mead have been studied in some capacity for the last 20 years. As past studies have shown, Lake Mead is somewhat unique in terms of consistent and continued recruitment of wild Razorback Sucker and the presence of juvenile individuals. Several methodologies were employed in long-term monitoring during the 2014-2015 field season to assess reproductive activity and population demography including; sonic telemetry, trammel netting, nonlethal aging, and larval fish surveys. The collection of these data aided in the identification of primary spawning areas, documentation of successful reproduction, and continued recruitment with a number of new, wild Razorback Suckers captured in Las Vegas Bay, Echo Bay, and the Muddy River/Virgin River inflow area. Additionally, efforts to specifically target juvenile Razorback Sucker in Lake Mead utilizing sonic-tagged juvenile individuals, were employed to better understand why Lake Mead Razorback Suckers are able to demonstrate natural recruitment. Movement and contact locations of sonic-tagged juvenile Razorback Suckers were used to help to characterize the associated habitat by quantifying the physicochemical attributes (temperature, dissolved oxygen concentration, conductivity, pH, turbidity, depth) and the qualitative assessment (type and percent composition) of inundated cover and substrate. Furthermore, a number of methods were also used to describe the associated fish community in these preferred areas. Continued research concentrating on understanding naturally occurring recruitment of Razorback Sucker in Lake Mead, will aid in assembling conservation applications for the species throughout the Colorado River basin.

11:15 Towards conservation of Razorback Sucker *Xyrauchen texanus* one population at a time

Kesner, Brian^{*1}, Ehlo, Chase¹, Pacey, Carol¹, Wisenall, Jamie¹, Marsh, Paul¹. (1-Marsh and Associates, LLC).

Once abundant throughout the Colorado River and its tributaries the razorback sucker *Xyrauchen texanus* is now critically imperiled and dependent on stocking to perpetuate its existence. Measures taken to stave off extinction began more than 30 years ago, and have succeeded by maintaining mostly isolated adult populations that are not self-sustaining. Short term measures designed to reverse the decline in abundance have become medium term solutions due to lower than expected survival of stocked fish and continued low to absent natural recruitment. The common impediment to producing self-sustaining populations is

the presence and continued invasion of nonnative fish species. However, each population of razorback sucker is exposed to a different suite of nonnative fish species, and those differences are evident in estimates of survival at different life stages. As longer term solutions to razorback sucker are pursued, estimates of population specific demographics should inform stocking programs to provide the largest return on limited invested resources.

11:30 Owens Speckled Dace, *Rhynchichthys osculus* sp., distribution and abundance in Round Valley, California

Buckmaster, Nicholas^{*1}, Neilsen, Daniel¹, Kauffman, Neil¹, Kruse, Christi¹, Otto, Elsbeth¹, Greene, Lacey¹. (1-California Department of Fish and Wildlife).

Owens speckled dace are a formally undescribed subspecies of speckled dace, and are a California species of special concern. Owens speckled dace were historically common in the Owens River watershed, but suffered dramatic declines and local extirpations following water development projects and introduction of non-native predators (e.g. brown trout, *Salmo trutta*, and largemouth bass, *Micropterus salmoides*). Our study examined speckled dace distribution, stream habitat characteristics, and population structure within the Round Valley sub-basin of the Owens River watershed. Round Valley was identified by previous researchers (Sada, 1982, unpublished data; Becker, 1999, CA Dept. of Fish and Game surveys) as one of the last remaining locations within the Owens Valley where speckled dace persist. Our surveys indicate that speckled dace within Round Valley are locally abundant in seasonally flooded waters (e.g. irrigation ditches), and present in low-gradient perennial streams: notably Owens speckled dace co-occurred with piscivorous brown trout in several low-gradient streams. Owens speckled dace were absent entirely from high-gradient stream reaches. Our results indicate that Owens speckled dace are a batch-spawning species, and remain reproductive from April to September; however, all sampled populations indicated a single recruitment event in late spring. Preliminary results indicate that seasonally flooded habitat contained speckled dace populations with higher condition factors than perennial streams, and simple population structures, typified by unimodal length-frequency distributions. Perennial streams, where speckled dace occurred, supported speckled dace populations with bi-modal or tri-modal length frequency distributions, which is indicative of multiple recruitment events. Presumably, ubiquitous predation from brown trout has precluded speckled dace from high-gradient streams. Seasonal habitat and low-gradient stream reaches comprise the majority of occupied speckled dace habitat in Round Valley; the unimodal population structure of seasonally flooded habitats indicates that speckled dace are not persisting within these habitats year-to-year. Thus, speckled dace persistence appears to be contingent upon only a portion of the occupied habitat, such as perennial irrigation ditches and low-gradient stream reaches.

11:45 An evaluation of Supaverm® as a catfish specific piscicide

Ward, David L.^{*1}, Morton-Starnes, Rylan¹, Vaage, Ben¹. (1-U.S. Geological Survey, Southwest Biological Science Center, GCMRC).

The decline of native fishes in the southwestern United States is largely attributed to interactions with introduced fish. Attempts to remove nonnative fish from areas with native fish are common, but success is limited because very few tools are available for managing invasive fishes. We evaluated the chemical Supaverm® for potential use as a selective piscicide to remove catfish by testing its toxicity to three species of catfish and five species of native fish commonly found in Arizona. Channel catfish *Ictalurus punctatus*, black bullhead *Ameiurus melas*, flathead catfish *Pylodictis olivaris*, bonytail *Gila elegans*, humpback chub *Gila cypha*, roundtail chub *Gila robusta*, Sonora sucker *Catostomus insignis* and speckled dace *Rhynchichthys osculus*, were exposed to Supaverm® for 72 hours at two doses (0.69 microliters/liter and 1.39 microliters/liter) in replicated laboratory treatments. Both doses of Supaverm® were successful at eradicating catfish without harming bonytail, humpback chub, roundtail chub, or speckled dace, but Sonora suckers were also killed by the treatment. The apparent selectivity of this chemical makes it a good candidate for further evaluation as a catfish specific toxin.

12:00-13:30 Lunch

13:30-15:45 General Session VI: Kristen Humphrey, Moderator

13:30 Species identification of members of the Genus *Gila* within the Gila River Basin: A case study of complexity

Crowder, Clayton D.^{*1}, Carter, Julie Meka¹, Leavitt, Daniel¹, Hickerson, Brian¹, Makinster, Andrew¹. (1-Arizona Game and Fish Department).

The *Gila robusta* complex, comprised of Roundtail chub, *G. robusta*, Gila chub, *G. intermedia*, and Headwater Chub, *G. nigra*, as described by Minckley and DeMarais (2000)[*Copeia* 1:251-256], have overlapping morphologic and meristic characters used to identify species. We wanted to test the accuracy of observers using the key as developed by Minckley and DeMarais (2000) to identify members of *Gila* complex to species. For this test, a panel of 10 observers with at least 10 years of experience working with the *Gila* complex in Arizona or New Mexico was convened. We compared the success rate of identification for three species of *Gila* using 89 fish collected from 15 separate sites in the Gila River Basin. We calculated a success rate of 53.4% with 244 correct identifications on 451 trials utilizing the available key. No species was perfectly identified and this pattern differed from random chance ($G = 131.98$; $p < 0.0001$). By species, *G. intermedia* was most frequently identified correctly (67.9%), *G. robusta* was the second most frequently identified correctly (62.7%), and *G. nigra* was the least frequently identified correctly (32.7%). *Gila nigra* were most commonly misidentified as *G. intermedia* (45.1%) and occasionally as *G. robusta* (22.2%). Similarly, observers identified two species at all localities and 13 of 15 localities had all three species identified. The result of our study demonstrates the challenges of accurate species identification using the recognized key, whereby one of two scenarios is true; (1) multiple species identifications from the same collection locality are accurate, and *Gila* sp. are sympatric in most cases or (2) only a single species is present at each locality and multiple species identifications result from morphologically indistinguishable *G. intermedia*, *G. nigra*, *G. robusta*.

13:45 Molecular assessment of nonnative status for Largespring Gambusia (Poeciliidae: *Gambusia geiseri*) in West Texas: Conservation value of nonnative populations

Echelle, Anthony A.^{*1}, Schwemm, Michael R.², Echelle, Alice F.¹, Turner, Thomas F.³, Wilson, Wade². (1-Department of Integrative Biology, Oklahoma State University, 2-Southwestern Native Aquatic Resources and Recovery Center, 3-Department of Biology and Museum of Southwestern Biology).

Management errors can occur when native species are incorrectly treated as non-natives. A potential example is *Gambusia geiseri*, a species considered endemic to the Comal and San Marcos rivers on the east side of the Edwards Plateau in Texas. It has been assumed that populations in the Colorado River and Rio Grande basins in Texas were introduced by humans in the 1930s. This assumption was somewhat questionable because of the paucity of early records of *Gambusia* from the region. Further, a congener, *G. speciosa*, in the Rio Grande basin is polymorphic for an apparently "foreign" mtDNA haplotype that is most similar to, but 2% divergent from, a haplotype previously reported for eastern *G. geiseri*. This suggested that Rio Grande populations of *G. geiseri* might represent a divergent, native lineage of the species. To address this, we surveyed mitochondrial (cytb) and nuclear (S7 intron 1) variation in 125 *G. geiseri* representing all of six local areas supporting the species. Collections from the Rio Grande and Colorado River were either fixed for one or another of the markers detected in the San Marcos-Comal area or they were polymorphic for one of those haplotypes and weakly divergent (*G. geiseri* and fish assemblages supporting nonnative populations of the species are discussed).

14:00 A new, natural population of an endangered fish in southern Arizona?

Duncan, Douglas K.^{*1}, Timmons, Ross², Paulus, Sheridan². (1-Desert Fishes Council, 2-Arizona Game & Fish Department).

In September 2015, we received a credible report that Gila Topminnow *Poeciliopsis occidentalis* had been seen in Parker Canyon, Santa Cruz County, Arizona. The report was made by a retired U.S. Forest Service wildlife biologist, who had seen Gila Topminnow in the wild before. Timmons and Paulus surveyed the location on 30 September and observed and captured numerous poeciliids. When processing captured fish, Timmons identified topminnow, subsequently confirmed by Paulus. Duncan and others have since confirmed that identification. Western mosquitofish *Gambusia affinis* were also present. Parker Canyon is in the San Rafael Valley, which had three naturally occurring Gila topminnow sites; Santa Cruz River, Sharp Spring, and Sheehy Spring. The San Rafael Valley is also the headwaters for the Santa Cruz River. Parker Canyon is a major drainage on the east side of the valley largely on the Coronado National Forest, and contains Parker Canyon Lake. The surveyed site is on the National Forest, and downstream of Parker Canyon Lake. Parker Canyon Lake is the likely source of the Western Mosquitofish and other nonnative fish that have historically occurred in Parker Canyon below the lake. Parker Canyon empties into the Rio Santa Cruz in Mexico, about 2.5 km south of the International Border. In June 2006, we found three stream reaches of the Rio Santa Cruz in Mexico with water and fishes. Opportunistic surveys at the upstream-most site, 13 km below the border and 10 km below the confluence with Parker Canyon, found only western mosquitofish. The second watered section was 17 km below the border and preliminary surveys here we found all size classes of Gila Topminnow, and no Western Mosquitofish. The third site was another six kilometers downstream and our preliminary surveys found all size classes of Gila Topminnow, and no Western Mosquitofish. We need to have a genetic analysis of these topminnow to determine if they are a remnant, historical population, immigrants from Mexico, or may have been transported by humans. If this is a naturally occurring population, it is an incredibly important find, and of great conservation importance. The presence of nonnative fishes, especially Western Mosquitofish, at this site is of great concern. We will further discuss our findings, conservation implications, and plans for these Gila topminnow.

14:15 Wildfire effects on genetic diversity and recolonization of Longfin Dace, *Agosia chrysogaster*

Pilger, Tyler^{*1}, Gido, Keith², Propst, David¹, Whitney, James², Turner, Thomas F.¹. (1-Museum Southwestern Biology, UNM, 2-Kansas State University).

Wildfires are important disturbance events for cold and warm-water stream biota of southwestern North America. Whereas wildfire effects on abundance and community composition are relatively well-documented, effects on genetic diversity and structure are not. From 2011 to 2013, the upper Gila River basin experienced a series of wildfires with associated ash flows that led to local extirpations of native and nonnative fishes. One species, longfin dace, *Agosia chrysogaster*, is an abundant and widespread native that exhibits a "boom-bust" ecology and a rapid colonizer, making it an ideal candidate for evaluating wildfire effects on fishes. We used genetic data collected pre-wildfire (2010), immediately following the Whitewater-Baldy Fire (2012), and 2 years post Whitewater-Baldy (2014) to evaluate changes in genetic diversity and genetic structure that resulted from extirpation/recolonization dynamics. Genetic diversity (heterozygosity and allelic richness) decreased slightly rangewide in 2012 and 2014 compared to 2010, whereas genetic differentiation (F_{ST}) increased in 2012 but 2014 values were similar to pre-fire values. Genetic effective size (N_e) decreased in 2012 but returned to pre-fire levels in 2014. Longfin dace appeared to exhibit genetic resilience to the wildfires that is likely due to recolonization from refuge sites. Disentangling the roles of dispersal and local compensatory reproduction for genetic resilience is a necessary step for managing biodiversity following large wildfires.

14:30 Stalking native fish: Movement of endangered species in an Arizona stream

Love-Chezem, Tiffany^{*1}. (1-Arizona Game and Fish Department).

Restoring native fish to throughout their historic range through stocking is a common practice in the Southwest. Although there is extensive antidotal data about fish movement after stocking there is little

information published for threatened and endangered species in Arizona or desert streams. We will focus on movement and growth of Roundtail Chub, *Gila robusta*, and Spikedace, *Media fulgida*, in the Blue River in Eastern Arizona. Chub have been stocked twice into the Blue River in 2012 and 2014, after both events fish dispersed both upstream and downstream but during the next monitoring even their range was reduced. Growth and length distribution was similar to other chub populations in the Southwest. Spikedace on the other hand have only been stocked once and have never been detected above the upper stocking location. There are a variety of factors in the Blue River that could be affecting distribution; including non-natives Channel Catfish, *Ictalurus punctatus*, Green Sunfish, *Lepomis cyanellus*, and Northern Crayfish, *Orconectes virilis*.

14:45 Fish are more secure in the California desert

Parmenter, Steve^{*1}, Hughson, Debra², Hohman, Judy³, Boyd, Casey⁴, Keeney, Sharon¹, Buckmaster, Nick, Greene, Lacey¹, Emery, Dawne¹. (1-CA Dept. of Fish and Wildlife, 2-NPS Mojave National Preserve, 3-US Fish and Wildlife Service, 4-Bureau of Land Management).

A Desert Fish Habitat Partnership-funded project increased Shoshone Pupfish, *Cyprinodon shoshone*, habitat from a 25 m² to 2400m², including 141 m of springbrook. Mohave Tui Chubs, *Siphateles bicolor mohavensis*, established in Morningstar Mine Lake (Mojave National Preserve) in 2012 have reproduced annually. Mosquitofish have been eliminated from the second-to-last habitat of Long Valley Speckled Dace, *Rhinichthys osculus* ssp, by temporary diversion of spring flow during winter. Owens Pupfish, *Cyprinodon radiosus*, are extant in five locations; no population has been lost for 12 years and none have been added since 2005. The largest pupfish population at BLM Spring has persisted for 11 years; the longest period at this location since initial establishment in 1970. Near-annual removal of largemouth bass and aquarium fishes has been necessary to maintain the record. Lahontan Cutthroat Trout, *Oncorhynchus clarki henshawi*, were salvaged from ByDay Creek as it dried up and were distributed to Silver and Wolf Creeks (Mono County). Owens Speckled Dace, *Rhinichthys osculus* ssp, distribution and life history studies have been initiated and are the subject of a separate talk.

15:00 Edgbaston Reserve (Queensland, Australia): Managing endemic species in a desert spring complex

Upton, Lara^{*1}. (1-Self).

Located in Central Queensland, Edgbaston Reserve protects the Edgbaston Spring complex. This complex comprises over 100 springs discharged from the Great Artesian Basin, one of the largest underground water reservoirs in the world covering over 1.7 million square kilometers. The springs act like isolated aquatic islands in the desert and are rarely more than five centimeters deep. The Edgbaston Complex is described as Australia's most ecologically diverse network of inland springs, and are listed as nationally endangered by the Environmental Protection and Biodiversity Conservation (EPBC) Act. Two species of fish, eleven species of snail, and one species each of crustacean, flatworm, and spider reside exclusively in Edgbaston springs. The critically endangered Red-finned Blue-eye, *Scaturiginichthys vermeilipinnis*, was first discovered in the springs in 1990. Only four populations were identified at the time, but a captive breeding program over the next five years successfully increased their population to seven springs. Listed as vulnerable, the Edgbaston Goby, *Chlamydogobius squamigenus*, has long been ecologically separated from other desert Goby species but retains common features, such as the ability to breath air when the springs dry. Populations of both species are threatened by the invasion of non-native Eastern Mosquitofish, *Gambusia holbrooki*, which spread through the flat, expansive landscape via over-land flooding. The eradication of this common threat, observed globally across native fish management, remains a holy-grail for conservation programs in Australia and the U.S. Conservation efforts have focused on three key strategies: the chemical removal of *Gambusia*, which proves difficult in the complex and marshy habitat; captive breeding of Red-finned Blue-eye, which has met with some success but requires ongoing funding and resources; and barrier fencing around *Gambusia*-free springs, which, while effective at excluding *Gambusia*, impedes natural dispersal and re-colonization. Despite the drawbacks, this hands-on management is crucial to the species' persistence. As with desert fishes in the American

Southwest, conservation requires support from land-owners and Federal and State Government legislators.

15:15 Closing Comments and Meeting Wrap-up: Kathryn Boyer, DFC President

Sunday, November 22, 2015

08:00 - 12:00 FIELD TRIPS TO BE ANNOUNCED.....

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